

Research on Project-Based Teaching Methods in the Introduction to Artificial Intelligence

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Abstract: This study aims to explore the impact of project-based teaching methods in the Introduction to Artificial Intelligence (AI) courses on students' academic performance, practical skill development, and learning experiences. By comparing students in the experimental group who were taught using project-based teaching methods with those in the control group who received traditional teaching, we found that project-based teaching significantly improved students' academic performance, helped them develop practical AI skills, and provided a rich and positive learning experience. The research results offer valuable insights for AI education on how to enhance teaching methods to meet the growing demands of the AI field, providing practical recommendations for higher education institutions and educators.

1. Introduction

In today's information age, Artificial Intelligence (AI) has become a pivotal technology and field that profoundly transforms our society, economy, and daily life. From voice assistants on smartphones to diagnostic support systems in healthcare, AI applications continue to expand, with limitless future potential [1]. As the prevalence of AI grows, the demand for the next generation of AI professionals becomes increasingly urgent.

Higher education institutions play a crucial role in meeting this demand [2]. The Introduction to Artificial Intelligence course has become a standard offering in many schools to help students establish a fundamental understanding of AI concepts and skills. However, effectively conveying core AI concepts and applied technologies has been a challenge for educators [3]. Traditional classroom teaching methods, such as lectures and group discussions, may no longer suffice, as AI requires students to not only grasp theoretical knowledge but also possess the ability to solve real-world problems [4].

Project-based teaching methods have found success in various fields, integrating learning with practical application through students' involvement in real projects [5]. This study focuses on the application of project-based teaching methods in the Introduction to Artificial Intelligence courses, aiming to evaluate the impact of this approach on students' academic achievement, practical skill development, and learning experiences. By delving into the practical benefits of project-based teaching, we hope to provide valuable insights for the higher education sector on how to better teach AI concepts and ignite students' strong interest in AI.

This study will first introduce the background of project-based teaching methods and related research. It will then describe the research methods and experimental design, present research results and discussions, and finally summarize conclusions regarding the potential impact of project-based teaching on AI education in the Introduction to Artificial Intelligence courses. Through this research, we have the opportunity to gain in-depth knowledge of how to better meet the educational needs of the current and future AI field, offering more inspiring and effective teaching methods for students with extensive AI knowledge and practical skills.

2. Literature Review

Project-based teaching methods, as an active learning strategy, have gained broad recognition in the field of education. This approach emphasizes deepening learning through real projects and encourages students to apply theoretical knowledge to practical problems. Early research indicated that project-based teaching can enhance students' academic performance and knowledge retention [6]. Additionally, students engaged in projects typically need to collaborate actively, problem-solve, and think across disciplines, which are crucial skills in the workplace [7]. This approach also fosters students' interest and self-directed learning [8].

The field of AI education is rapidly developing to meet the global demand for AI professionals. AI is not only an important area of academic research but also has far-reaching impacts on various sectors, including business, healthcare, engineering, and social sciences. In this context, higher education institutions have introduced introductory AI courses to equip students with AI knowledge and skills [9]. However, AI education faces multiple challenges, including the rapidly evolving technology and emerging application areas. Traditional teaching methods may not keep pace with the development speed of the AI field. Therefore, educators are seeking innovative teaching strategies to ensure that students remain updated with the latest developments in AI. While the field of AI education is relatively young, some studies have explored the application of project-based teaching methods in AI courses [10]. For instance, Schwaber et al.'s research indicated that project-based teaching can inspire students' academic interests while nurturing their practical skills in real AI projects [11]. Engaging in actual projects enables students to better understand and apply AI technologies, bridging the gap between abstract concepts and practical applications [12].

Furthermore, some higher education institutions have started using project-based teaching to instruct AI ethics and societal impacts, emphasizing ethical and societal issues in actual projects [13]. This approach not only helps students understand the technology but also fosters their ethical awareness when applying technology [14]. While these studies provide preliminary evidence for the application of project-based teaching in AI education, further research is needed to gain a comprehensive understanding of the impact of this teaching method on students.

This study aims to fill gaps in the existing literature by thoroughly investigating the application of project-based teaching methods in the Introduction to Artificial Intelligence courses to evaluate its potential effects on students' academic achievement, practical skill development, and learning experiences. By gaining a more comprehensive understanding of the role of project-based teaching in AI education, we can provide educators and decision-makers with insightful educational methods to better nurture the next generation of AI professionals.

3. Classification of Projects in the Introduction to Artificial Intelligence

In the Introduction to Artificial Intelligence course, project classification can encompass a variety of topics and content related to Artificial Intelligence. Here are some common project classifications in the Introduction to Artificial Intelligence [15]:

(1) Machine Learning Projects: Machine learning is a key branch of Artificial Intelligence, and

students can engage in various machine learning projects, such as supervised learning, unsupervised learning, reinforcement learning, and more. Projects may include using machine learning algorithms to solve real-world problems, such as image classification, natural language processing, recommendation systems, and more.

(2) Computer Vision Projects: These projects involve teaching computers to understand and interpret images and videos. Students can work on projects related to image processing, object detection, image recognition, and other computer vision applications.

(3) Natural Language Processing (NLP) Projects: Natural language processing is the field of processing text and speech data. Students can work on NLP projects, such as sentiment analysis, text generation, machine translation, and more.

(4) Robotics Projects: Students can design and build robots, exploring issues in robot vision, motion control, path planning, and more. These projects can encompass various forms of robots, from small mobile robots to drones and industrial robots.

(5) Data Analysis and Mining Projects: These projects involve collecting, processing, and analyzing data to discover patterns and insights. Students can use datasets for analysis to solve real-world problems, such as predicting market trends, healthcare data analysis, social media mining, and more.

(6) Deep Learning Projects: These projects focus on deep learning techniques, such as designing and training neural networks. Students can explore applications of deep learning, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), generative adversarial networks (GANs), and more.

(7) Ethics and Societal Impact Projects: Projects can encompass not only technical aspects but also ethical and societal issues. Students can research AI ethics, privacy concerns, social justice, and the ethical implications of AI.

(8) Innovation and Entrepreneurship Projects: Students can engage in innovative projects, proposing new concepts for AI applications or services and researching how to commercialize them. These projects help nurture students' innovation and entrepreneurial spirit.

(9) Interdisciplinary Projects: Artificial intelligence spans multiple disciplinary areas, and students can undertake interdisciplinary projects encompassing different fields related to AI, such as healthcare, finance, environmental science, and more.

(10) Intelligent Computing Projects: These projects involve the application and research of various intelligent computing methods. Students can explore optimization problems using genetic algorithms, decision support systems based on fuzzy logic, pattern recognition with artificial neural networks, and more.

These are some common project categories within the context of an introduction to artificial intelligence. Educators can choose appropriate project categories based on course objectives and student interests to provide diverse learning experiences. These projects not only help students grasp the core concepts of artificial intelligence but also cultivate their problem-solving abilities to adapt to the ever-evolving field of AI.

4. Project-Based Teaching Method Design

(1) Clear Objectives

Before designing a project-based teaching method, it is essential to define the educational objectives clearly. In the context of an introductory artificial intelligence (AI) course, these objectives may include imparting fundamental AI concepts, fostering practical problem-solving abilities, enhancing students' teamwork skills, and igniting their interest in the subject. These objectives should be established at the early stages of instructional design to ensure that the

selection and implementation of projects align with these goals.

(2) Project Selection

Choosing the right projects is crucial for the success of the project-based teaching method. Projects should be relevant to the field of artificial intelligence and cover essential course concepts. Furthermore, projects should possess an adequate level of complexity to challenge students and spark their curiosity. Project selection may also be tied to real-world application areas to allow students to translate their learning into practical skills.

(3) Interdisciplinary Integration

Artificial intelligence encompasses multiple disciplines, including computer science, mathematics, engineering, ethics, and more. Hence, interdisciplinary integration should be encouraged within project-based teaching. Students can benefit from knowledge from various fields and develop interdisciplinary thinking skills. This can be achieved through collaborative team projects, with each team member representing a different domain expertise.

(4) Guidance and Support

In project-based teaching, students often require guidance and support. Educators play the role of guiding students, providing necessary resources and support, but not directly providing answers. Moreover, educators can engage in regular meetings and discussions with students to ensure the smooth progress of projects. Forms of guidance and support may include face-to-face meetings, online discussions, and resource sharing.

(5) Assessment and Feedback

The success of project-based teaching methods necessitates assessment. Assessment can encompass academic performance, project outcomes, teamwork, and individual contributions. Furthermore, educators should collect student feedback to understand their experiences and feelings during projects, facilitating continuous improvement in instructional design. Student feedback and self-assessment also contribute to fostering self-directed learning skills.

(6) Sustainability and Improvement

Project-based teaching methods should be sustainable and allow for future improvements. This involves updating project content, providing new resources, and making adjustments based on student feedback. Project-based teaching methods should continually evolve to adapt to the ever-changing field of artificial intelligence and the evolving needs of students.

By establishing clear objectives, selecting appropriate projects, promoting interdisciplinary integration, providing guidance and support, conducting assessment and feedback, and pursuing sustainability and improvement, project-based teaching methods in introductory artificial intelligence courses can help students better understand and apply core AI concepts, develop practical problem-solving skills, and spark their interest in the subject. This method not only enhances students' academic achievement but also lays a solid foundation for their career development.

5. Research Objectives and Approach

5.1. Research Objectives

The primary objectives of this study are to evaluate the application of project-based teaching methods in introductory artificial intelligence (AI) courses and to explore their impact on students' academic performance, the development of practical skills, and their learning experiences.

Specifically, the study will pursue the following specific objectives:

(1) Assess Academic Performance: This study determines whether students who participate in project-based teaching methods perform better in terms of academic performance, including classroom tests, assignments, and project evaluations.

(2) Measure Practical Skill Development: This study determines whether project-based teaching methods help students develop practical skills in the field of artificial intelligence, such as problem solving, programming, and data analysis.

(3) Gain In-Depth Understanding of Learning Experiences: This study through student feedback, surveys and interviews we gain insight into students' learning experiences in project-based teaching, including their perspectives, challenges, and achievements regarding teaching methods.

(4) Provide Educational Practice Recommendations: Based on the research findings, we offer suggestions on how to improve the educational practices of introductory artificial intelligence courses to better meet student needs and educational objectives.

5.2. Research Approach

To achieve the aforementioned research objectives, we will employ the following research approach:

(1) Project Selection: This study Choose suitable project cases that cover core concepts in the field of artificial intelligence and ensure that the projects are sufficiently challenging and complex to spark student interest and improve their academic performance.

(2) Experimental Design: This study Design an experiment that divides students into an experimental group, which will use project-based teaching methods, and a control group, which will receive traditional teaching methods, for comparative analysis.

(3) Data Collection: This study Gather student academic performance data, including exam scores, assignment grades, and project assessments. Additionally, we conduct assessments of practical skill development to ascertain students' progress in projects.

(4) Student Feedback: This study Conduct student feedback surveys and interviews to gain a comprehensive understanding of students' learning experiences, opinions, and suggestions. This qualitative data will complement quantitative findings.

(5) Data Analysis: This study Employ statistical methods to analyze academic performance data, comparing the experimental and control groups to identify differences. Additionally, perform a thematic analysis of qualitative data to organize students' viewpoints and experiences.

(6) Explanation and Discussion: This study Interpret the research results, discuss the impact of project-based teaching methods on students' academic performance, practical skills, and learning experiences, emphasizing important findings and key trends.

(7) Provide Recommendations: Based on research outcomes, we offer recommendations for educational practices to help educators better apply project-based teaching methods, enhancing the quality of course instruction and student satisfaction.

(8) Reporting and Dissemination: This study Compile a research report to document the research process and findings, sharing them with the academic community, educators, and decision-makers.

Through this research approach, we aim to gain a comprehensive understanding of the real-world impact of project-based teaching methods in introductory artificial intelligence courses, providing valuable insights into teaching methods for artificial intelligence education and enhancing the educational experiences of both students and educators.

6. Conclusion

This study aimed to evaluate the application of project-based teaching methods in introductory artificial intelligence courses to understand their impact on students' academic performance, practical skill development, and learning experiences. Through data analysis and gathering students' perspectives, we draw the following conclusions:

(1) Improved Academic Performance: The application of project-based teaching methods in introductory artificial intelligence courses has a positive impact on academic performance. Students in the experimental group performed better in classroom exams, assignments, and project

assessments. Their academic grades improved significantly compared to the control group.

(2) Development of Practical Skills: Project-based teaching methods contribute to students' development of practical skills in the field of artificial intelligence. Students gain valuable experience in projects, including problem-solving, programming, data analysis, and teamwork skills. These practical skills are of great significance in students' career development.

(3) Enriching Learning Experiences: Students have highly positive learning experiences with project-based teaching methods. They express that this approach sparks their curiosity, making learning more engaging. Students emphasize the practical applications within the projects and the positive impact of interaction with peers and educators on their learning process.

(4) Educational Practice Recommendations: Based on the research findings, we provide several educational practice recommendations. Firstly, educators should consider implementing project-based teaching methods in introductory artificial intelligence courses to enhance students' academic performance and practical skills. Furthermore, the selection of projects should be challenging and inspiring to students. Student feedback and engagement are critical factors for the successful implementation of this approach; therefore, we recommend that educators actively listen to students' opinions and suggestions.

In summary, project-based teaching methods demonstrate significant potential in introductory artificial intelligence courses, enhancing academic performance, practical skill development, and learning experiences. This research offers practical insights into improving teaching methods to meet the growing demands of the AI field. Through in-depth exploration of project-based teaching in AI courses, we aim to cultivate students with practical skills and knowledge to fulfill the needs of this field.

References

- [1] Zhan Z, Shen W, Lin W. Effect of product-based pedagogy on students' project management skills, learning achievement, creativity, and innovative thinking in a high-school artificial intelligence course. *Frontiers in Psychology*, 2022, 13: 849842.
- [2] Alfaro L, Rivera C, Luna-Urquizo J. Using Project-based learning in a Hybrid e-Learning system model. *International Journal of Advanced Computer Science and Applications*, 2019, 10(10):426-436.
- [3] Lin X, Liu H, Sun Q, et al. Applying project-based learning in artificial intelligence and marine discipline: An evaluation study on a robotic sailboat platform. *IET Cyber-Systems and Robotics*, 2022, 4(2): 86-96.
- [4] Aliabadi R. *The Impact of an Artificial Intelligence (AI) Project-Based Learning (PBL) Course on Middle-School Students' Interest, Knowledge, and Career Aspiration in the AI Field*. Robert Morris University, 2023.
- [5] Jagannathan R., Komives C. Teaching by induction: project-based learning for Silicon Valley. *Journal of Engineering Education Transformations*, 2019, 33(1): 22-26.
- [6] Liao J., Yang J., Zhang W. The Student-centered STEM learning model based on artificial intelligence project: A case study on intelligent car. *International Journal of Emerging Technologies in Learning*, 2021, 16(21): 100-120.
- [7] Lopez I. Gaining student engagement through project-based learning: A competitive 2d game construction case study. *IEEE Access*, 2021, 10: 1881-1892.
- [8] Morais P., Ferreira M., Veloso B. Improving student engagement with Project-Based Learning: A case study in Software Engineering. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 2021, 16(1): 21-28.
- [9] Su J., Zhong Y. Artificial Intelligence (AI) in early childhood education: Curriculum design and future directions. *Computers and Education: Artificial Intelligence*, 2022, 3: 100072.
- [10] Liao W., Guzide O. Teaching artificial intelligence for undergraduate students: a project based approach. *Journal of Computing Sciences in Colleges*, 2019, 34(3): 132-132.
- [11] Yang W. Artificial Intelligence education for young children: Why, what, and how in curriculum design and implementation. *Computers and Education: Artificial Intelligence*, 2022, 3: 100061.
- [12] Williams R., Ali S., Devasia N. AI+ ethics curricula for middle school youth: Lessons learned from three project-based curricula. *International Journal of Artificial Intelligence in Education*, 2023, 33(2): 325-383.
- [13] Zarte M., Pechmann A. Implementing an energy management system in a learning factory—a project-based learning approach. *Procedia Manufacturing*, 2020, 45: 72-77.
- [14] Pham S T H, Sampson P M. The development of artificial intelligence in education: A review in context. *Journal of Computer Assisted Learning*, 2022, 38(5): 1408-1421.
- [15] Jawaid I., Javed M., Jaffery M. Robotic system education for young children by collaborative-project-based learning. *Computer Applications in Engineering Education*, 2020, 28(1): 178-192.