

Research and Practice on the Teaching Reform of Programming Courses Enabled by AI: --A Case Study of "Python Fundamentals and Applications"

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Abstract

This paper analyzes current issues in programming courses at applied undergraduate institutions. The issues mainly includes the outdated teaching content and lacking practical abilities, outdated teaching methods, over-reliance on artificial intelligence (AI) tools, lack of computational thinking and innovation ability, the assessment method is simplistic, etc. This article explores and proposes a set of innovative teaching reform plans in four aspects: the reconstruction of the teaching knowledge system, the teaching model, the teaching resources and tools, and the assessment and evaluation. All these are carried out under the empowerment of AI. Based on the AI assistant provided by the FanYa platform, a "comprehensive integration of classroom and extracurricular activities, combined with online and offline elements" interactive and exploratory blended teaching model is constructed. Through specific implementation methods such as project case-based teaching, hierarchical task design, and human-computer collaborative programming, and by adopting a multi-dimensional and full-process goal achievement assessment and evaluation system, the aim is to systematically enhance students' engineering practice and innovative collaboration abilities. This research provides a theoretical-depth and practically feasible reference model for the reform of programming courses in computer-related majors of applied-type universities.

Keywords

Artificial Intelligence; Python; Blended Learning; Curriculum Reform.

1. Introduction

With the explosive development of artificial intelligence and large language models, humanity has entered the era of AI. In 2017, the State Council issued the "New Generation Artificial Intelligence Development Plan", which explicitly stated that intelligent technologies should be utilized to accelerate the reform of teaching methods and talent cultivation models[1]. Higher education has witnessed unprecedented opportunities and challenges. With the rise of generative artificial intelligence technologies, such as DeepSeek, Wenxin Yiyan, and GPT, the emergence of these generative intelligent AI tools has brought new opportunities and potential for transformation to the teaching models of traditional computer programming courses. In response to the challenges faced by current computer programming courses, such as outdated and monotonous teaching content, theoretical disconnection from practice, and lack of practical innovation, in order to adapt to the rapidly changing technology and students' learning needs, this paper explores the application of AI technology to enhance the teaching innovation of computer programming courses, aiming to improve teaching effectiveness and cultivate students' innovative thinking abilities.

2. Characteristics and Current Status Analysis of Programming Courses

2.1. Course Features

Programming design courses are a public basic course offered by science and engineering majors in colleges and universities, and they are also a compulsory basic course in computer education. Programming ability is a digital skill that college students must master. The objective of such courses is to require students to acquire good programming literacy, and to be able to comprehensively apply the programming languages and programming methods they have learned to design, construct and apply computer systems to solve scientific or engineering problems.

Programming courses include C, C++, Java, Python, PHP, JavaScript, JSP, etc. Through the study of programming courses, students acquire theoretical knowledge, have computational thinking, programming skills and problem-solving abilities, and at the same time cultivate the spirit of craftsmanship, innovative consciousness, teamwork and the ability of self-directed learning..

2.2. Analysis of Current Teaching Status

At present, the programming design courses have undergone preliminary reforms in the teaching process: such as digitization of knowledge resources and stereotyping of planar resources. However, these measures cannot solve the problem of effective utilization of teaching resources, and traditional, rigid teaching methods can't adapt to the comprehensive digital transformation of teaching resources effectively. With the shifts from "teacher-centered instruction" to "student-centered learning", personalized education urgently requires the support of automated and intelligent tools. The integration of modern information technology and the teaching process still demands to be further deepened. The traditional teaching concepts and methods are no longer able to adapt to the higher requirements for programming skills training imposed by the development of new engineering industries. It is imperative to achieve the intelligent transformation of programming courses. In the teaching of programming courses, innovating the teaching methods and implementing personalized and differentiated education, how to utilize the emerging technologies of AI and big data is an important issue that urgently needs to be addressed in the teaching of programming courses.

Through literature research, and own teaching practice, there are several critical issues in the pedagogy of programming courses for computer-related majors. Firstly, in the field of programming, students show great differences in their foundation, ability and interest. Secondly, students' learning status is uneven. By using conventional methods, it is difficult to master the learning of each student.

Furthermore, some students are not strong in learning initiative, learning interest and enthusiasm are insufficient. The teaching content update failed to adapt to the rapid development of computer technology [2]. Lastly, during the learning process, many students overly rely on AI tools, lacking independent thinking and innovative consciousness, and makes it more difficult to evaluate the teaching effect[3]. In response to above problems, various scholars have tried to introduce various pedagogical reforms, such as project-based learning, personalized learning recommendation, collaborative grouping and online-offline hybrid teaching models. They have achieved some results. However, there are still shortcomings in the cultivation of students' computational thinking ability, innovation ability and personalized learning growth.

3. Reform Strategies and Model Design

In view of the above problems, this paper takes the course "Python Basics and Applications" as an example. According to the problems encountered in the teaching practice, this article

provides a teaching reform under the empowerment of AI from four aspects: knowledge reconfiguration, teaching mode, teaching resources and tools, and assessment. The reform can adapt to the developmental trends of the era of AI[4]. It also enhances the quality and efficiency of curriculum teaching. It deepens personalized talent cultivation. The course reform model of "Python Basics and Applications" is shown on Fig. 1.

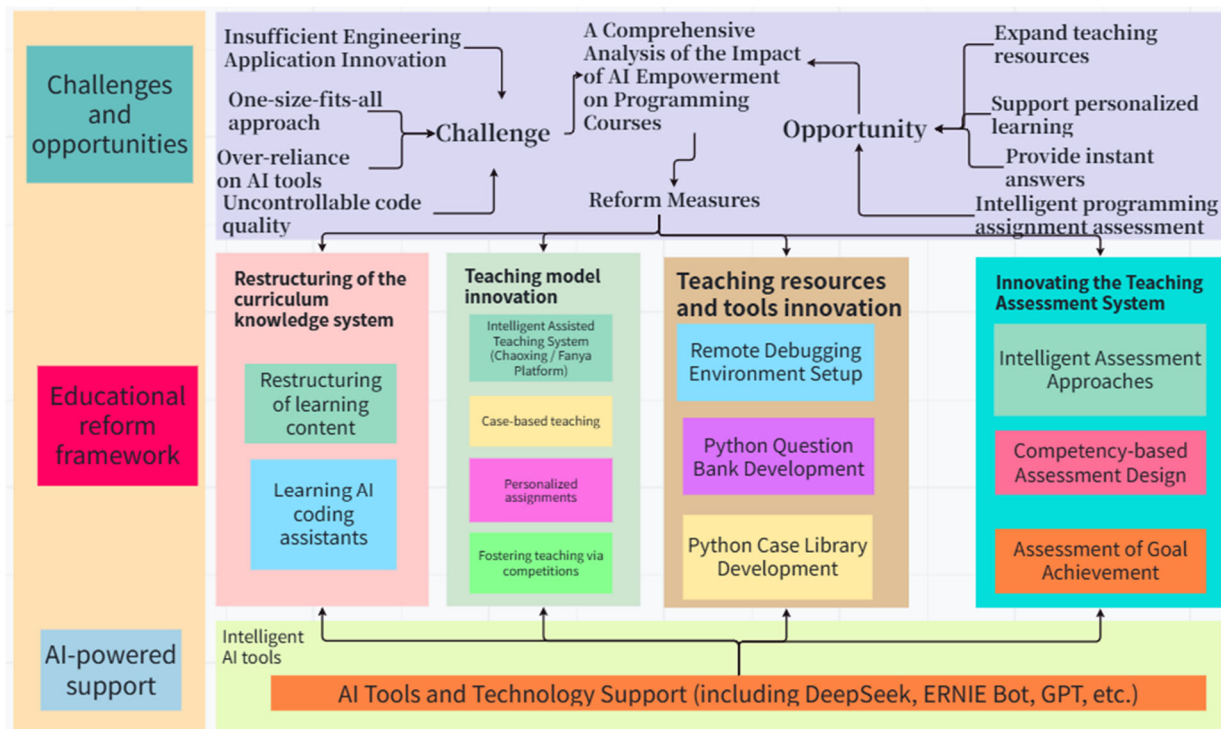


Figure 1. Architecture Diagram of the Teaching Reform Model for Programming Courses Enabled by AI

In response to the challenges encountered in the current course teaching process, this paper puts forward the following teaching reform ideas:

- (1) Following the Outcome-Based Education (OBE) philosophy, with the fundamental goal of moral education. Under the empowerment of AI tools, the new teaching mode restructures the knowledge system. It constructs course teaching cases and introduces AI programming assistants. These strategies can help students to independently learn the programming courses.
- (2) Based on students' needs, through the Fanya Platform, we design differentiated teaching activities. Personalized homework is assigned to students. Students are encouraged to participate in various competitions to improve programming abilities. This aims to facilitate students' individualized learning and growth.
- (3) With the help of the AI programming assistant on the Fanya platform, we establish a step-by-step question bank and case base for the needs of different students. It can solve the differential problem of students not enough to eat or not able to eat.
- (4) In the aspect of assessment, this paper gives full play to the advantage of large language models in code. It also carries out intelligent check and re-score of students' programming homework. By using the model to perform functional discrimination, structural analysis, and normative evaluation on the code, we can promptly provide customized feedback to students. And it also can help to achieve an integrated teaching support system of "teaching - learning - assessment".

4. Implementation Process of AI-Empowerd Programming Course Reform

To resolve the problems existing in the teaching of programming courses, it is urgent to adopt new teaching methods. The new teaching methods can stimulate students' interest in learning. They also can enhance their abilities in computational thinking, programming innovation and problem-solving. In the "Python Basics and Applications" course, by leveraging the Fanya platform and importing AI-assisted teaching tools, personalized exercise recommendations are made based on students' learning results analysis. This precisely matches students' abilities and knowledge gaps. Then they can enhance the effectiveness of personalized programming learning.

4.1. Restructuring the Curriculum Framework and Developing a Multi-level Case Library

Artificial intelligence, as a cutting-edge technology, is highly attractive. AI also has a wide range of application fields. Python, as the preferred programming language for artificial intelligence, the course teaching needs to be in line with artificial intelligence. Throughout the teaching reform, we integrate practical AI application cases into the teaching process. This reform can spark student interest and facilitate a rapid introduction to the field [5].

The Python language has a very rich set of third-party extension libraries. The third-party libraries cover almost all fields. Therefore, choosing teaching cases is particularly crucial. At the same time, it is necessary to enhance the innovative design[6]. Through the demonstration and analysis of cases, students can enhance their programming thinking and strengthen their practical ability in solving problems using Python, enabling them to experience the joy of programming. In teaching, project cases are the focus, and key knowledge points are integrated into them, ensuring that students have clear learning goals and can apply what they have learned. The case designs are shown in Table 1, see Table 1.

Table 1. Course Case Library Design

Theoretical Knowledge Category	Teaching Cases	Difficulty Level	Key Concepts
Python Basics	Drawing a Rainbow with the Turtle Library	☆	Importing and using modules
Python Basics	Outputting a Gobang (Five-in-a-Row) Board	☆☆	Flow control
Python Basics	Idiom Solitaire (Idiom Chain)	☆	Lists, tuples, sets, and dictionaries
Comprehensive Training 1	Fibonacci Sequence (Rabbit Sequence)	☆☆	Functions
	Intelligent Chatbot, Automatic Drink Vending Machine	☆☆☆☆	Functional programming mindset training, use of third-party libraries
	Human-Machine Rock-Paper-Scissors Game	☆☆☆	Classes & objects, encapsulation, inheritance, polymorphism
Common Third-Party Libraries	Appearance Task	☆☆☆	Usage of time, random, jieba, wordcloud, Pygame, Pandas, etc.
	Statistics	☆☆☆	Comprehensive application of Python syntax, OOP mindset training, program refactoring and optimization
Comprehensive Training 2	Aircraft War (Plane Wars) Game Design	☆☆☆☆☆	

4.2. Constructing a "comprehensive teaching model integrating classroom and extracurricular activities, and combining online and offline elements" with AI-driven interactive inquiry-based teaching

By integrating the online platform and AI intelligent assistance tools in the teaching process, a three-stage closed-loop teaching model of "pre-class diagnosis - in-class exploration and internalization - post-class AI-assisted reinforcement" was adopted." [7] . As shown in Fig. 2.

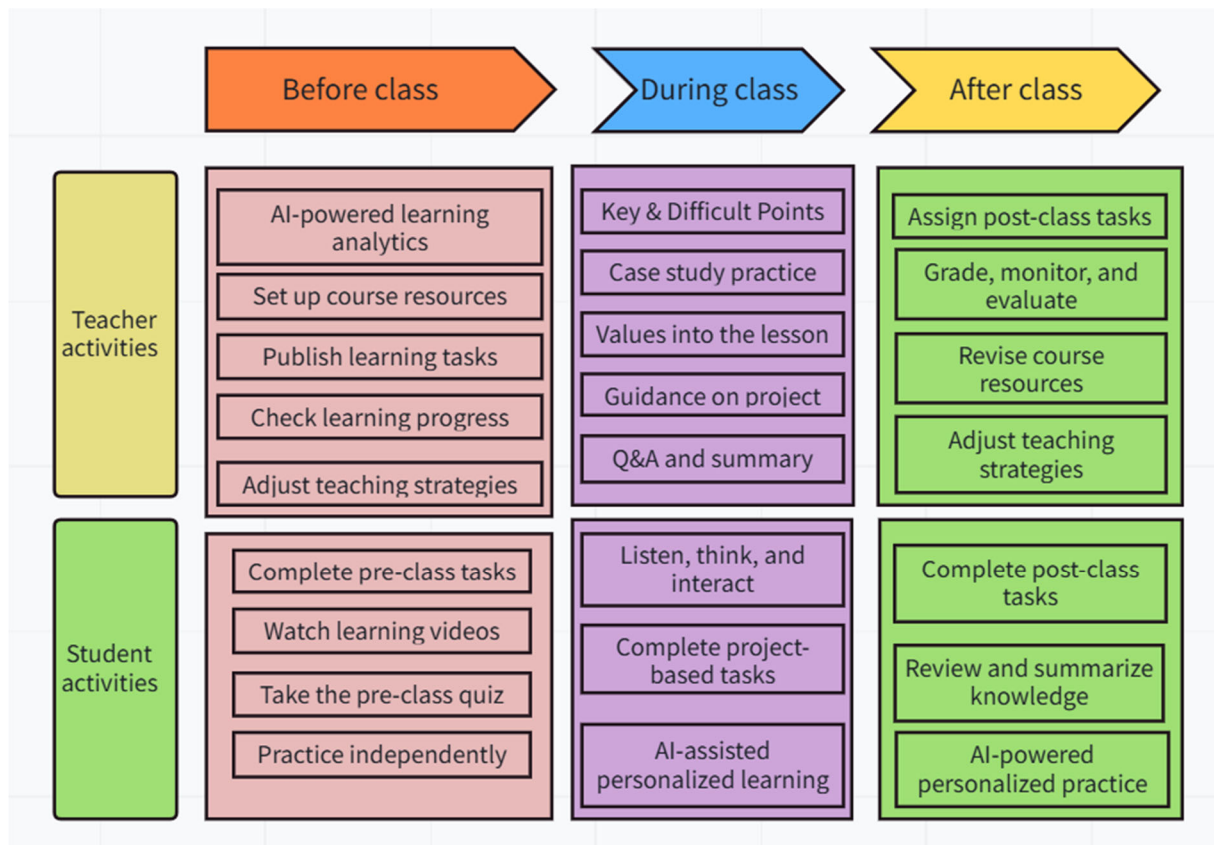


Figure 2. The teaching model design of "integrating classroom and extracurricular activities, and combining online and offline methods"

(1) Pre-class: Utilizing generative AI tools, "customized on-demand" intelligent design of teaching materials is carried out. A database of typical case resources is constructed, including explanations of core knowledge points. The knowledge is transmitted and courses are developed using the Fanya platform. At the same time, the AI learning situation analysis function in the Fanya platform is utilized to analyze students' learning data for courses. And then we update materials in a timely manner, adjust teaching methods. The new materials lay a foundation for deepening learning in the classroom.

(2) In-class: By combining teaching methods such as lecture, practice, flipped classroom and summary, through diversified classroom activities like group tasks and independent design and implementation, students can master the course content. Students also simultaneously develop their teamwork and problem-solving abilities.

(3) Post-class: The Python exercise library built based on the Fanya platform. It enables differentiated assignment push to students. Combined with in-depth evaluation reports, the AI assistant can provide many functions such as heuristic answering, heuristic knowledge learning, and code analysis. These functions enable students to receive timely solutions when

encountering problems. Thereby it improves learning efficiency and forms a "practice-feedback-optimization" closed-loop for ability improvement.

4.3. Innovating Teaching Evaluation and Assessment Models

In line with the goal of cultivating practical innovation abilities for applied talents, this research adopts the online and offline blended teaching framework based on the Outcome-Based Education (OBE). This course focuses on the actual learning outcomes, such as design works and experimental reports during the evaluation and assessment process. It also emphasizes the principle of "learning for application and application to promote learning".

The assessment system of the "Python Basics and Applications" course includes both process-based evaluation and final assessment evaluation. It adopts a multi-dimensional and all-round assessment method for the achievement of goals throughout the entire process. Emphasis is placed on process assessment, and project-based assessment is integrated to ensure that students can comprehensively master the basic knowledge and comprehensive projects. Their computational thinking ability and practical innovation ability are well exercised. The teaching quality is well guaranteed.

In the entire assessment process, four course objectives were formulated to align with the graduation requirements. The requirements regarding three aspects: engineering knowledge, problem analysis, and the use of modern tools. The specific assessment and evaluation system is shown in Table 2 below.

Table 2. Course Assessment and Evaluation System

Course Objectives	Assignments	Discussions	Class participation	Stage assessment	Final exam	Grade distribution (%)
Course Objective 1	2	3	2	3	15	25
Course Objective 2	3	2	3	2	15	25
Course Objective 3	2	3	2	3	15	25
Course Objective 4	3	2	3	2	15	25
Total	10	10	10	10	60	100

5. Effectiveness of Course Reform

With the application of AI technology, this course adopts an innovative teaching model. Before class, AI learning status analysis is used to perceive students' learning conditions, which helps with lesson preparation. During the class, AI tools assist in teaching. After class, AI is utilized to recommend personalized learning question banks and completes the evaluation of learning outcomes. These pieces of information are combined with individual learning needs to form a closed loop. This teaching reform model has changed the teaching content and schedule, meeting the individualized and differentiated learning needs of students.

In the fall semester of 2025, after implementing the teaching method in the GUST of Excellence Class, the satisfaction rate was close to 95% through the teaching satisfaction survey. The entire course resource was rich. The course's visits on the platform reached 736,837 times, the total number of activities was 80,595 times, and the total number of questions in the question bank was 741. These data indicate that through the innovation of the teaching mode for programming courses, students' learning motivation has increased significantly. Students' self-

confidence and enthusiasm for learning have been enhanced. Their learning ability has also improved.

6. Conclusion

Under the empowerment of AI technology, leveraging AI to accelerate the reform of teaching methods and the innovation of talent cultivation models have become a new research direction. Guided by Outcome-Based Education (OBE) principles, this study has introduced generative AI to innovate pedagogical approaches and invigorate heuristic teaching.

By implementing a stratified teaching strategy and leveraging the Fanya Smart Teaching Platform alongside AI support, we have constructed a diversified blended learning model that integrates in-class and extracurricular activities with online and offline resources. Additionally, an OBE-based blended teaching evaluation system has been established. These measures aim to design a programming curriculum system adapted to contemporary development, promoting the digital and intelligent transformation of education, deepening personalized talent cultivation, and providing a reference for training composite application-oriented talents in regular undergraduate universities.

In future teaching practices, we will continue to advance research on the application of AI technology, particularly in advanced areas such as personalized learning path recommendations and learning behavior analysis. Meanwhile, we will stay closely aligned with disciplinary frontiers, regularly updating elective content. With a student-centered approach, we remain committed to the continuous exploration and optimization of course reforms to steadily enhance the quality of talent cultivation.

Acknowledgements

This work is supported by the Higher Education Teaching Reform Project of Quality Engineering at Guangdong University of Science and Technology (Grant No. GKZLGC2025031).

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