

Reform and Construction of Python Courses Based on the PBLD Concept

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Abstract

With the widespread application of Python in fields such as data science, artificial intelligence, and web development, the popularity of the Python learning mode based on Project Based Learning Design (PBLD) has been on the rise, and this mode has garnered high recognition in society. This paper applies this method to the teaching course design in colleges and universities, reforming the Python programming course. The aim is to address the shortcomings of traditional teaching methods and achieve the teaching goals of cultivating students' innovation ability and improving their practical skills.

Keywords

Python; Project Based Learning Design (PBLD); Curriculum Reform.

1. Introduction to the Background of Curriculum Reform

With the continuous advancement of technologies such as artificial intelligence and big data, Python's application in these domains is becoming increasingly widespread. Consequently, numerous universities have initiated the teaching of this course [1]. However, traditional teaching methods primarily concentrate on elucidating individual knowledge points. Typically, instructors adhere to the book's order, explaining from the beginning to the end. This approach leads to students forgetting much of the preceding chapters' content while learning subsequent ones, diminishing their learning effectiveness. Additionally, when designing practical case studies, teachers often present examples solely pertinent to the current lesson's knowledge points [2]. For instance, in the chapter discussing Python syntax structure, where the primary focus is on program selection and loop structures, a common practical exercise might be printing out numbers from 1 to 10. Such cases merely assist students in comprehending specific knowledge points, but they fall short of meeting the course requirements for knowledge transfer and application. Consequently, students struggle to integrate their learning into real-world engineering projects.

In this context, this paper introduces a curriculum reform method based on PBLD, which integrates theoretical knowledge with practical application in projects, thereby enabling students to master Python programming skills more rapidly through this approach [3]. This learning method enhances students' practical abilities. By engaging in the project development process, students gain a deeper comprehension of Python syntax and library usage, while continuously reinforcing and expanding their knowledge through practical application. Additionally, during the project development, students are required to tackle and resolve various practical issues, necessitating strong problem-solving skills, including analyzing problems, devising solutions, writing code, and debugging programs. Through project-based learning, students enhance their problem-solving abilities, better aligning with the future market's skill requirements for Python professionals, thus facilitating employment.

2. Curriculum Reform Methods

In this paper, through the research on the introduction of PBLD into the teaching process, students in Colleges and universities are selected as the research object [4]. Relying on the course of Python Programming for computer major, the PBLD teaching mode is combined with the design of teaching at three time nodes before, during and after class to reform and construct the course, and combine the traditional theoretical teaching with practical operation. The reform design is mainly carried out from the following aspects.

2.1. Teaching Design Reform Page Setup

Unlike the traditional approach where the entire class is primarily taught by teachers, this design divides classroom time into three parts: pre-class design, in-class design, and post-class design, incorporating a project-based teaching method. In the pre-class design phase, we clarify project objectives and requirements, determine the necessary knowledge and skills, and identify the project topics to be introduced. For instance, when developing a simple student management system, we first establish expected project objectives, such as mastering Python basic syntax, file operations, GUI design, etc. Based on the project objectives, the pre-class design lists the Python knowledge points and skills that students need to preview. During the in-class design phase, we break down and complete the project. By decomposing the project, students gain a clear sense of purpose. The teacher explains relevant knowledge points, guides students to complete and showcase the final project results. In the post-class design phase, teachers guide students to summarize the project process and share their learning experiences. The teacher then evaluates the entire project presented by the students, highlighting key points and challenges, recommends advanced learning resources [5], helps students broaden their horizons, and encourages them to continue deepening their Python coursework.

2.2. Reform of Teaching Activities

This design adopts a student-led project-based teaching approach, supplemented by classroom instruction from teachers, emphasizing students' understanding and practical application of knowledge. Before the course begins, preview materials and directions are provided, such as preparing relevant Python basic tutorials, videos, or documents for students to preview; sharing tutorials on the use of project-related libraries and tools, like the use of the Turtle library; and designing preview quizzes to ensure students are prepared for the upcoming content. During the class, the key Python knowledge points involved in the project are explained in stages. Firstly, a brief review of the previous knowledge that will be used in the project is conducted. Then, for new knowledge points such as variable types, control flow, function definitions, etc., code demonstrations and real-time programming practice are carried out in combination with the actual needs of the project. In this process, students are grouped to collaboratively complete the project implementation, with each group assigned different task modules, such as function implementation, querying, modification, testing, etc. Teachers provide guidance and assistance during the students' programming process. After the project is completed, each group presents their results and shares programming experiences and encountered problems. Teachers provide comments, and groups evaluate each other, suggesting improvements. After class, teachers ask students to continue refining their respective project modules and encourage them to explore more functional implementations and code optimization methods. In terms of assignments, diversified tasks are assigned, such as writing project documentation, test reports, etc., to exercise students' communication and expression skills. More challenging projects are provided as optional assignments to encourage students to extend their learning and take on challenges.

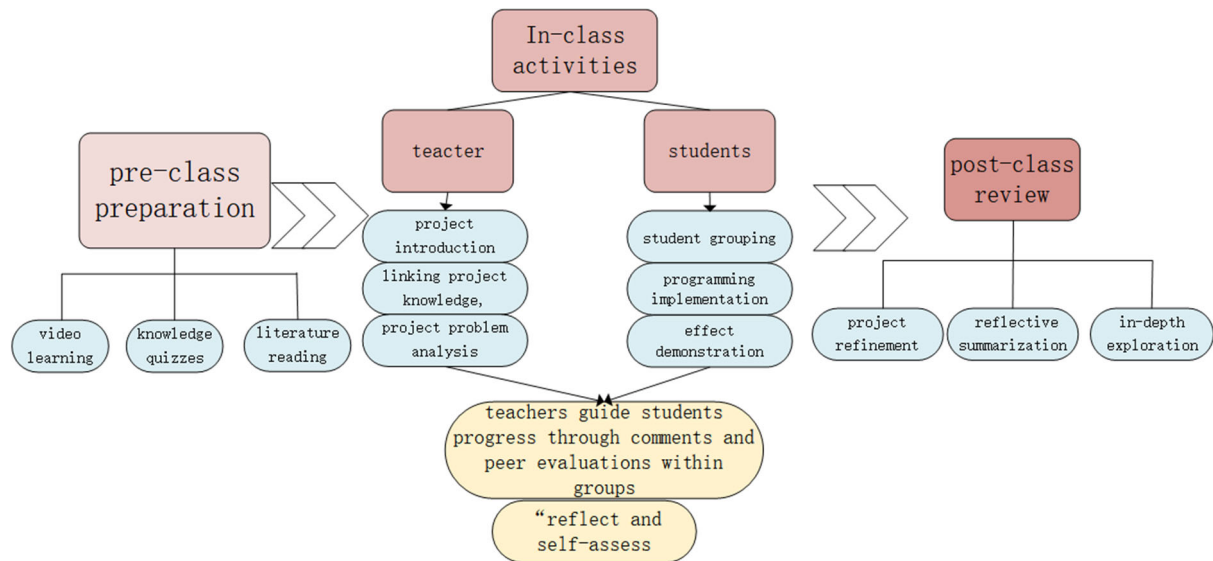


Figure 1. Flowchart of Instructional Activity Design

2.3. Reform of Testing and Evaluation

Implement diversified evaluation methods, including assignments, projects, tests, competitions, and other forms, to comprehensively assess students' programming abilities and overall qualities. The reformed curriculum places greater emphasis on process evaluation, focusing on students' programming processes, thinking processes, and innovative processes.

2.4. Example of Specific Course Design

The specific design of project introduction in the chapters of "Python Programming" is as follows. Firstly, this paper divides the course into eight chapters and then selects appropriate projects for each chapter to carry out teaching, as shown in the table below.

Table 1. Curriculum Chapter Design

Chapter	1	2	3	4	5	6	7	8
Translation Theme	Basics of Python	Flow Control	Strings	Composite Data Types	Functions	Files and Data Formatting	Object-Oriented Programming	Exception Handling
Project	Design and Implementation of Body Mass Index Calculator	Design and Implementation of a Mortgage Calculator	Design and Implementation of Sensitive Word Replacement	Design and Implementation of a Mobile Phone Address Book System	Design and Implementation of a Student Management System	Design and Implementation of a User Account Management System	Design and Implementation of a Bank Management System	Design and Implementation of a Product Detection Feature

This article mainly takes the first two chapters of the course as examples to elaborate on. Each chapter includes four stages: importing items, pre-class design (project preparation), in class design (project implementation), and post class design (project summary).

2.4.1. Chapter 1: Fundamentals of Python

Project: Design and Implementation of Body Mass Index (BMI) Measurement.

Pre-class Design (Project Preparation): The teacher introduces the project function: measuring BMI. The formula for BMI is $BMI = \text{weight (kg)} / \text{height}^2 \text{ (m)}$, enabling users (students) to input their height to calculate their BMI.

In-class Design (Project Implementation): The teacher explains key concepts: types and differences of identifiers, variables, and data types. Analysis of project functionality: Guiding students to draw a project flowchart, identifying the required data types for input, methods of

input (keyboard input or variable definition), basic arithmetic operations, selection of print output methods, use of print output functions, and data type conversion during the process. Students are grouped based on project functions to complete tasks and comment on each small functional code. Repeated Content for Emphasis: (Note: This section repeats content for clarity in an academic context) The teacher re-explains the concepts and leads students through the analysis, input methods, operations, print functions, data type conversions, grouping, and code commenting as detailed above.

Post-class Design (Project Summarization): Students are required to review the knowledge points used in the project, summarize which functions in the practical case can be optimized, and how to optimize them.

2.4.2. Chapter 2: Flow Control

Project: Design and Implementation of a Mortgage Calculator.

Pre-class Design (Project Preparation): The teacher introduces the project function: an online calculator that calculates monthly mortgage payments (yuan), total repayment amount (yuan), interest paid (yuan), etc., based on user-selected loan type (commercial loan, public fund loan, combined loan), loan amount (ten thousand yuan), term (years), and interest rate (%). Relevant materials are posted on the learning platform.

In-class Design (Project Implementation): The teacher reviews prerequisite knowledge: data types and usage, data input and output. Introduction of new knowledge points: The teacher analysis the project flow, such as user selection of loan type, leading to the use of selection structures. After selecting the loan method, formula calculations are introduced, involving decreasing interest per year/month and the use of loop structures. Types and syntax structures of loop structures, and how to end a function within a loop (introducing break and continue statements) are explained. During the explanation, the teacher guides students to contemplate the distinctions between these two methods of exiting the loop. Students are encouraged to program, employing various approaches, inputting identical data, observing the outcomes, and conducting analysis. The teacher introduces one or more knowledge points after each functional analysis of the project and reviews previously learned points. Finally, the teacher decomposes the project, assigns tasks to students, and guides them to integrate functions and knowledge points to complete the full functionality.

Post-class Design (Project Summarization): Assignments of a similar type are given to students to summarize the knowledge used in the project and consider how to apply it in other contexts. The reformed curriculum employs project-based learning (PBL) [6] to drive the learning process, where students are grouped by teachers to collaboratively complete an entire project. This comprehensive process encompasses project requirement analysis, functional design, coding implementation, and data input testing, all independently handled by students. Prior to class, teachers utilize relevant tools, such as the Learning Tong online platform, to provide basic project information, including project background and functional requirements, and to publish supplementary materials. Students can preview these materials through the platform beforehand. During class, the teacher introduces the project, breaks it down into smaller tasks, explains the project structure, and the knowledge required for each task, thereby elaborating on key concepts. The teacher then guides students to analyze, think critically, and practice completing the individual tasks. Finally, students are instructed to integrate all the tasks into the overall project. Throughout this process, teachers must promptly respond to student feedback to ensure that students learn and master Python programming skills through practice. Through project-based practice, students can apply their theoretical knowledge of Python to real-world scenarios, thereby deepening their understanding and mastery of the key concepts.

3. Literature References Expected Outcomes of the PBLD Teaching

3.1. Enhancement of Students' Practical Abilities

During the project development process, students are confronted with various practical issues, which they must resolve through coding, debugging, and other means. This experience contributes to the improvement of their practical abilities and serves as invaluable practical knowledge for their career development.

3.2. Improvement of Students' Problem-Solving Skills

The development process presents a multitude of challenges and problems, necessitating the application of students' acquired Python knowledge and skills to analyze and resolve these issues. By consistently encountering and addressing problems, students' problem-solving skills undergo significant enhancement, which is highly beneficial for navigating complex situations in their future work environments.

3.3. Enhancement of Students' Team Collaboration Abilities

Project development necessitates collaboration with team members to collectively complete project tasks. This requires students to possess good teamwork and communication skills, enabling effective interaction and cooperation with others. Through project-based learning, students can hone their teamwork and communication skills, which are crucial for their future development in the workplace.

4. Comparison between PBLD Teaching Method and Traditional Course Teaching

4.1. Enhancement of Students' Practical Abilities

In traditional teaching methods, the teacher serves as the primary agent, with students typically in a passive role, acquiring knowledge through memorization and imitation to grasp key concepts. Conversely, project-based learning (PBL) fully respects the student's status as the main subject of learning. The teacher is no longer the sole conveyor of knowledge but rather a guide and supporter for student learning. Students become the central figures in the learning process, required to actively engage in problem-solving and teamwork. This model encourages students to actively participate in the design and implementation of projects, acquiring knowledge through autonomous and collaborative learning.

4.2. Enhancement of Students' Practical Abilities

Differences in Emphasis: Traditional teaching methods primarily focus on the explanation of theoretical knowledge, with minimal involvement in practical applications. Project-introduction-based learning emphasizes practice, allowing students to acquire knowledge and skills through hands-on operations while completing projects, thereby enhancing their practical abilities. This model is more comprehensive and innovative, encouraging students to propose new ideas and solutions, integrate knowledge from other disciplines to solve problems, and cultivate students' innovative and comprehensive practical abilities.

5. Summary

This paper employs the PBLD (Project-Based Learning and Development) teaching method, integrating curriculum design across pre-class, in-class, and post-class phases to systematically assist students in mastering Python programming skills and cultivating their ability to solve practical problems. It achieves truly effective integration of theory and practice in teaching, making this approach more suitable for university students' learning. In the future, I will

continue to conduct in-depth research on the impact of this method on students during the teaching process and further optimize and reform the design method to achieve better teaching outcomes.

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