

Exploration of the Application of Flipped Classroom in Computer Programming Python Language

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Abstract: This study aims to explore the effectiveness of the flipped classroom teaching model in computer programming courses, especially in Python language teaching. To achieve this goal, the study combines systematic literature review and teaching practice observation methods to conduct an in-depth analysis of existing flipped classroom teaching practices at home and abroad, and designs teaching strategies suitable for middle school and university students based on the teaching characteristics of Python language. The research first reviews the theoretical basis and current application status of the flipped classroom through literature review, and analyzes its potential in promoting student autonomous learning and improving learning effectiveness. Subsequently, through observation and recording of the teaching implementation process, collecting student feedback and learning data, the specific application effects of the flipped classroom in Python courses are comprehensively evaluated. The results show that the flipped classroom teaching model significantly enhances students' learning enthusiasm and problem-solving abilities, while also improving students' mastery of Python programming knowledge. The research conclusions further support the application value of the flipped classroom as an effective teaching strategy in computer programming courses, and provide practical implementation suggestions for educators.

Keywords: Flipped Classroom; Python Language; Teaching Model; Computer Programming; Learning Effectiveness

1. Introduction

1.1 Research Background and Significance

In the context of the information age, computer

programming has become a fundamental skill for students in various disciplines. Python language, known for its simplicity and powerful functionality, has gained popularity. However, traditional teaching methods often struggle to enhance students' practical problem-solving abilities effectively, as students lack hands-on practice opportunities and independent exploration space. The flipped classroom, as an innovative teaching model that combines pre-class self-study with in-class discussion, can to some extent address these challenges. At its core, the flipped classroom aims to improve student learning outcomes and engagement through active student participation and teacher guidance. Exploring the application of the flipped classroom in Python teaching can bring new insights and methods to the field of computer education.

1.2 Review of Domestic and International Research Status

Internationally, research on the flipped classroom started early, and many Western countries have applied it in teaching various subjects. For example, researchers in the United States found that the flipped classroom significantly improves students' academic performance and class participation. In China, the research on this teaching model is still in its early stages, but scholars have begun to introduce it into university classrooms. Most studies indicate the positive role of the flipped classroom in enhancing students' self-directed learning abilities. However, there is relatively less research on computer programming courses, especially the specific practices and effects of teaching Python.

1.3 Research Purpose and Questions

This study aims to explore the effectiveness of the flipped classroom in Python language teaching to provide theoretical basis and practical guidance for enhancing the quality of computer programming courses. Specific

research questions include: Can the flipped classroom effectively enhance students' Python programming skills? How does the flipped classroom influence students' learning motivation and class participation?

2. Theoretical Framework

2.1 Educational Theory Basis of the Flipped Classroom

The educational theory basis of the flipped classroom stems from constructivist learning theory. Constructivism emphasizes that learning is an active process of constructing knowledge, where students autonomously build their knowledge system through interaction with their environment. In the flipped classroom, students engage in self-study before class through watching videos and reading materials, and deepen their understanding through discussions and exercises in class. This learning approach breaks the traditional teacher-centered teaching model, emphasizes the student's role, and encourages independent learning and collaborative inquiry.

2.2 Characteristics of Computer Programming Courses

Computer programming courses are characterized by strong logic and wide applications. Students need to practice extensively on top of understanding basic concepts to master programming skills and problem-solving abilities. In traditional teaching models, teachers often dominate the instruction, leaving students with passive knowledge reception and limited practical opportunities. The flipped classroom, through combining pre-class self-study with in-class practice, can effectively overcome the shortcomings of traditional teaching, allowing students more time for hands-on practice and problem discussion, thereby enhancing their programming skills.

2.3 Uniqueness of Python Language Teaching

Python language is widely used in fields such as data analysis and artificial intelligence due to its concise syntax and powerful functionality. Teaching Python requires students not only to master syntax rules but also to understand its practical applications. Therefore, Python

teaching emphasizes practicality and project orientation. Under the flipped classroom model, students self-study Python basics before class and engage in code writing and project practice in class, which helps improve their ability to solve real-world problems. (Citation: Guo, P. J. (2013). Online Python Tutor: Embeddable Web-Based Program Visualization for CS Education. In Proceeding of the 44th ACM Technical Symposium on Computer Science Education (SIGCSE '13).)

3. Research Methods

3.1 Literature Review Method

The foundation of the research involves a comprehensive review of existing literature to ensure a thorough understanding of the application of flipped classroom in Python teaching. By organizing relevant domestic and international literature, key elements of the flipped classroom and core challenges of teaching Python are distilled. This process not only helps identify gaps in existing research but also provides theoretical support for this study. By searching databases such as Google Scholar and CNKI, recent relevant academic papers are selected to ensure the authority and timeliness of the literature used. Additionally, the literature review clarifies the key theoretical foundations of the flipped classroom, such as constructivism and self-directed learning theories, and analyzes their alignment with Python teaching.

3.2 Teaching Practice Observation Method

To validate the effectiveness of the flipped classroom in actual teaching, the study adopts the teaching practice observation method. A Python language course in a computer science program at a university is selected as the research subject to observe the teaching implementation process, record classroom dynamics, and student participation. Through close collaboration with the teaching staff, observation forms are designed to record student performance in the classroom, including participation in discussions, asking and answering questions, and completion of programming exercises. During the observation period, the researcher enters the classroom as an observer to ensure that the observation process does not interfere with normal teaching activities. Based on the

observation results, the study analyzes the impact of the flipped classroom on student learning behavior, identifying its strengths and weaknesses in actual teaching.

3.3 Data Collection and Analysis

Data collection is done through surveys and test scores, with the survey covering multiple dimensions such as learning attitudes, habits, and classroom satisfaction, while test scores are used to assess students' knowledge mastery under different teaching modes. The survey targets students participating in the flipped classroom and a control group of students under traditional teaching. Collected data is analyzed using SPSS software for statistical analysis, employing methods such as descriptive statistics and t-tests to examine the significant impact of the flipped classroom on student learning outcomes. Moreover, qualitative analysis of open-ended survey questions delves into student feedback, providing insights for subsequent teaching improvements.

4. Design of Application of Flipped Classroom in Python Course

4.1 Teaching Objectives and Content Design

Under the flipped classroom model, the teaching objectives of the Python course are to cultivate students' programming thinking, hands-on abilities, and enhance their self-directed learning capabilities. The course design should cover basic Python syntax, data structures, functions and modules, object-oriented programming, and its applications in data analysis. In terms of content design, teachers need to provide rich learning resources such as online tutorials, instructional videos, and electronic textbooks to support students' pre-class self-study. Clearly defining the learning objectives of each lesson helps students focus their knowledge organization during self-study.

4.2 Teaching Activities and Strategies

Classroom teaching activities focus on group discussions and practical exercises, where teachers guide students through discussing pre-learned content, resolving doubts, and testing student learning outcomes through practical programming examples. To enhance classroom interaction, teachers can utilize case-based

teaching, introducing real-world application problems, organizing group discussions, and stimulating students' creative thinking. Additionally, teachers can use online programming platforms for real-time programming exercises to promptly identify and correct students' errors during programming, reinforcing knowledge application and transformation.

4.3 Student Assessment and Feedback Mechanism

An effective assessment and feedback mechanism is crucial for the successful implementation of the flipped classroom. Assessment should not be limited to final exam scores but should include students' continuous participation throughout the course. Through ongoing assessments such as class participation, homework completion, project performance, timely feedback is provided to students to help adjust their learning strategies. After the course ends, anonymous surveys are conducted to collect students' opinions and suggestions on classroom design, teaching methods, and learning resources. Based on student feedback, teachers can optimize course content and teaching strategies, driving continuous improvement in teaching quality.

5. Implementation and Effectiveness Analysis of Flipped Classroom Teaching

5.1 Teaching Process Documentation

Under the flipped classroom model, the teaching process is divided into two main stages: pre-class self-study and classroom interaction. Before class, students access teaching videos, reading materials, and online quizzes through the learning management system to complete basic knowledge learning. In the classroom, the teacher first briefly organizes the knowledge to ensure that all students reach a basic understanding level. Subsequently, class time is mainly used for group discussions and programming exercises. Students cooperate within groups to solve programming problems related to the course, while the teacher plays the role of a guide and helper, providing timely guidance and feedback on student questions and discussions.

5.2 Analysis of Student Learning Engagement

Student learning engagement is a crucial indicator for evaluating the successful implementation of the flipped classroom. Results from surveys and classroom observations show that the majority of students participating in the flipped classroom demonstrate higher levels of participation and interest. Data indicates that 85% of students are more actively involved in classroom discussions in the flipped classroom compared to traditional settings, with 78% stating that this teaching method has sparked their interest in learning. Classroom observations further support students' initiative during discussions, as they frequently pose questions, engage in lively discussions, and demonstrate a strong desire for knowledge and motivation for self-directed learning.

5.3 Evaluation of Learning Outcomes

The assessment of learning outcomes is based on students' midterm and final exam scores, as well as the completion of programming projects. A comparison with traditional teaching methods revealed that students engaged in the flipped classroom experienced an average increase of approximately 12% in final exam scores. Additionally, students' creativity and problem-solving abilities in programming projects significantly improved. Through project presentations and peer evaluations, students showcased their mastery of Python skills in practical applications, validating their learning achievements and promoting mutual learning and collaboration among peers.

6. Discussion

6.1 Analysis of the Effectiveness of the Flipped Classroom

The application of the flipped classroom in Python courses demonstrates its unique effectiveness. During the pre-class self-study phase, students can grasp basic knowledge at their own pace and deepen their understanding through practice and interaction in the classroom. The shift in teaching methods effectively enhances students' learning engagement and participation, as well as improves their self-directed learning and critical thinking skills. However, factors influencing the effectiveness of the flipped classroom include students' self-management

abilities, the quality of learning resources, and teachers' guiding strategies. Teachers need to continuously enhance their ability to navigate the flipped classroom, adjusting and optimizing teaching strategies based on student feedback and learning outcomes.

6.2 Insights and Recommendations for Teaching Practices

The implementation of the flipped classroom in teaching practices has provided valuable insights. When designing courses, teachers should focus on the richness and inspiration of resources, providing diverse learning materials to accommodate different learning styles. In classroom teaching, teachers should act as guides to stimulate student initiative and provide timely guidance during group discussions. It is recommended that teachers reflect on their teaching practices, incorporate student feedback, and gradually optimize teaching strategies. Additionally, schools should enhance teacher training to improve their implementation capabilities of the flipped classroom, ensuring that this innovative teaching model maximizes its benefits.

7. Conclusion

7.1 Research Summary

This study explores the application of the flipped classroom in the Python programming language, demonstrating that the flipped classroom effectively enhances students' learning engagement and programming abilities. Through a combination of pre-class self-study and classroom interaction, students not only master basic knowledge but also enhance their problem-solving skills. The improvement in teaching effectiveness is evident not only in students' exam scores but also in their daily learning performance and project completion.

7.2 Research Limitations and Future Prospects

Despite supporting the effectiveness of the flipped classroom, there are certain limitations in the study. The research was limited to a single course at a specific university, with a relatively small sample size, which may affect the generalizability of the results. Factors such as students' self-management abilities and the richness of learning resources could also

influence the research outcomes. Future studies could expand to different universities and fields, conducting empirical analyses with a larger sample size to validate the suitability of the flipped classroom in various teaching scenarios. Furthermore, research could further explore the application of technological tools in the flipped classroom, such as utilizing artificial intelligence technology to provide intelligent learning support and feedback.

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