Analysis of the Teaching Effectiveness
of the Flipped Classroom Model with Python

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Abstract. This paper mainly explores the teaching effectiveness of the flipped classroom model in the college English listening teaching. Ninety subjects from Xi'an Mingde Institute of Technology were organized into two experiment groups and one control group so as to show a contrast between the traditional listening teaching model and the flipped classroom model. After one-year experiment, a comprehensive analysis of the evaluation of different groups is conducted by scientific computing with Python. The research results prove that the effects of the flipped classroom model on the English listening are positive.

Keywords: the Flipped Classroom model · teaching effectiveness · College English Listening Teaching · Python

1 Introduction

With the recent advances in education, there have been significant changes in the teaching ideas and methods of English listening. One of the goals of college English courses is to cultivate students' ability to actively expand and utilize learning resources, acquire information through multiple channels, and use information to express themselves systematically. The use of modern educational technology in college English listening teaching is an important way to achieve these goals. How to use modern educational technology to cultivate students' autonomy in the listening process is always the center of attention. Then the flipped classroom model comes into being and rises to the challenge. Based on this, this study is designed to analyze the teaching effectiveness of the flipped classroom model in college English listening teaching with Python.

2 The Flippled Classroom

The flipped classroom, also known as the inverted classroom or reverse classroom, refers to the readjustment of the time inside and outside of the classroom and the transfer of the decision-making power of learning from teachers to students [1]. The flipped classroom model highlights internalizing knowledge within the classroom and learning knowledge outside of the classroom [2]. In this teaching model, students autonomously

learn knowledge before class with the help of modern educational technology, such as video lectures, micro-courses, online materials, etc., and complete relevant learning tasks and exercises assigned by the teacher. They plan what to learn and they can learn at their own pace, which promotes their personalized learning, thus achieving better teaching results [3].

As early as April 2000, J. Wesley Baker constructed the flipped classroom teaching model in a paper presented at the 11th International Conference on University Teaching [4]. It was not until 2007 that two chemistry teachers, Jonathan Bergmann and Aaron Sams, from a high school in Colorado, USA, began using video software to record PPT and uploading videos of their lectures and PPT online to help absent students with their lessons. Soon they made a more innovative attempt, gradually based on the students who watched videos and listened to lectures at home, teachers mainly provided guidance for students who had encountered difficulties in learning in the classroom, and promoted this mode to be widely used in primary and secondary education in the United States [5]. With the development and popularization of the Internet, this new teaching mode gradually became popular worldwide and received widespread attention and application.

3 An Empirical Study of the Effectiveness of the Flipped Classroom Model

3.1 Research Questions

The main research questions of this empirical study are as follows.

1. What is the attitude of students towards the flipped classroom model? In comparison with traditional listening teaching, which teaching mode do students prefer?
2. What is the effectiveness of English listening teaching in the flipped classroom model? Does students' academic performance in English listening improve under the flipped classroom model?

3.2 Research Subjects

The study involved a total of 90 freshmen majoring in English from three classes. The number of students (N is short for number of students in the following tables) in each class was 30, and there were no significant differences in the English listening proficiency of the students before the experiment. Class 1 and Class 2 were chosen as experimental groups, while Class 3 served as the control group. The entire experiment lasted for one academic year, starting in September 2021 and ending in June 2022. In an attempt to compare the traditional listening teaching mode and the flipped classroom model, the students in Class 1 was taught in the flipped classroom for one year. The students in Class 2 were taught in the traditional listening teaching mode in the first semester and transferred to the flipped classroom model in the second semester. The students in Class 3 received one year of traditional listening instruction.

3.3   Research Methods

Considering the research purpose and questions, two research methods were primarily employed: questionnaire and testing. The questionnaire method aimed to investigate students' attitudes and acceptance of the flipped classroom model in English listening. The effectiveness of the flipped classroom model was assessed by comparing the final listening test scores of the 3 classes across two semesters. The software Python was used to analyze the test results.

3.4   Research Design

A. **Pre-Experiment Phase**

Before the experiment, all the students in the three classes took an English listening proficiency test. According to the data shown in the Table 1 and Fig. 1, there were no significant differences in the listening scores of Class 1, Class 2 and Class 3.

B. **Experiment Phase**

Based on the situation of students in private universities, the main teaching objective of English listening is to help students gradually acquire basic language knowledge through systematic listening training, master essential listening skills, and cultivate their ability to express themselves through oral activities [6]. This aims to establish a solid foundation in listening and speaking for the development of students' comprehensive English communication skills. Therefore, based on the teaching goals

Table 1. Group Statistics of Pre-Test

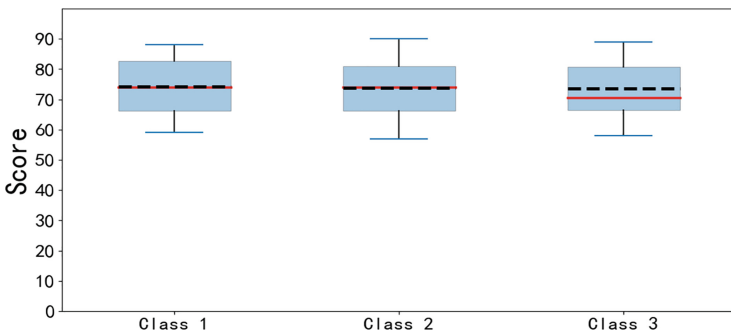| Class	N	Mean	Std. Deviation	Std. Error Mean
ScoreClass 1	30	74.233	8.936	1.631
Class 2	30	73.90	8.945	1.633
Class 3	30	73.567	8.856	1.617

Fig. 1. Distribution of Pre-Test Scores

of the listening course, the flipped classroom model was adopted in the experimental groups, while the traditional listening teaching mode was employed in the control group. The total class hours for one semester were 64, with 4 h per week.

C. **Post-Experiment Phase**

In order to ensure the reliability and validity of the research data, the test content and test tasks and item types of the final listening exams in both the first and second semesters were the same with similar levels of difficulty. The flipped classroom was only adopted in Class 1 in the first semester, while the traditional listening teaching mode was employed in Class 2 and Class 3. After the first semester's listening final exams, the researcher compared the listening scores among students from Classes 1, 2 and 3 using the software Python.

In the second semester, Class 1 continued with the flipped classroom model, while Class 2 shifted from the traditional mode to the flipped classroom. Class 3 continued with the traditional listening teaching mode. Therefore, at the end of the second semester, the researcher conducted questionnaires for the students in Class 1 with a major focus on the students' attitudes and acceptance of the flipped classroom model. The researcher also conducted questionnaires for the students in Class 2, mainly investigating their ideas about the differences between the traditional mode and the flipped classroom model, as well as their preference for the traditional listening teaching mode or the flipped classroom model. Furthermore, after the second semester's listening final exams, the researcher conducted a detailed comparative analysis of the listening scores among students from Class 1, Class 2 and Class 3 with Python. This included comparing the listening scores of each class between the first and second semesters, as well as comparing the listening scores of all three classes in the two semesters.

3.5   Research Results and Analysis

In this part, Numpy and Matplotlib are used to analyze the results. Numpy is the fundamental package for scientific computing with Python, which offers comprehensive mathematical functions, random number generators, linear algebra routines, Fourier transforms and other numerical computing modules. Matplotlib is a library for creating static, animated, and interactive visualizations in Python. A comprehensive statistical analysis of the test performance of the sample group (Class 1, Class 2 and Class 3) is presented as follows. The main focus of discussion is on the respective test results of three classes and the differences among three classes through a series of Tables 2 and 3, Figs. 2, 3, 4 and 5.

Table 2. Group Statistics of the Listening Test after the First Semester

Class	N	Mean	Std. Deviation	Std. Error Mean
Score Class 1	30	80.767	6.173	1.127
Class 2	30	72.767	8.628	1.575
Class 3	30	72.633	9.250	1.689

Based on Table 2 and Fig. 2, it is evident that the application of the flipped classroom in the experimental group, namely Class 1, leads to the result that the mean score of Class 1 (80.767) is significantly higher than the means scores of Class 2 (72.767) and Class 3 (72.633) at the end of the first semester. Also, it can be found that there is a minor difference in the test scores of Class 2 and Class 3 under the traditional listening mode. Furthermore, the standard deviation of experimental group, Class 1 (6.173) is smaller than that of experimental group, Class 2 (8.628) and control group, Class 3 (9.250). The standard error mean of the experimental group (Class 1) is 1.127, which is smaller than the standard error mean of Class 2 (1.575) and that of Class 3 (1.689). The differences in the listening scores of students in Class 1 are smaller than the differences in the listening scores of the students in Class 2 and Class 3, which indicates that the differences in the test performance of the students in Class 1 are narrowing after the application of the flipped classroom in the English listening teaching. Figure 3 is the scatter plot which shows the improvement in listening test scores after the first semester compared with the students' test scores before the experiment. The x-axis marks the extent to which students have improved their listening test performance, and y-axis tracks students' listening test performance at the end of the first semester. The color of the dots shows the students' listening scores before the experiment. According to the Fig. 3, it is concluded that students in Class 1 have improved their listening scores by a large margin, while students in Classes 2 and 3 have improved their listening scores by a small margin. Moreover, it suggests that the self-regulated learning and cooperative learning emphasized by the flipped classroom makes for achieving positive learning outcomes [7].

According to Table 3 and Fig. 4, it can be found that the listening test results of all the three classes at the end of the second semester have improved compared with the test results in the first semester. Specifically, it is evident that the experimental group (Class 1), which has adopted the flipped classroom approach for the whole academic year, achieves the highest test scores among the three classes. Compared with the first semester, the experimental group (Class 2), which has adopted the flipped classroom starting from the second semester, has a greater improvement in the listening test perfor-mance than the control group (Class 3) under the traditional teaching mode for the whole academic year. Furthermore, it is shown that the standard deviation of Class 1 in the sec-ond semester remains relatively steady compared to the first semester, while after the
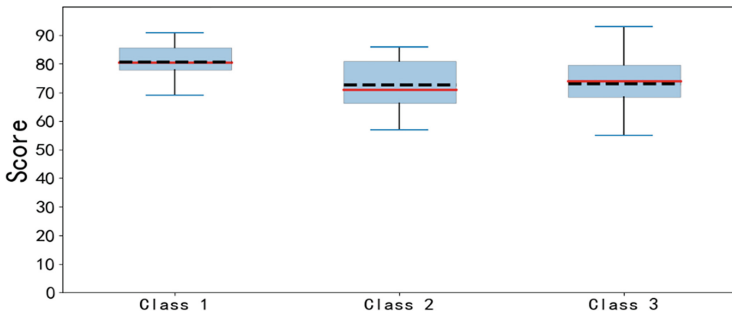

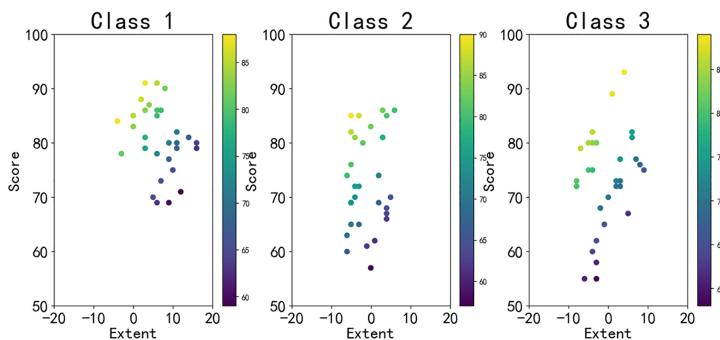**Fig. 2.** Distribution of the Listening Test Scores after the First Semester

Fig. 3. Scatter plot of the Improvement in Listening Test Scores after the First Semester

Table 3. Group Statistics of the Listening Test after the Second Semester

Class	N	Mean	Std. Deviation	Std. Error Mean
Score Class 1	30	84.833	7.589	1.386
Class 2	30	79.033	6.853	1.251
Class 3	30	77.033	9.401	1.716
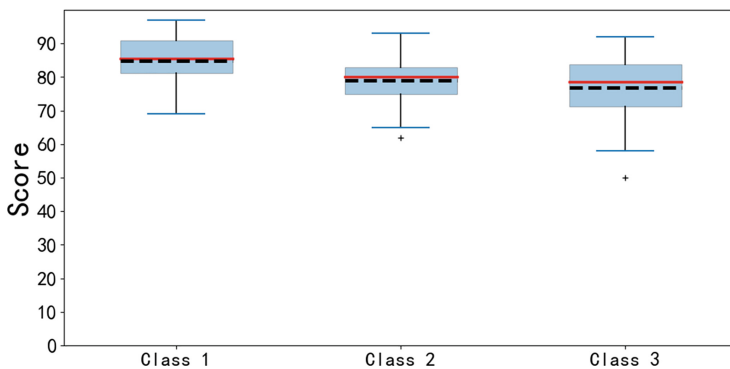
Fig. 4. Distribution of the Listening Test Scores after the Second Semester

application of the flipped classroom in Class 2, the standard deviation of Class 2 demonstrates a marked reduction compared with the previous semester. This signifies that the application of the flipped classroom can significantly narrow the gap between students in the English listening, but this downward trend will gradually slow down or remain largely unchanged over time. Figure 5 demonstrates convincingly that the flipped classroom model is effective. Compared with the students' test scores before the experiment, the students in Class 1 show the greatest improvement in listening performance. The students in Class 2 demonstrate an intermediate improvement in listening performance, and the students in Class 3 show the least improvement in listening performance.
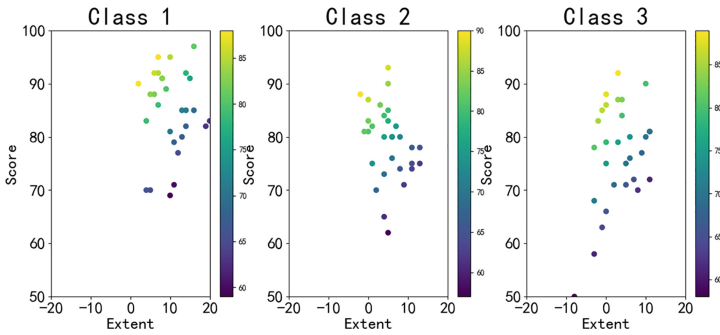
Fig. 5. Scatter plot of the Improvement in Listening Test Scores after the Second Semester

According to the questionnaires, the data of the students in Class 1 shows that the overall attitude of the students towards the flipped classroom is relatively positive, and they are very optimistic about the outcome of listening learning in the flipped classroom. Research indicates that the students in Class 1 have gradually adapted to the flipped classroom. Specifically, 72.41% of the students indicate that they would support the flipped classroom model, and 75.86% of the students indicate that the flipped classroom is effective. An overwhelming majority of the students (93.10%) make clear that the flipped classroom does facilitate active and self-regulated learning. 68.97% of the students show that they are able to complete most of the listening tasks before class, and 72.41% of the students mention that they are able to grasp the main points of listening knowledge in the flipped classroom. 82.76% of the students show that they spent significantly more time on English listening each week. A surprising 100% of the students indicate that they are more likely to actively engaged in the listening activities and learn thoughtfully during the activities. 89.66% of the students point out that the English listening instruction in the flipped classroom help them develop their independent learning, their ability to analyze and solve problems and communication and coordination skills.

Based on the questionnaire data from the students in Class 2, after the students have experienced the flipped classroom in the second semester, they generally indicate that compared with the traditional listening class in the first semester, they prefer the flipped classroom. The students in Class 2 think that the flipped classroom involves more interactive teaching and learning, more thinking, more interesting content, richer and more diverse listening materials, more time for listening practice and self-regulated learning outside of class. They have learned a lot of useful listening knowledge and skills, and their levels of listening proficiency have been improved. Therefore, the students in Class 2 indicate that the flipped classroom is more conducive to a great improvement in their achievements in listening, and learning in the flipped classroom is more effective.

To sum up, based on the above data analysis, it can be concluded that students generally have a highly positive attitude towards the flipped classroom and they express a strong preference for the flipped classroom. The research results show a better performance in the flipped classroom. Students in the flipped classroom do have improved

more than those in the traditional mode, that is to say, the effect of the flipped classroom on the English listening is positive. The flipped classroom model is effective in the English listening teaching and learning [8].

4   Conclusion

In conclusion, in the context of constantly updated modern educational technology, the flipped classroom is more personalized and effectively enhances students' initiative in learning, cultivates students' self-regulated learning ability and critical thinking and improves teaching efficiency and effectiveness. Admittedly, in the teaching practice of the flipped classroom, there are also some problems, such as the transformation of teachers' traditional teaching ideas, improvement of teaching technology, popularization of teaching equipment, and assurance of the effectiveness of learner autonomy, which will be the focus of attention in the follow-up research. In summary, the teaching effectiveness of the flipped classroom model is demonstrated and the flipped classroom model presents new challenges for both teachers and students, yet brings much benefit.

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