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The Application of Flipped Classroom Teaching Mode Based on SPOC in College English Teaching: Taking the Zhihuishu Knowledge Graph Platform as an Example

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Abstract: In recent years, with the continuous development of educational digitalization, the integration model of SPOC (Small Private Online Course) and flipped classroom can integrate online teaching resources and offline teaching resources, overcome the shortcomings of traditional teaching models, and enhance students' enthusiasm for learning and autonomous learning ability. This model has become a popular direction in the reform of teaching models. Meanwhile, the advantages of the Zhihuishu knowledge graph platform, such as knowledge coherence and complete teaching modules, are highly beneficial for the promotion of the flipped classroom teaching model based on SPOC. This research will adopt methods such as literature review, investigation and research, questionnaire survey, and in-depth interview to analyze the application effect and optimization path of the flipped classroom teaching model based on SPOC on the Zhihuishu platform in college English teaching. The theoretical basis, practical effect and existing problems of the model were specifically analyzed, and corresponding optimization suggestions were put forward.

Keywords: Zhihuishu App; SPOC; Flipped Classroom; College English Teaching; Digital education

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1. Introduction

With the acceleration of the digitalization process in education, China will implement a new round of digitalization strategy in education from 2025–2028, providing clear policy support and development paths for the innovation of teaching models. Against this backdrop, SPOC and flipped classrooms, as innovative models that integrate the advantages of online and offline and restructure the teaching process, have received extensive attention and have demonstrated remarkable results in multi-disciplinary practices. The two are based on the organic combination of constructivism, mastery learning and blended learning theories to achieve complementary advantages.

The knowledge graph function and teaching module of the Zhihuishu App platform provide strong technical and platform support for the integration and application of SPOC and flipped classroom. However, most current research focuses on the deep integration of SPOC and flipped classrooms. Not much attention has been paid to addressing challenges such as resource fragmentation on the platform and providing personalized guidance. This study aims to bridge this gap through the following measures. Firstly, constructing a new SPOC flipped classroom model that can be compatible with the knowledge graph of the Zhihuishu. Secondly, conduct empirical research to analyze the effectiveness of this model in addressing issues such as adapting to college English resources and improving student learning outcome. Third, is to provide operational optimization strategies for the platform-based teaching method.

This study will use research methods such as literature review, questionnaire survey, and in-depth interviews to summarize previous research results and experiences, and further systematically analyze how the SPOC based flipped classroom education model is constructed and its application status on the Zhihuishu App platform, in order to promote the digital reform of university English education.

2. The integration of SPOC and flipped classroom

2.1. The theoretical basis and internal logic of the integration of SPOC and flipped classroom

The combination of SPOC and flipped classroom is based on constructivist theory, mastery learning theory, and blended learning theory. Constructivism emphasizes that the construction of meaning needs to be accomplished through dialogue and collaboration in specific contexts [1]. In this model, SPOC provides students with rich online learning resources, supports their autonomous online learning, and utilizes the flipped classroom to enable students to participate in rich offline interactions, thereby deeply integrating the four links of context, dialogue, collaboration, and meaning construction [2]. Mastery learning theory points out that there is no significant difference in learning ability among most people, and the key lies in whether appropriate learning conditions are obtained [3]. This model helps teachers accurately track students' learning situations, adjust teaching strategies, provide personalized guidance, and at the same time offer students rich online resources, flexible learning time and space, and other suitable learning conditions. The blended learning model is a learning mode that combines the traditional offline teaching mode with the online learning mode [4]. This blended learning model combines the advantages of online self-study and offline interaction, achieving a continuous learning environment across multiple scenarios through the interlocking process of "pre-class self-study, in-class interactive enhancement, and post-class consolidation and expansion" [5].

2.2. The practical effect and challenge of integrating SPOC and flipped classroom in college English teaching

The integration model of SPOC and flipped classroom is in line with the characteristics of college English teaching and has achieved remarkable results, but challenges still exist.

In terms of adaptability, this model can overcome the drawbacks of large-class teaching and effectively adapt to the characteristics of college English teaching, such as a wide audience, emphasis on practice, and significant differences in student levels. The SPOC platform is rich in online resources, supporting students to study independently and make up for regional and individual differences [6]. The flipped classroom enhances language practice skills through creative debates, group cooperation, and more [7].

From the perspective of teaching practice, in terms of resources, this model helps teachers integrate

high-quality resources to provide students with rich learning materials [8]. In terms of teaching effectiveness, experiments show that this model not only improves students' English grades and theoretical levels, but also enhances their practical abilities such as self-expression and practical application [9]. In addition, students' ability for self-directed learning and collaborative problem-solving is greatly enhanced in the closed-loop learning of "self-learning interaction reflection" [10]. However, this model has also encountered many difficulties in its development, including the lack of guaranteed quality of SPOC resources, difficulties faced by teachers in transitioning their roles, and poor self-directed learning abilities of students [9, 11–13].

3. The support of the Zhihuishu platform for the integrated model of SPOC and flipped classroom

The SPOC based flipped classroom teaching model based on the Zhihuishu platform is an innovative teaching model that combines SPOC teaching concepts with flipped classrooms, and reconstructs the teaching process based on platform technology and functions. The knowledge graph of Zhihuishu APP can help teachers accurately match learning resources with corresponding knowledge points, and teachers can upload targeted learning resources to the platform [13]. At the same time, the platform provides teachers with convenient teaching management functions, helping them track learning situations, reduce the burden of progress supervision, and promote their transformation into a guiding role. The interactive function of this platform has also played an important role in addressing the issue of students' insufficient autonomous learning ability.

At present, although the flipped classroom teaching model based on SPOC on the Zhihuishu platform has made certain progress in disciplines such as clinical medicine and mathematics, its application in college English teaching is still in the initial exploration stage and lacks systematic and in-depth research. At present, there are not many research achievements in this field in China. Therefore, it is even more necessary to use this platform to explore effective application content methods for this fusion mode. This study has significant theoretical value and practical urgency.

4. Research methods

This study mainly explores the application status of the SPOC flipped classroom teaching model based on the Zhihui Book platform in college English teaching, its influence mechanism on students' English proficiency, the difficulties faced by teachers and students, and the countermeasures. The research subjects were 328 students from different disciplines, as well as teachers engaged in English teaching on the Zhihuishu APP platform and the technical operators of the platform.

Firstly, interviews were conducted with teachers and technical personnel to obtain first-hand information on model construction, platform operation, teaching integration and other aspects. Secondly, quantitative research was conducted through questionnaires. The questionnaire survey covered five dimensions: platform learning habits and platform experience, the effect of the flipped classroom teaching model based on SPOC, the learning effect and gains of the flipped classroom teaching model based on SPOC on Zhihuishu platform, and difficulties and suggestions. Questionnaires were distributed and collected through the Wenjuanxing App, and the data were analyzed using Excel and SPSS. Finally, qualitative research will be conducted through interviews. The basic information collected was shown in **Table 1**. Based on the questionnaire survey and previous research results, in-depth interviews were conducted with experienced teachers, and qualitative research was carried out using content analysis.

Table 1. The basic information collected through the questionnaire

Participants	Major	Gender Ratio	Effective Quantity	Cronbach.α	KMO value
328	Literature, engineering, economics, etc	1.09:1	295	0.800	0.873

5. Results

5.1. The construction method of this teaching mode and its current operation status

As shown in **Figure 1**, the flipped classroom teaching model based on SPOC on the Zhihuishu platform mainly consists of three parts: teaching preparation, teaching implementation, and teaching evaluation. The following will provide a detailed introduction to the specific links of each part.

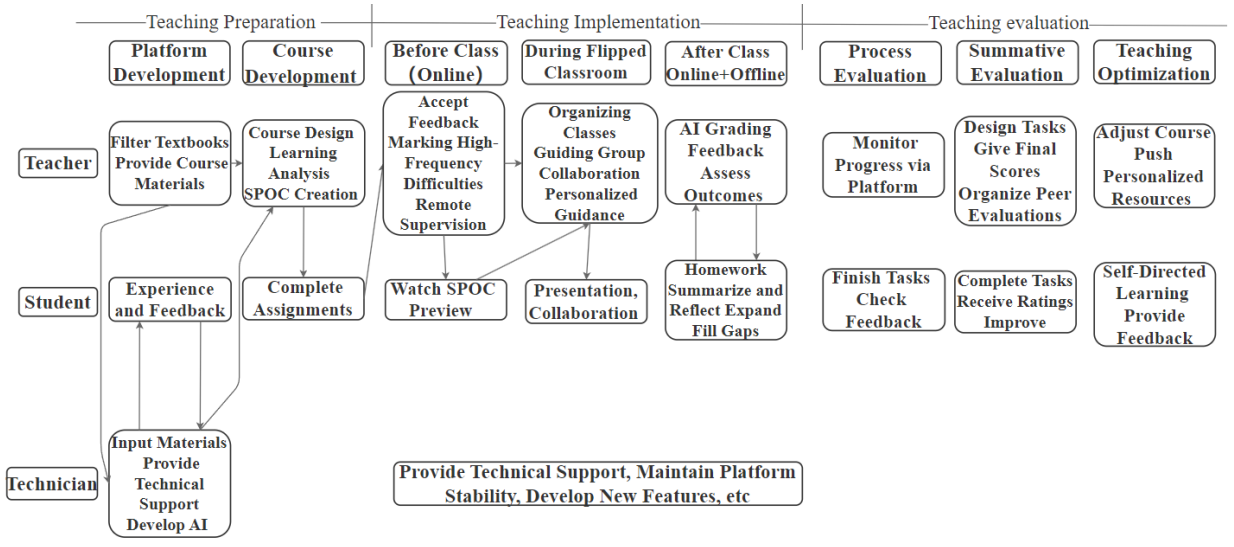


Figure 1. The construction of a flipped classroom based on SPOC on the platform of Zhihuishu.

5.1.1. Platform development stage

At this stage, teachers first analyze the students' learning situation. Based on the results of the English class placement test, teachers collaborate to select multi-level teaching materials suitable for different levels and develop a stratified course framework for the technical team to use and refer to. Subsequently, technicians input the resources into the platform and, at the same time, developed various functions, such as using AI technology to achieve homework correction, grading, and resource push and other auxiliary teaching tasks, effectively reducing the burden on teachers. The current platform's AI technology supports both Chinese and English corpora. Combined with NLP models, it has a natural advantage in supporting Chinese and English grammar correction, translation scoring, and writing logic analysis. Finally, after being tested by students during the holiday and collecting their feedback, the platform was further optimized and improved.

5.1.2. Course development stage

Teachers first rely on the automatic matching algorithm rules of the platform's AI assistant to obtain online resources with high similarity and conduct secondary screening to ensure the fit. Then, based on the knowledge graph of the Zhihuishu App, the framework of the English course was initially constructed, and the SPOC courses at different levels were further refined. On this basis, teachers improve the course content based on the

learning situation data they have mastered, design and record SPOC teaching videos, and select appropriate personalized course resources to upload to the platform. Students accept tasks through the platform and complete corresponding learning tasks and practice tests.

5.1.3. Before class

Students log in to the platform to watch the SPOC video and preview it. They need to complete the chapter synchronization test. During this process, teachers can implement supervision and reminders through the remote monitoring function, and test the previewing effect in offline classes by asking questions and other methods, achieving coordinated guarantee both online and offline. Subsequently, teachers can utilize the platform's data feedback function and artificial intelligence-assisted system to analyze data such as the accuracy rate of questions, key and difficult points, identify common difficulties, and make appropriate adjustments to the course content to better meet students' learning needs.

5.1.4. During class

The teaching adopts a flipped model. The teacher first sorts out the key and difficult points of the course based on the feedback from the platform preview (about 10–15 minutes). Then comes the group presentation session, where group members will take turns to report on the discussion questions assigned in the previous class. A diversified evaluation mechanism including teacher evaluation, peer evaluation, and self-evaluation is adopted during group classroom presentations to ensure comprehensive and objective evaluation. In order to fully cultivate students' comprehensive development, each group has clear division of labor and cooperates with each other to ensure that every student has effective participation. Each group conducts at least one classroom presentation per semester. After the group presentation and evaluation are completed, the teacher gives a summary and, based on this, expands and extends, raising more profound and inspiring questions to deepen students' understanding of the knowledge. At the end of the class, teachers assign inquiry-based homework to enhance the ability of autonomous learning and problem-solving, and to internalize knowledge.

5.1.5. After class

At this stage, students are required to complete their homework and conduct a summary and reflection. Students can make up for and expand their learning independently by leveraging the platform resources. Teachers can use artificial intelligence assistants to help grade homework and provide feedback to students. Meanwhile, teachers can reflect on their teaching effectiveness based on students' learning outcomes, and thus push supplementary learning resources to students in a targeted manner to promote their in-depth learning and all-round development.

5.1.6. Process evaluation

Accounting for 40% of the total evaluation, it covers self-evaluation, peer evaluation and teacher evaluation. Student evaluation can cultivate their critical thinking and evaluation skills, and promote communication and cooperation. Teachers provide professional feedback based on classroom participation, group assignments and platform learning data.

5.1.7. Summative assessment

Mainly the final exam, accounting for 60% of the total evaluation, comprehensively examines the core knowledge and skills of the course. The types of test questions are diverse, and the marking criteria are strict. Scores are assigned reasonably based on knowledge points and difficulty, truly reflecting students' academic performance.

5.1.8. Teaching optimization

It is the ultimate goal of teaching evaluation. Teachers compare and analyze students' learning situations through the platform, as well as their feedback and evaluation results. They dynamically adjust the course content and structure, continuously improve teaching methods, and enhance teaching effectiveness and learning experience.

5.2. Analysis of students' usage habits, experience and teachers' feedback on the Zhihuishu platform

In terms of students' platform usage habits, In the questionnaire survey, students generally felt that the platform had abundant resources and could meet various learning needs. They carried out various learning activities on the platform, such as reading, watching SPOC videos and reciting words, etc. However, about 54% of the students spent less than one hour online per week, and only 3% spent more than three hours online per week. The actual level of students' use of activities was relatively low. The contradiction between "high resource utilization rate" and "low duration" requires a thorough analysis of the underlying reasons. According to an interview with Teacher A, who has nearly 20 years of teaching experience, on the one hand, there is a gap between students' autonomous learning ability and the requirements of digital learning. More than two-thirds of the students indicated that they found it difficult to balance their study tasks and time allocation, and lacked the willingness to study in depth after class. On the other hand, students are still accustomed to and rely on the passive acceptance mode of traditional classrooms, have insufficient adaptation to online learning (especially practical content) and are easily distracted.

In terms of students' experience using the platform, they are generally satisfied with the friendly and smooth interface of the platform as well as the richness and applicability of the learning resources. More than 71% of the students recognize the smoothness of the platform. Data shows that the platform usage experience is significantly positively correlated with the acceptance of teaching models (correlation coefficient > 0, $p = 0.000$). Among the students who recognize the ease of use of the platform, more than 63% have accepted this teaching model. On the contrary, the recognition rate among students who are skeptical about usability is significantly lower. However, there is still room for improvement on this platform. Nearly 40% of the students expressed doubts or uncertainties about usability. The investigation found that the interface guidance and search functions still need improvement to enhance the student experience and promote their English learning.

In terms of teachers' feedback on the platform, when they first came into contact with this platform, their attitude was not very enthusiastic; in fact, they even had a resistant attitude. However, as the usage time increased, they gradually realized the effectiveness of this platform in assisting teaching. The knowledge graph function of this platform is a relatively prominent advantage. It can integrate knowledge points, build a knowledge framework and help teachers master the teaching material system. Teacher B and Teacher C pointed out that this platform can break through the limitations of time and space, provide abundant resources, facilitate personalized teaching, reduce the burden of homework correction, and improve teaching efficiency. However, the platform is still in its infancy in terms of functionality and technology and needs improvement. Teacher A mentioned that although the platform has diverse resources, the content recommended by AI often varies in quality and has a low accuracy rate, requiring teachers to conduct a second manual screening. In addition, the platform can only score objective questions and does not support scoring subjective ones. Moreover, the format requirements for the answers to objective questions are mechanical, which affects the teaching experience.

5.3. Impacts and current deficiencies of the flipped classroom teaching model based on SPOC

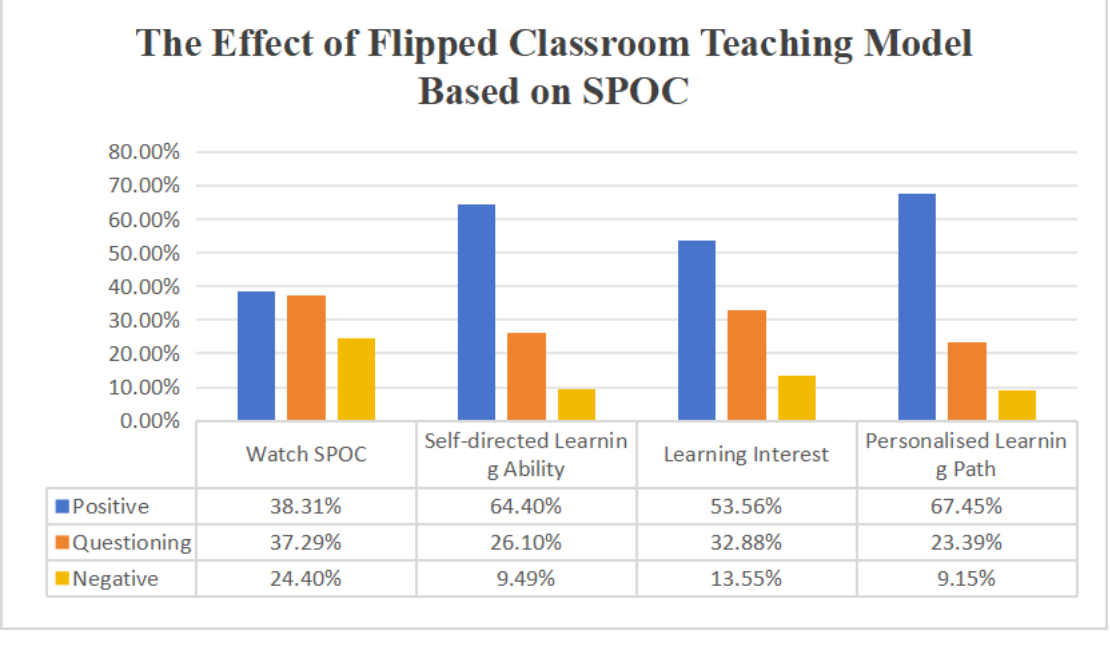
Firstly, regarding the SPOC teaching model, nearly 47% of the students indicated that they were unable to

complete the self-study tasks before class with high quality, and approximately 62% of the students did not repeatedly watch the SPOC teaching videos in their daily studies. This is because the online course resources of SPOC for non-English major students have not yet reached a sufficient scale. Teachers do not force students to study but merely supplement classroom teaching, which leads to low enthusiasm for students to watch, low efficiency in resource utilization, and low quality of self-study before class.

The flipped classroom has effectively enhanced students' autonomous learning ability. About two-thirds of the students believe that it has improved. Project-based learning and group presentations have also strengthened their writing skills and learning perseverance. However, 47% of the students are skeptical or negative about the improvement of their learning interest. The main reason is that this model has high requirements for students' output ability. Some students lack confidence and regard group tasks as a burden, failing to recognize their value. Middle and low-level students are prone to develop a fear of difficulties and a resistant mentality when encountering them.

The results of the questionnaire survey on the flipped classroom teaching model based on SPOC show that 67.45% of the students believe that this model can provide personalized learning approaches and meet differentiated needs. However, in the open-ended questions, students also generally feedback some problems. There are situations such as an increase in extracurricular burdens, a rise in study pressure, and a disconnection between previewing videos and classroom progress. Meanwhile, students have insufficient understanding of the model itself. Even after explaining the relevant concepts, only 54% of the students said they had a basic understanding, while 46% still did not understand. If students, as the main body of teaching, still do not understand the current teaching mode, it will directly affect the learning effectiveness of students and the teaching effectiveness of teachers. Therefore, teachers should systematically introduce current teaching concepts and methods to students.

In short, advanced teaching models still have shortcomings in cultivating students' good study habits, improving their self-learning ability, and stimulating their interest in learning. In response to the above phenomenon, teachers should optimize teacher design, strengthen curriculum guidance, and improve learning supervision mechanisms. The effect of flipped classroom teaching model based on SPOC was shown in **Figure 2**.



	Watch SPOC	Self-directed Learning Ability	Learning Interest	Personalised Learning Path
Positive	38.31%	64.40%	53.56%	67.45%
Questioning	37.29%	26.10%	32.88%	23.39%
Negative	24.40%	9.49%	13.55%	9.15%

Figure 2. Flipped classroom teaching model based on SPOC.

5.4. Analysis on learning outcome feedback and teaching model recognition of the SPOC-based flipped classroom teaching model with Zhihuishu platform as the carrier

Survey data shows that this model has a significant effect on improving students' language proficiency: 62.3% of the students recognize its overall promoting effect. In terms of specific skills, listening, reading and writing abilities have all been positively affected-abundant listening materials and intensive training have enhanced listening comprehension. Most students have reported an increase in reading speed and text comprehension ability. The grammar training, writing materials and logical guidance provided by SPOC have also effectively improved writing skills. However, nearly 90% of the students reported that their spoken English had not improved significantly. Studied pointed out that one of the reasons is that the Zhihuishu platform lacks oral interaction resources. Even if students have the opportunity to communicate verbally about artificial intelligence, they mainly do so by typing. Secondly, students have insufficient reading volume and knowledge reserves. The large class size leads to few opportunities for oral communication and difficulties in oral output.

Meanwhile, the research found that students' recognition of this teaching model was significantly positively correlated with the improvement of their autonomous learning ability and comprehensive English proficiency (the correlation coefficients were all > 0, and p values were all 0.000). Among the student group with positive evaluations, 73.1% of the students believe that their autonomous learning ability has been effectively improved. However, at present, only 53.4% of the students clearly recognize this model, while nearly half of the students are uncertain or hold an uncertain or negative attitude.

The recognition of this teaching model by students will be influenced by multiple factors. From the perspective of students, those with strong learning motivation are more inclined to actively participate in the teaching mode and utilize online and offline learning opportunities for learning; However, some students with weaker learning foundations, such as those with weak listening abilities, may have comprehension barriers in English classrooms, leading to negative resistance towards the learning process; Intermediate level students are also influenced by various factors such as the difficulty of learning tasks and the degree of matching of learning resources. The teaching methods adopted by teachers also have a significant impact on students' recognition. If teachers cannot patiently guide students and pay attention to individual differences among them in teaching, it will also reduce students' learning experience and further affect their recognition of the teaching mode.

Students generally expect to receive personalized guidance, and this is precisely the deficiency of large-class teaching. Teachers should make use of the SPOC platform to develop differentiated teaching content and guidance plans to make up for the deficiencies of traditional classrooms. The functions of the platform and the quality of resources will have an impact on recognition. The Zhihuishu platform has abundant resources, but the quality of content varies greatly, especially in terms of spoken language resources, which are very scarce. At the same time, the quality of resources recommended by AI algorithms is also uneven, often requiring teachers to conduct secondary screening, which increases their workload. The platform needs to further improve the quality of its resource library, especially oral and writing resources, to enhance the teaching efficiency of teachers and the learning experience of students.

6. Discussion

This research mainly studies the flipped classroom teaching mode based on SPOC and its implementation effect on the Zhihuishu platform. This teaching mode is of great significance in the digitization process of college English education. Therefore, its application effect and the challenges it faces deserve in-depth exploration.

From the perspective of application effect, the teaching process and evaluation system of this teaching

mode have been relatively complete. In this mode, the three stages of pre class, in class, and post class are arranged very reasonably and interrelated. The Zhihuishu platform has an artificial intelligence assistant to help teachers correct homework and push relevant teaching resources, effectively reducing teachers' work pressure, allowing them more time and energy to communicate with students, and providing personalized guidance for students. In addition, teachers can also timely understand students' learning situation based on the feedback data from the platform, providing real-time supervision and guidance for students, alleviating the pressure of teacher role transformation emphasized by Li, and demonstrating that platform analysis helps alleviate the pressure of the "guidance" role [9].

This model combines the advantages of online and offline to break through the limitations of time and space. It not only enables students to obtain abundant learning resources anytime and anywhere to meet their needs, but also makes the learning methods and resource utilization more diversified, thereby meeting the differentiated learning needs of students and stimulating their interest and enthusiasm for learning. Crucially, the knowledge graph functionality, that would be unique to Zhihuishu, has resolved the SPOC resource fragmentation issue identified by Gu et al., by enabling precise knowledge point-resource mapping [11]. The various activities in the flipped classroom have enhanced students' language application ability, learning tenacity, teamwork ability and critical thinking ability, and have also played a positive role in the cultivation of autonomous learning ability

However, this teaching model has also encountered many difficulties. Firstly, in terms of students, due to their weak ability to learn independently, most students not only cannot develop reasonable study plans, but also find it difficult to ensure the quality of self-study before and after class. Secondly, due to the limited channels for students to input English in their daily lives after class and their own psychological barriers such as inferiority complex, they still lack confidence in their oral output stage. This situation is consistent with the research results of Gao on SPOC completion barriers [12]. However, by revealing the user stickiness pattern of a specific platform, this research has been expanded. From the perspective of teachers' teaching practice, in large-scale general English courses, there are a large number of students at different levels. Teachers can only categorize these students and provide targeted guidance, making it difficult for them to offer personalized guidance to individual students. Meanwhile, when the SPOC teaching mode is applied to the teaching of non-English major students, it has not formed a complete and mature curriculum system and scale, which limits the exertion of the personalized teaching advantages of SPOC. This systemic gap partially explains the mixed student acceptance (53.4%) observed, underscoring the need for institutional-level SPOC curriculum development.

In terms of the Zhihuishu Book Platform, although it can currently offer relatively abundant resources, there are still some issues. The quality of the resources varies greatly, the accuracy of AI recommendations is not satisfactory, and the subjective question type scoring function is also not perfect. These problems have had a certain impact on the smooth progress of teaching. These technical limitations echo Wang et al.'s warning about over-reliance on AI in blended learning, suggesting algorithmic refinement as a priority [5].

This model has achieved significant results in the application of college English teaching, but at the same time, there are also some urgent problems that need to be solved in many aspects and links. This requires us to start from multiple aspects such as students, teachers, and platforms to solve these problems, so as to give full play to the potential and advantages of this teaching model and improve the quality of college English teaching.

7. Conclusion

This study mainly conducts a comprehensive and in-depth analysis of the current application effects and

existing problems of the flipped classroom teaching model based on SPOC using literature review questionnaire survey, teacher interviews, and case analysis as research methods. Through research, it has been found that this teaching model has achieved certain results in the teaching of general English courses in universities. However, there are still many problems that need to be solved in various aspects such as student participation in teacher teaching implementation platform function support. After careful consideration and analysis, researchers have proposed a series of feasible optimization strategies to solve these problems and provide useful references for the improvement and development of teaching models.

From the perspective of students, teachers can make use of the sign-in function and learning record function of the notification letter platform to guide students in cultivating self-management skills and enhancing their autonomous learning ability. By recommending high-quality English learning resources on the platform, they can broaden the input channels and organize activities such as English dubbing and speeches, encouraging students to use the AI oral communication function to increase language output opportunities and enhance their confidence in oral expression. Secondly, at the teacher level, in large-class teaching, they should adopt stratified teaching and group cooperative learning methods, design differentiated tasks and guidance plans based on students' levels. For non-English major students, they should build a complete SPOC online course system, innovate the design of flipped classroom activities, adjust the proportion of online and offline learning time, and enhance students' participation enthusiasm. Finally, at the Zhihuishu platform level, they should strengthen resource review and screening, establish a mechanism for recommending high-quality resources, improve AI algorithms, and precisely push resources. They should also increase the development of subjective question correction functions, improve the student data feedback mechanism, and assist teachers in teaching.

Through the above optimization strategies, it is expected to solve the existing problems of the current teaching model, improve teaching effect, and promote the continuous improvement of university English teaching quality. This research provides beneficial references and inspirations for the digital teaching reform of university English, but due to the limitations of research samples and time, it still has certain limitations. Future research can further expand the research scope to cover more students of different levels and majors, extend the research period, and deeply explore the long-term impact and mechanism of this teaching model, injecting new vitality into university English teaching and cultivating more high-quality English talents who adapt to the demands of the times.

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