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Research on Ecological Construction of Computer SPOC Course Based on Grey Fuzzy Algorithm

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Abstract: *With the advancement of educational informatization, online open courses (MOOC) and micro-online courses (SPOC) have been widely used. However, these courses are facing many challenges in the implementation process, such as the instability of course ecology and insufficient adaptability. In order to solve these problems, this study introduces the grey fuzzy algorithm, aiming at building a more stable and adaptable computer SPOC course ecology. This study adopts the empirical research method, and verifies the effectiveness of grey fuzzy algorithm in the ecological construction of computer SPOC course through experimental comparison and analysis. Therefore, this study aims to explore the ecological construction of computer SPOC course based on grey fuzzy algorithm, in order to provide some theoretical support and practical guidance for the innovation and development of computer education.*

Keywords: *Grey fuzzy algorithm, SPOC course, Online course*

1. Introduction

In today's information age, the importance of computer education is increasingly prominent. In particular, the rise of computer SPOC (Small Private Online Course) provides students with flexible and personalized learning methods and has become an important part of modern educational innovation[1]. The construction of computer SPOC course ecology has become a research hotspot in the current education field[2], in order to better meet the individualized learning needs of students and improve the quality of education and teaching effect.

As an effective mathematical model and prediction method, the grey fuzzy algorithm has been widely used in various fields because of its unique advantages[3]. However, at present, there is relatively little research on the ecological construction of computer SPOC course based on grey fuzzy algorithm, mainly focusing on teaching evaluation and student behavior analysis under the traditional teaching mode[4].

Therefore, this study will combine the grey fuzzy algorithm and the characteristics of SPOC course to build an ecological model of computer SPOC course, and analyze and optimize the core elements. This study will combine theoretical research and practical case analysis in order to promote the research and practice of ecological construction of computer SPOC course. Through the research method based on grey fuzzy algorithm, it provides a brand-new, scientific and effective teaching mode for computer education, promotes the realization of students' quality education and lifelong learning, and contributes to the construction of a learning society.

2. Literature review

2.1 Overview of Grey Fuzzy Algorithm

Grey fuzzy algorithm is a method for forecasting and analyzing based on a small amount of uncertain data[5]. It is often used to predict the future trend when the data is incomplete, uncertain or lacking sufficient information. The algorithm is mainly divided into two methods: grey system theory and grey correlation analysis[6].

The theoretical method of grey system is based on grey mathematical theory, and the data sequence is predicted and analyzed by establishing grey differential equation[7], grey GM(1,1) model[8] and other

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mathematical models. This method is mainly suitable for trend analysis and development trend prediction of time series data[9]. The grey relational analysis method is to analyze and predict a small amount of data according to the degree of correlation between the data[10]. This method obtains the correlation coefficient by calculating the correlation degree between the data, and then predicts and evaluates the unknown data. It is mainly suitable for multi-index evaluation, decision analysis and so on[11].

Grey fuzzy algorithm has a wide range of fields in practical application, including economic forecasting, market research, environmental evaluation, project management and so on[12]. It can predict the future trend and development by using a small amount of data, and provide decision-making reference, especially in the case of incomplete data or lack of sufficient information. At the same time, the grey fuzzy algorithm is simple, fast and practical, which can provide relatively accurate prediction results and has certain guiding significance for solving some practical problems.

2.2 Overview of computer SPOC

SPOC is an online course mode based on Internet and suitable for small-scale teaching[13]. This course aims to provide high-quality personalized learning experience by taking advantage of modern information technology. SPOC course aims to provide students with a more flexible and personalized learning environment through online teaching platform[14]. By optimizing the organization of learning resources and providing interactive and feedback mechanisms, the learning effect of students can be improved. Computer SPOC course usually cover basic knowledge and professional skills related to computers. For example, computer working principle, programming language foundation, database management, network security, artificial intelligence and so on[15]. According to different settings, the course content can range from elementary to advanced to meet the different learning needs of students.

Since the online teaching platform is adopted in the SPOC course, students can learn according to their own learning progress and timetable. Teach and consolidate knowledge through a combination of video courses, teaching materials and online homework. At the same time, students can communicate with teachers and other students through online discussion and question answering. In order to ensure students' learning effect, SPOC courses usually set up various evaluation methods, including online test, homework completion evaluation, project practice and so on[16]. The evaluation results will be used to guide students' learning process and provide students with personalized suggestions and feedback.

Generally speaking, computer SPOC course provides a more flexible and personalized learning mode through online teaching platform, which enables students to learn according to their own characteristics and learning needs. This course model can improve students' learning effect and interest, and it is an important innovation in the field of computer education.

2.3 Computer SPOC course ecological construction

The ecological construction of computer SPOC course involves the following aspects:

(1) course design and content: For a specific computer discipline, the course should clearly define the course objectives and learning objectives, and design an appropriate syllabus and course structure. The course content should be substantial and targeted to ensure that students can get a comprehensive learning experience. (2) Teaching team formation: In order to ensure the quality and effect of the SPOC course, an appropriate teaching team needs to be formed. The team includes subject experts, teaching designers, technical support personnel and teaching assistants, who are jointly responsible for the design, development, maintenance and management of the course. (3) Selection and construction of technical platform: It is necessary to select and establish a technical platform suitable for SPOC courses. These platforms should have the functions of online teaching, resource navigation, learning management and interactive communication, and can support teaching and learning activities between teachers and students. At the same time, the platform should also provide rich learning resources and teaching tools. (4) Production and integration of learning resources: In order to provide high-quality learning experience, it is necessary to produce and integrate a variety of learning resources, such as teaching videos, textbooks, exercises, experimental data, etc., to meet the different learning needs of students. (5) Learning evaluation and feedback mechanism: Establish a reasonable learning evaluation and feedback mechanism, including homework, tests, exams and other evaluation methods, as well as timely learning feedback and guidance. This can help students to know their learning progress in time and make corresponding adjustments. (6) Optimization and improvement: Continuously optimize and improve the ecosystem of SPOC course, and adjust teaching methods, course content and learning

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resources according to students' feedback and actual effect, so as to improve the quality and learning effect of the course.

Through the implementation of the above steps, we can build a perfect computer SPOC course ecosystem and provide students with high-quality, convenient and flexible learning experience.

2.4 Blackboard platform based on SPOC

Blackboard is a platform developed by American Blackboard Company, which can support millions of users at the same time[17]. It can be used in enterprises, government, education and other fields. At present, it is widely used as a network teaching platform in the field of education, and is generally called BB platform in China[18]. Blackboard platform mainly includes four core modules: teaching delivery system, network learning community, content management system and student evaluation system. At present, more than 3,700 universities around the world use Blackboard platform, including Duke University, Harvard University, Princeton University and many other famous universities[19, 20]. In China, Sun Yat-sen University, as the "leader" in introducing online teaching platform, introduced Blackboard network platform to colleges and universities in 2005, which was the first pilot university in China[21]. After Sun Yat-sen University, China Renmin University, Tianjin Nankai University and many other universities have also joined the ranks, using Blackboard platform to assist teaching.

The advantages of Blackboard platform mainly include the following three points:

(1) Easy to use and open: Blackboard network teaching platform has simple and reasonable pages, clear functional modules, and is easy for users to operate. The convenience of use has been favored by many users at home and abroad, and it has also become a key factor in choosing Blackboard platform. In addition, Blackboard platform has certain openness, allowing teachers and managers to adjust the layout of each module and design personalized content and page design that meets their own needs[22]. (2) Product maturity: Blackboard platform can support large-scale users to learn at the same time, and it is a relatively mature platform. Blackboard platform uses relational database to store data, so that its advantages in finding, storing and managing data are improved compared with the previous file system storage methods, and its performance is optimized. Among all kinds of online teaching, Blackboard stands out and has been widely recognized and applied in the world. More than 1,000 universities at home and abroad use this platform to assist teaching. Blackboard platform has a strong background monitoring function. This function helps teachers to know the basic situation of students' learning at any time to some extent. (3) Data security: Blackboard platform has data backup function, which provides different permissions for administrators and users respectively. Among them, the platform administrator has greater authority than the teachers, and can back up the whole teaching platform including database and file system[23]. Teachers can make a complete backup of students' test scores, test questions and course content. This is of great significance for teachers to effectively analyze students and improve the utilization rate of courses. Moreover, Blackboard adopts unique irreversible encryption technology in authentication mode, which effectively ensures the security of authentication.

3. Research Methods

3.1 Research methods adopted

In this study, the following research methods can be used.

(1) Literature review: Through the collection and analysis of relevant literature, we can understand the research status, development trend, relevant theoretical and practical cases of computer SPOC course ecological construction based on grey fuzzy algorithm. For example, researchers can understand the application prospect of grey fuzzy algorithm in course ecological construction, as well as the challenges and solutions in practice by investigating a large number of academic papers, books and research reports. In addition, researchers can also reveal the successful application cases of grey fuzzy algorithm in different fields, such as e-commerce, financial risk assessment and medical diagnosis, by consulting the papers of relevant journals and academic conferences[24].

(2) Empirical study: By collecting the actual SPOC course data, the grey fuzzy algorithm is used to analyze and model, and the effectiveness of the algorithm in course ecological construction is verified. For example, researchers can choose a specific SPOC course, collect students' learning behavior data and academic performance, and then use grey fuzzy algorithm to process and analyze these data to explore students' learning dynamics and learning effects at different learning stages. By comparing the

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differences between the course ecological construction using grey fuzzy algorithm and traditional methods, it can evaluate the potential of grey fuzzy algorithm in improving course effect and student satisfaction.

Through literature review and empirical research, researchers can deeply understand the application status and potential of grey fuzzy algorithm in the ecological construction of computer SPOC course, and provide scientific basis and practical guidance for future course design and teaching improvement. At the same time, this research is also helpful to promote the popularization and application of grey fuzzy algorithm in the field of education, and make positive contributions to improving the quality of education and the learning effect of students.

3.2 Reasons for adopting the above methods

The reason for adopting the literature review method is to establish the theoretical basis and background of the research. The application of grey fuzzy algorithm in the ecological construction of computer SPOC course is a relatively new field[25]. Through literature review, we can understand the existing research results and viewpoints, and provide support and inspiration for further empirical research. The reason for adopting empirical research method is to verify the feasibility and effectiveness of grey fuzzy algorithm in the ecological construction of computer SPOC course. By collecting the actual SPOC course data, it can use the grey fuzzy algorithm to analyze and model, and explore the application effect of the algorithm in course design, learning behavior analysis and student evaluation, so as to provide scientific basis for further practice.

3.3 Data collection

Data collection involves the collection of actual SPOC course data and related literature. For the collection of actual SPOC course data, we can cooperate with relevant educational institutions to obtain the data of the course learning platform, including students' learning behavior data and academic performance data. At the same time, we can also collect the questionnaire survey data of relevant teachers and students to obtain their views and opinions on the construction of course ecology. For literature review, we can collect the literature related to the ecological construction of computer SPOC course based on grey fuzzy algorithm by searching relevant academic databases, periodicals, conference papers and dissertations. By analyzing and integrating these documents, the theoretical framework and ideas of the research are established. Through the above data collection methods, actual data and related documents can be obtained, which provides support and basis for the research on the ecological construction of computer SPOC course based on grey fuzzy algorithm. At the same time, reasonable data collection methods can ensure the scientificity and credibility of the research.

In this study, students majoring in information and computing science in Suzhou University of Science and Technology in 2022 participated in the questionnaire survey. There were 195 students in 4 classes, and these students were between 18 and 20 years old. In the student analysis stage of this study, using questionnaire research method, taking the public basic course "Information Technology Foundation" as an example, all the students who participated in the practice were investigated by questionnaire, and some survey results were selected. Student class information is shown in Table 1.

Table 1: Student Class Information.

Classes	Class 2201	Class 2202	Class 2203	Class 2204
Number of students	52	49	48	46

4. Application cases

4.1 "Information Technology Foundation" course as an example

The course "Information Technology Foundation" is a public basic course for non-computer major undergraduate and vocational majors, and it has a strong foundation and practicality. Its purpose is to make students understand the basic knowledge of computer and information technology, train students to master the basic operating skills of computers, and improve students' own quality and lay a good foundation for their autonomous learning and lifelong learning. The daily online time and proportion of students are shown in Table 2.

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Table 2: Students' Daily Online Time and Proportion.

Online time	0-2 hours	2-5 hours	5-8 hours	More than 8 hours
Percentage/%	31.82%	54.55%	9.09%	4.55%

According to the statistical results in Table 2, students spend an average of longer time online every day. A total of 68.18% students spend more than 2 hours online every day. Among them, the number of students who spend 2-5 hours online is the largest, accounting for more than half of the total number of students, reaching 54.55%, and the proportion of students who spend more than 8 hours online every day is also 4.55%. The main reasons and proportion of students surfing the Internet every day are shown in Table 3.

Table 3: Main reasons and proportion of students surfing the Internet every day.

Internet access reasons	Online learning	Visit QQ ,Weibo	Browse news	Watch TV dramas
Percentage/%	9.09%	31.82%	40.91%	18.18%

According to the data in Table 3, although students spend a large proportion of their time online every day, less than 10% of them use the Internet to study online, accounting for only 9.09% of the total number. 40.91% of students surf the Internet mainly for browsing news information, while half of them surf the Internet mainly for watching TV dramas or socializing.

According to the statistical chart of the survey results, the vast majority of students have plenty of online time, which provides the possibility for the development of mixed teaching in schools. Due to the lack of effective guidance from teachers and the influence of existing teaching models, most students do not make full use of the advantages of the network to study in their daily study and life. Therefore, it is necessary to use the existing Blackboard network teaching platform to carry out mixed teaching, effectively promote students' autonomy and inquiry learning, and improve the efficiency and benefit of teaching and learning. The students' interest in this course is shown in Table 4.

Table 4: Students' interest in this course.

Degree of interest	Very interested	Interested	General	Uninterested	Strongly uninterested
Percentage/%	13.64%	31.82%	54.55%	0.00%	0.00%

More than 50% of the students are interested in the course "Fundamentals of Information Technology", of which 31.82% are interested and 13.64% are very interested. The degree of students' learning about computers is shown in Figure 1.

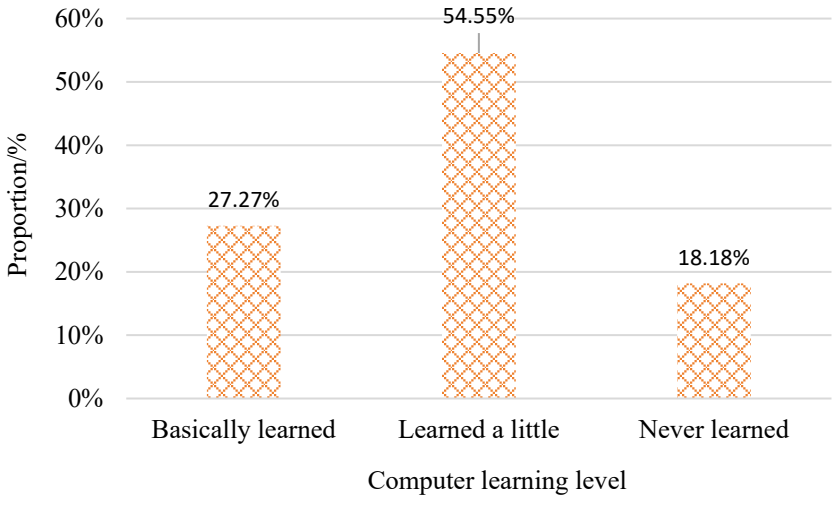

Figure 1: Students' Learning Level of Computer.

In students' daily study and daily life, more than 50% students know and master the basic knowledge of computers less, less than one third of them have learned the basic knowledge of computers, and the proportion of students who have never learned computer knowledge is 18.18%.

From the statistical analysis of the above survey results, it is known that most students are interested

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in the course "Fundamentals of Information Technology", but they have not systematically studied the knowledge and skills involved in this course in peacetime, resulting in that most students do not have a thorough understanding of the basic knowledge of information technology and cannot master the computer operation skills skillfully. The way students expect to learn this course is shown in Figure 2.

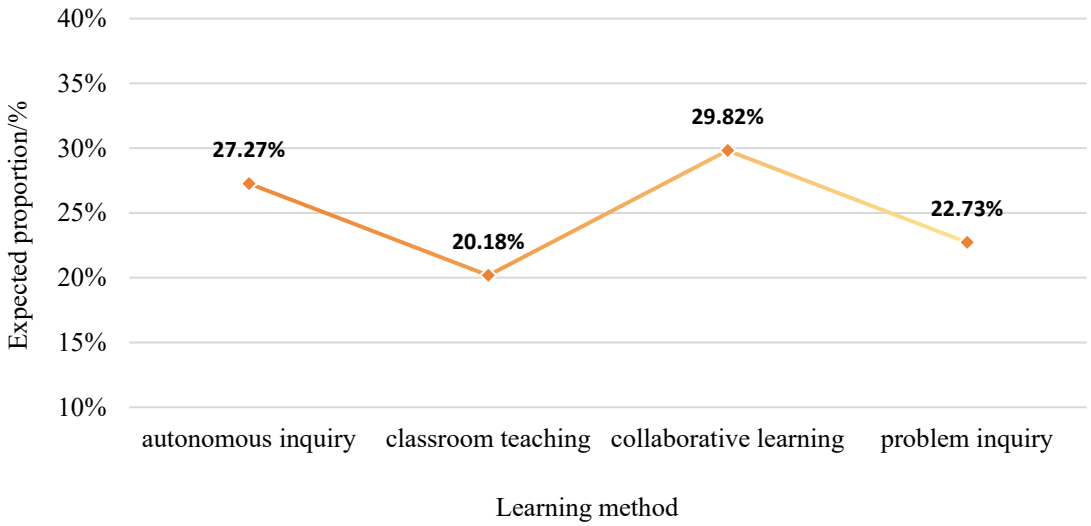

Figure 2: How students expect to learn this course.

Among the ways students expect to learn this course, the proportion of students in four learning methods, autonomous inquiry, classroom teaching, collaborative learning and problem inquiry, is 27.27%, 20.18%, 29.82% and 22.73% respectively. Through the analysis of the above figure, we can see that the students' preference for the learning mode of this course is relatively balanced. The learning mode of autonomous inquiry learning, collaborative learning and classroom teaching, interspersed with question inquiry, is more in line with the learning preferences of the students, and this research conclusion has important guiding significance for this study.

4.2 Application Implementation Effect Analysis

(1) Analysis of students' acceptance: We divide students' acceptance or satisfaction into five grades. Students' previous satisfaction with this course is shown in Figure 3.

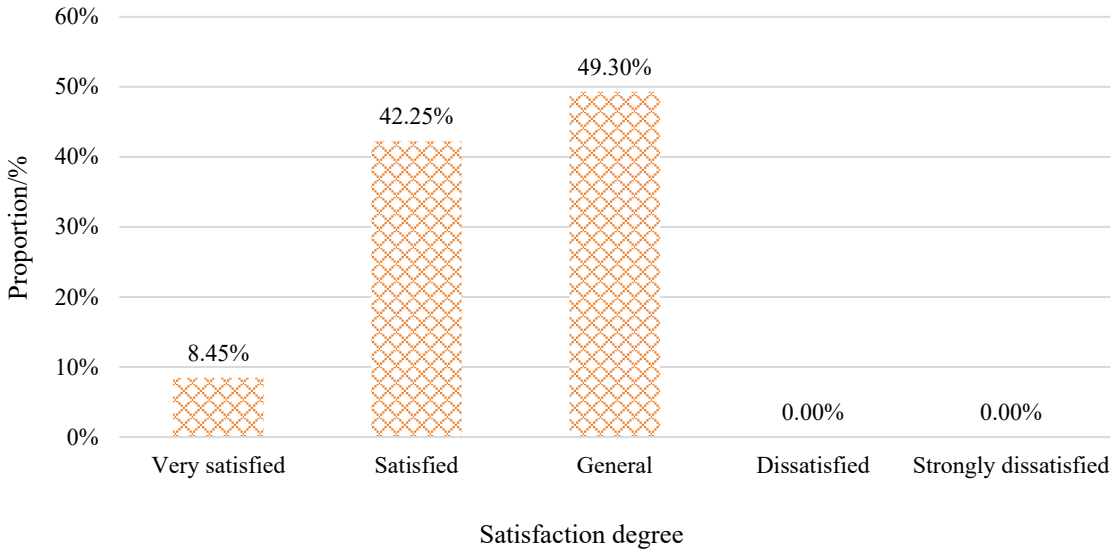

Figure 3: Students' previous satisfaction with this course.

The degree of satisfaction after teaching with Blackboard is shown in Figure 4.

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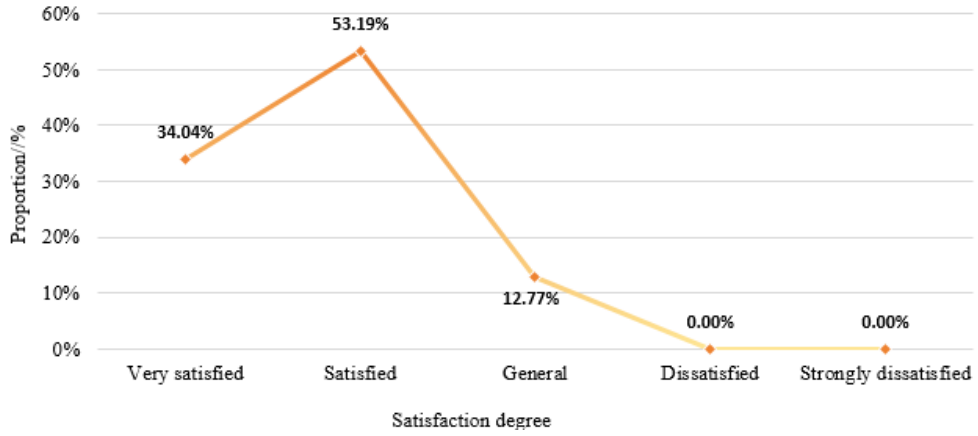

Figure 4: Satisfaction after teaching with Blackboard.

From the comparison between Figure 3 and Figure 4, it can be found that before the beginning of teaching practice, 49.3% of students expressed general opinions about the course "Information Technology Foundation", but after the mixed teaching practice on Blackboard platform, the satisfaction degree changed obviously, and it dropped to less than 15%, accounting for only 12.77% of the total number of students. The number of people interested in the course has also increased significantly. The number of people who are very satisfied with the course is the most obvious, and the growth rate is also greater, accounting for 34.04% from the previous 8.45%. More than half of the people are satisfied with using Blackboard platform to carry out blended learning, accounting for 53.19% of the total number.

From the above data, we can know that most students prefer to use this online and offline way to study, and agree with the mixed learning method. Students have a high degree of acceptance of using Blackboard platform to carry out mixed teaching, which lays a good foundation for the application of mixed teaching in schools in the future.

(2) Analysis of students' learning effect: The main purpose of this study is to improve students' learning efficiency through online and offline mixed teaching methods. Whether students think learning efficiency has been improved is shown in Figure 5.

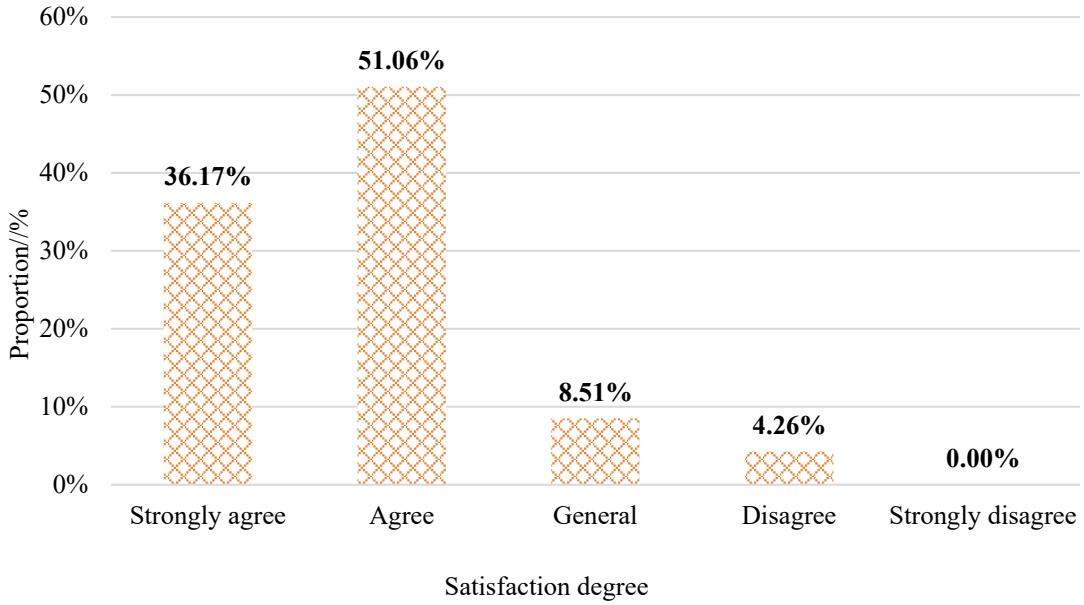

Figure 5: Students' recognition of whether learning efficiency has been improved.

Research shows that the number of people who think that this teaching method has not improved their learning efficiency is only 4.26% of the total number, less than 5%. There are 170 students who believe that this teaching method or learning method can improve learning efficiency. In other words, 87.23% students still think that learning through this online and offline learning method can improve learning efficiency to a certain extent. Among them, nearly 70 students think that this learning method

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can improve learning efficiency very much. This figure is very impressive, which fully reflects the significance of this study. Whether students think they have deepened their understanding of knowledge is shown in Table 5.

Table 5: Students' agreement on whether they have deepened their understanding of knowledge.

Strongly agree	Agree	General	Disagree	Strongly disagree
25.53%	57.45%	17.02%	0.00%	0.00%

In addition to pursuing students' learning efficiency, we should also pay attention to students' learning quality, that is whether students can deeply understand their learning knowledge. The effective combination of efficient learning and deep understanding of knowledge can promote students' continuous learning. As can be seen from Table 5, the majority of students think that this learning method is helpful to understand and deepen their knowledge, reaching 82.98%. Among them, 57.45% and 5.53% agreed and strongly agreed to deepen the understanding of knowledge. According to the data analysis, there are 33 people who have a general attitude towards deepening their understanding of knowledge, but nearly 161 students think that the combination of online and offline learning methods is helpful to deepen their understanding of knowledge. Among them, 49 people thought it was helpful and 112 people thought it was very helpful to deepen their understanding of knowledge. It can be seen that the mixed teaching method combining online and offline has greatly deepened most students' understanding of knowledge, and students are willing to accept this new learning and teaching method. These data further reflect the significance of this study.

4.3 Analysis of the satisfaction degree of the implementation process

This section focuses on the overall satisfaction of students' learning courses through questionnaires from the aspects of course objectives, course resources, course activities, course design, course evaluation. The evaluation results of the satisfaction degree of the course implementation process are shown in Table 6.

Table 6: Satisfaction Evaluation of course Implementation Process.

	Strongly dissatisfied	Dissatisfied	General	Satisfied	Very satisfied	Average score
Course objectives	0.00%	4.26%	12.77%	29.79%	53.19%	4.23
Course resources	1.38%	2.26%	12.51%	20.02%	63.83%	4.28
Course activities	1.26%	3.38%	17.89%	28.53%	48.94%	4.09
Course design	2.03%	8.51%	10.64%	19.25%	59.57%	4.19
Evaluation of course	2.11%	4.38%	12.64%	25.53%	55.37%	4.26

(1) The course objective fully embodies the student-centered: The course objective is of great significance and function to the development of students, which is reflected in teaching activities. Teachers should set different learning goals according to different teaching methods, students' actual learning situation and students' learning needs. Through the hybrid teaching method combining online and offline, 161 people are satisfied with the student-centered, among which 103 people are very satisfied, accounting for 53.19% of the total number. There are 24 students with general attitude, accounting for 12.77% of the total number. There are 8 students who are dissatisfied, accounting for only 4.26% of the total number.

(2) Rich content and diverse forms of course resources: The rich content and diverse forms of students' learning resources are the characteristics and innovations of this study. Teachers can use the high-quality and rich learning resources of MOOC platform to integrate online learning resources and provide them to students. According to the data in the table, in this study, 83.85% of the students are satisfied with the richness of content and diversity of forms of course resources, among which 39 are satisfied and 124 are very satisfied. However, the survey data also reflects that some students are not satisfied with the learning resources, which is also a place that needs further improvement and perfection in the future teaching process.

(3) Diversification of course evaluation methods: Diversification of course evaluation methods means using a variety of different evaluation methods to comprehensively evaluate students. In this

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paper, formative evaluation and summative evaluation are used. According to the data, 80.87% students agree with this evaluation method and are satisfied with these two evaluation methods. Among them, the number of students who strongly agree accounts for half of the total number.

5. Conclusion

This study shows that the construction of computer SPOC course ecology based on grey fuzzy algorithm is an effective method, which can improve the teaching effect and the stability and adaptability of course ecology. And through combing and analyzing the relevant literature, we can see that the research on the ecological construction of computer SPOC course based on grey fuzzy algorithm has made some achievements, but there are still some problems and challenges.

In the future, the research related to this topic can be carried out from the following aspects:

(1) Further study the application of grey fuzzy algorithm in SPOC to improve the accuracy of the algorithm.

(2) Explore how to build a more perfect computer SPOC course ecosystem, including teaching evaluation, incentive mechanism and so on.

(3) Pay attention to the impact of emerging technologies on the ecology of computer SPOC courses, such as artificial intelligence and big data.

To sum up, the research on the ecological construction of computer SPOC course based on grey fuzzy algorithm is a subject of great significance, which requires us to explore and sum up experience in practice and make contributions to the development of higher education informatization. In the future, we can further explore the application of grey fuzzy algorithm in other types of online open courses and the combination with other teaching methods.

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