

Retraction

Retracted: An Empirical Study of Blended Teaching Mode Based on SPOC in the Postpandemic Era

Discrete Dynamics in Nature and Society

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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- [1] X. Chen, J. Guo, and H. Xu, "An Empirical Study of Blended Teaching Mode Based on SPOC in the Postpandemic Era," *Discrete Dynamics in Nature and Society*, vol. 2022, Article ID 7094272, 8 pages, 2022.

Research Article

An Empirical Study of Blended Teaching Mode Based on SPOC in the Postpandemic Era

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The COVID-19 pandemic broke the normal of school education and sounded the horn for future education reform. This paper designs the online and offline mixed teaching mode of the SPOC platform in the postpandemic era according to the actual situation of teaching at application-oriented colleges and universities, and the blended teaching mode is applied to real teaching scenarios. The teaching effect and students' behaviors are analyzed in such scenarios. Empirical research shows that the situational teaching model based on mixed SPOC for course design, teaching resources are more abundant, and task assessments are more reasonable. Through the questionnaire survey, about 95% of the students think that the learning mode based on SPOC has improved their learning interest, autonomous learning ability, and problem-solving ability, which is much higher than the assessment of traditional courses. The exploratory practice has shown that the online and offline blended teaching mode based on SPOC can dramatically improve teaching quality.

1. Introduction

Blended teaching is a teaching method that integrates face-to-face teaching and online learning and has drawn increasing attention in recent years. Under this teaching mode, the students' ability of self-adjustment and their mastery of the learning techniques are put to the test. Meanwhile, the teachers are also faced with the challenges of how to better apply the new technologies to teaching. The education institutions are expected to offer adequate training for teachers on the teaching techniques and other skills that are needed under this blended teaching mode [1]. Since the global outbreak of COVID-19, nearly every educational institution has resorted to online teaching or online and offline blended teaching. New requirements have arisen for teaching in the postpandemic era. All three parties involved, namely, students, teachers, and teaching institutions, must work together to face up to the new challenges. Along with the updates of teaching theories and techniques, the individualized aspect of the blended teaching mode has become a subject of intense interest [2]. Literature [3] discussed the development of the teaching profession and the rapid

undergoing transition towards digital teaching and learning during the COVID-19 pandemic. It was pointed out in literature [4] that higher education institutions are confronted with the demand of making a rapid transition towards online teaching. The new teaching mode is centered around students. It prioritizes instructive learning based on interactions and communications as well as student feedback. Literature [5] discussed the five challenges facing higher education during COVID-19 as it moved towards online education: synchronous/asynchronous learning tool integration, access to technology, faculty and student online competence, academic dishonesty, and privacy and confidentiality. These are also the crucial factors to be addressed and emphasized in the curriculum construction of blended teaching. Many outstanding teaching methods and styles designed specifically for the blending teaching mode have emerged worldwide. The scholars have conducted a large number of dialectical analyses regarding the opportunities and challenges facing this new mode. Apart from the above, extensive empirical studies also offer valuable clues.

So far, the global outbreak of COVID-19 has caused a significant impact on medical education, which further

brings about enormous pressure for project managers and clinical education work. It is now urgent to maintain and continue training education and evaluation. One research [6] offers an overview of the influence of the unprecedented COVID-19 lockdown on education. Some international perspectives were introduced to analyze the influence on rheumatology training. Besides, some retrospective thoughts are described concerning the challenges and opportunities associated with using social media in online education. Finally, it was concluded that the blended teaching mode might be an ideal mode for student learning in the future. Literature [7] introduced how to organize the teaching activities in premedicine and clinical radiology. In one example, the students were required to participate in offline courses regularly and attend the teaching sessions for resident physicians. Literature [8] described a self-adaptive blended teaching method, which was then applied to the neurology course. The teaching effect improvement was significant compared with the traditional face-to-face learning. Some studies [9–11] argued that the COVID-19 pandemic made medical teaching and education difficult. Nevertheless, the innovation of medical teaching by new technologies is expected to give rise to a long-lasting blended teaching mode.

Apart from medicine, some impressive teaching experience in the engineering field has already been reported. Literature [12] pointed out that the COVID-19 pandemic is a great challenge for the entire society and the industry. Under the context of Industry 4.0, engineering courses should incorporate real cases while turning towards the blended teaching mode. Abundant experience is now available for a variety of topics in this field, ranging from theme design to curriculum implementation and from examples of practice to teaching methods. The University of St. Thomas [13] designed a blended teaching mode (discovery, learning, practice, collaboration, and evaluation) for chemical engineering students during the pandemic. The implementation results proved this strategy manageable and effective. Their success also lays a foundation for blended teaching in the postpandemic era. Another research [13] suggested the ease of transferring the teaching of theories and concepts to a blended learning environment as opposed to the difficulty of practical teaching in such an environment. This research also described building a new international teaching platform beyond the conventional laboratory. The experience in platform collaboration sheds some light on building a global education community with shared concerns and interests. Some researchers [14] designed the chemical engineering courses with teams and projects as the basic units. The final report, final exam, and oral evaluation were restructured to support students' learning achievements. Some retrospective thoughts were given to the construction of an online practice community to ensure the quality of students' learning experience and academic achievements.

Many schools and research institutions have been conducting teaching reform based on their respective situations and putting blended teaching mode into practice. In the meantime, scholars worldwide have carried out empirical studies of the implementation effect of the blended

teaching mode. Their finding offers useful information for reference. School of Medicine of Alfaisal University in Saudi Arabia [15] administered an online questionnaire survey to over one thousand students and teachers, which covered the following dimension: communication, student evaluation, technical tools used, and online experience. In this survey, 76% of the respondents planned to incorporate the professional knowledge they learned online into their practice. At ESIC Business and Marketing School [16], there has been a change from the face-to-face teaching environment to a virtual or semivirtual or blended learning environment. The norms of communication, education, organization, evaluation, and planning have been revolutionized. All these changes are favorable for transforming the learning process under the context of teaching innovation. A Spanish scholar [17] believed that innovative teaching methodologies begat blended learning, facilitating competence attainment among engineering students. In another [18] literature, the blended teaching mode at two universities in India during the pandemic was evaluated. Students' performance in the curriculum taught under the conventional mode and the blended mode was compared. It was found that a large number of tools, technologies, frameworks, and models were available for use in the blended teaching mode to improve the learners' competence. Another researcher [19] employed the SPSS software to survey and evaluate students at an Indian college. It was confirmed that the students had a significantly different perception of the prepandemic learning and postpandemic learning methods. This indicates that students have a higher perception of the prepandemic learning blended learning than that of the postpandemic learning web-assisted learning. Hong Kong Polytechnic University [20] carried out a survey among students on the blended teaching mode during the pandemic. It was found that the students had a better learning experience through synchronized or asynchronous online learning. Other researchers adopted different perspectives for their study. Literature [21] analyzed in the light of the lifecycle of incident theory. Literature [22] discussed the efficiency of the online neurology training curriculum under the SPOC and blended learning mode during the COVID-19 pandemic. Another study [23] assessed the psychological health of participants in blended-mode teaching during the pandemic. The results indicated the necessity for strengthening cooperation and communication between relevant parties apart from drawing onto conventional and online learning advantages. In addition to the above-given theory, a large number of recent studies [24–26] have offered guidance on the implementation of the blended teaching mode during the pandemic.

Since the COVID-19 pandemic, it has made a significant impact on normal teaching in universities at home and abroad. Whether in the medical field or in the engineering field, many colleges and universities have adopted the hybrid teaching mode to ensure the normal development of teaching tasks. During this period, many innovative teaching modes and teaching methods have appeared. A large number of studies prove that the implementation of a mixed teaching mode is conducive to the cultivation of

students' self-learning ability and the achievement of professional skills. With full reference to excellent teaching methods, Tianfu College of Southwestern University of Finance and Economics also actively carries out online and offline mixed teaching based on SPOC and has gained certain experience.

2. The Online and Offline Blended Teaching Mode Based on the SPOC Platform in the Postpandemic Era

In early 2020, COVID-19 hit the whole world unexpectedly. The Southwest University of Finance and Economics Tianfu College responded actively to the Guiding Opinions on Online Teaching Organization and Management at Ordinary Colleges and Universities during COVID-19 Pandemic Prevention and Control released by the Ministry of Education. It was required in this opinions that the "schools should not stop teaching and the students should not stop learning even the offline classes are closed. All schools should carry out online teaching activities." The authors put into practice the following aspects of online teaching: selection of the online teaching platform, utilization of the online teaching resources, design of the teaching process, and diversified evaluation of students' performance in the curriculum. Based on large-scale online teaching practice, the authors think retrospectively and prospectively on the teaching mode reform [27]. On this basis, we design a blended mixing mode based on the SPOC platform according to the teaching situation of our school in the postpandemic era.

Based on the teaching practice of our college, the design of the SPOC-based online and offline blended teaching mode in the postpandemic era is illustrated in Figure 1. The blended teaching mode is realized with the SPOC platform as the carrier. The teacher plays a leading role, and the students are at the center of all teaching and learning activities. The teacher first analyses the objects, contents, and environment of teaching. Then, the teacher designs the curriculum and prepares the teaching resources according to the conclusions of front-end analysis. The teacher dominates the implementation of the entire teaching process. Before the class, the teacher prepares high-quality online learning resources to guide self-learning and discussion among the students [28, 29]. During the class, catechetical teaching is carried out with the focus placed on challenging problems. Guidance is performed for the inquiry learning of the students. After the class, instructions are offered to assist the students in summarizing what has been learned and in the mastery of the knowledge points and skills. The students' performance in the course is evaluated based on assignments, quizzes, the number of online course visits, and classroom discussion. Therefore, the students' performance can be evaluated in a diversified manner. The blended teaching mode achieves a profound fusion of information technology and teaching. The teacher is responsible for reshaping the course contents and reconstructing teaching design and teaching procedures.

Once the learning process is restructured, the teaching-learning relationship is also remodelled.

3. An Empirical Analysis of the Teaching Effect for the Course Operating Systems: Principles and Practice

The SPOC-based flipped classroom and the mobile terminals offer robust support for students doing mobile and fragmented learning via mobile terminals [30]. The teaching situation of one specific course, Operating Systems: Principles and Practice, offers a good example for empirical study. We empirically analyze the learning situation of students under the blended teaching mode and assess the teaching effect.

3.1. Design Case of a SPOC-Based Course. Front-End Analysis.

This course is oriented towards students who minor in information management and usually have a poor knowledge base in computer science. However, these students are highly motivated in learning and strong in self-learning ability and self-discipline. However, the students' learning motivation may be dampened if too much theoretical knowledge is imparted through the operating system principle and practice course. In the real world, this course is intended to train the patients to apply what they learn to practice. Contents with strong practicability are prioritized to enhance ability and quality training. The teaching of theoretical knowledge is of lesser importance. As to the teaching environment, 100% of the students in the class have personal computers and use smartphones.

3.1.1. Curriculum Design. The teaching is conducted in a theme-oriented manner. One theme and one task are assigned per week. The teacher prepares microvideo, PPT, and reference materials for instructions in the knowledge points easily accessible for students. The curriculum content mainly includes Windows server configuration and Linux server configuration. The thematic decomposition is shown in Table 1. Here, the theme of Windows FTP server configuration and administration is taken as an example. The knowledge point decomposition and course design are shown in Table 2. The syllabus, courseware, and microvideo for each knowledge point in this theme are prepared and uploaded, along with the reference materials and learning tasks.

3.1.2. Teaching Organization. The students are divided into groups based on the difficulty of the tasks. The competitive mechanism is set up between the groups. That is, question answering and presentation are undertaken competitively. A reward and punishment mechanism is also set up to promote the motivation to learn in each group. Theme-related tasks are assigned before class. Members of each group first learn the assigned contents by themselves by watching the microvideo and PPT. The teacher and the teaching assistant are responsible for students' raising questions on the SPOC

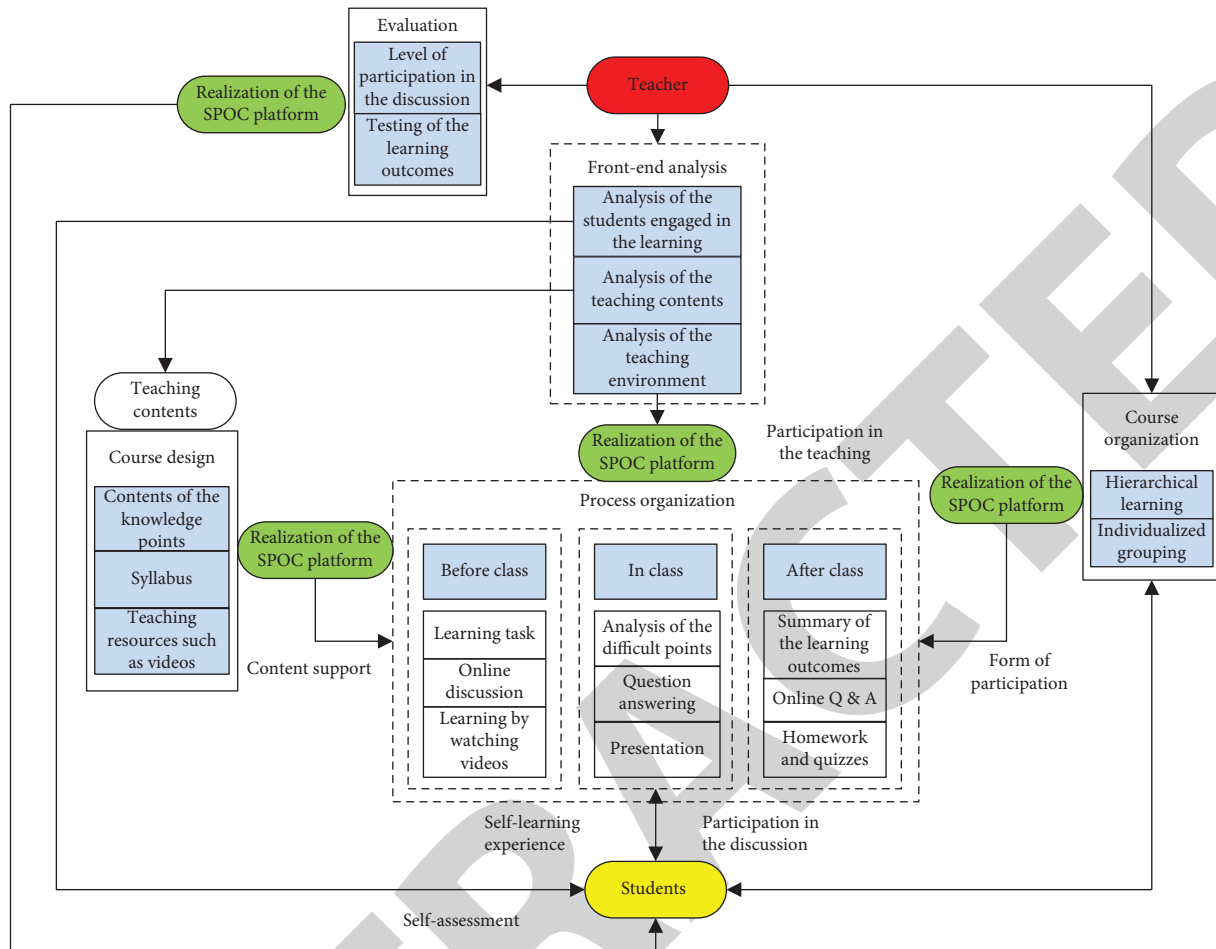


FIGURE 1: In the postpandemic era, the design of the blended teaching mode is based on the SPOC platform.

TABLE 1: Table of thematic decomposition of the Operating System Principle and Practice course.

Windows server configuration and administration		Linux server configuration and administration	
Theme 1	Discussion on virtual machine installation and the three online modes	Theme 1	Linux installation and usage
Theme 2	Windows DNS server configuration and administration	Theme 2	Linux commands and vi editor
Theme 3	Windows FTP server configuration and administration	Theme 3	Linux samba server configuration and administration
Theme 4	Windows WEB server configuration and administration	Theme 4	Linux NFS server configuration and administration
Theme 5	Windows MAIL server configuration and administration	Theme 5	Linux remote access connection server

platform and answering these questions. The group leader is responsible for managing the group’s learning and task completion and realizing hierarchical teaching. The teacher is a director and the students are actors in a flipped classroom. Driven by the theme-related task, each group can choose a presentation or lecturing for in-class discussion and analysis of the difficult points. The teacher is the director responsible for teaching organization and offering summary and analysis when appropriate. After class, the students complete the experiment, and the teacher holds an online discussion on the relevant themes. The emergence of the blended teaching mode has changed the face of the conventional cramming method of teaching. In this context, the

students are motivated for the learning, and the learning is also more pertinent.

3.1.3. Teaching Evaluation. The SPOC platform records the number of logs onto the curriculum, number of courseware downloads, number of views, number of participations in the discussion, assignment submission and completion, and test scores. All of these are included in the appraisal of student’s participation in SPOC-based teaching. The teacher gives part of the scores for students’ performance in flipped classroom teaching according to the students’ participation and discussion in group assignments and offline classroom

TABLE 2: The knowledge point decomposition and content design of the course themes.

Theme 1	Task and guidance on learning (before class: Teaching contents)	Knowledge point decomposition (before class: Course design)	Resources (before class and in class: SPOC platform)	Discussion and expansion (In class: Process organization)	Assignment (after class: Answer questions)
Windows FTP server configuration and administration	1.For the FTP server constructed by the company, the employees of different departments are only allowed to access the FTP catalogs of their own department 2.For the FTP server constructed by the school, different users have different read and write permissions to FTP	Theme 1-1: Construction of the basic FTP site Theme 1-2: Construction of isolated user sites Theme 1-3: The issue of FTP permission Theme 1-4: Permission setting for different users	Theme 1.1: Microvideo PPT Theme 1.2: Microvideo PPT Theme 1.3: Microvideo PPT Theme 1.4: Microvideo PPT	Discussion on the issue of FTP permission setting Learning of FTP commands	Provide guidance for the experiment of constructing FTP sites

activities. Weights are assigned to each evaluation indicator. Thus, the final appraisal is conducted from different dimensions.

3.2. Student Behavior Analysis and Teaching Performance. More than 60 thousand pieces of click data generated during the SPOC-based learning process are collected from 150 students. These data are sorted, cleaned, and converted for the following purposes: to explore the blended teaching mode based on the SPOC platform; study the learning habits of students; get acquainted with the learning motivation and psychological features of the students in learning; improve the teaching mode and the management method; formulate a targeted teaching strategy. The collected data are analyzed statistically to delineate the learning behaviors and habits of the students. We focus on the distribution of the learning hours, contents of students' interest, the influence of the teaching resources on learning, and the use effect of different teaching resources.

Among many indicators of data analysis, the students' weekly activeness and their interest in different teaching resources are analyzed here by citing them as examples. Students' weekly activeness is as follows: the students are more ready to learn on Mondays, Tuesdays, and Sundays. The number of clicks on Friday and Saturday is relatively low (3,546 and 2,990 times, respectively). The number of clicks on Monday and Tuesday is relatively high (8,427 and 10,926 times, respectively), which is about triple that of Friday and Saturday. By contrast, the students feel tired to learn on Fridays and Saturdays, which are holidays. With the overall class schedule unchanged, the online curriculum arrangement can be adjusted based on the students' readiness to learn and according to the learning law to mobilize the learning motivation and maximize the learning outcomes (see Figure 2). The click rate of each type of teaching resources per semester is as follows: microvideo offers a more intuitive way of learning and has become the type of teaching resources with the highest click rate. However, PPT no longer draws interest from the students as it once did. Watching microvideos has become students' favorite way of learning, with a total of 11,970 times played and an average

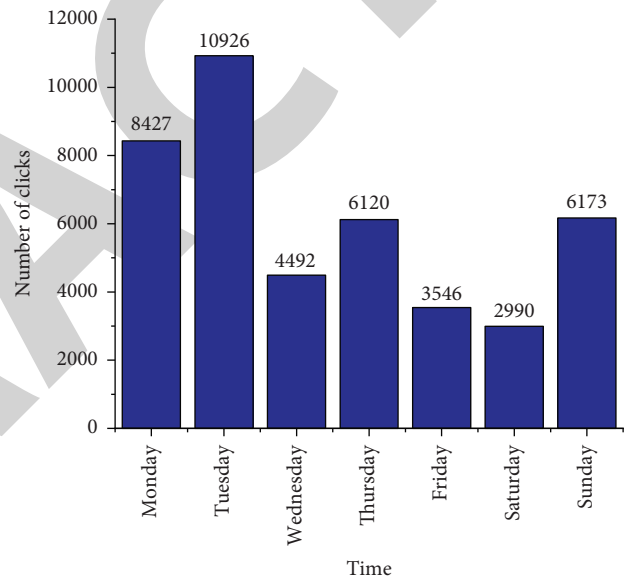


FIGURE 2: The number of clicks made by students per week.

of 1.2 times played per video. Students prefer to quickly acquire knowledge by watching videos on mobile devices. On the SPOC platform, the students prefer participating in curriculum discussions and forums, which accords with the expectation about flipped classroom teaching, with 11,400 responses to the discussion topics, that is almost twice as many as PPT presentations. Teachers and students are engaged in a more active interaction via this teaching mode, which promotes active thinking from the students (see Figure 3).

In this study, 248 students from 3 classes under SPOC-based blended teaching (150 students) and 2 classes under conventional teaching (98 students) were included for comparison within one semester [31]. They were compared in the following dimensions: classroom performance, completion of group task, test-based evaluation, and scores. A questionnaire survey was conducted in students' learning hours, attainment of problem-solving ability, achievement of learning outcomes, feedback concerning the teaching method, and acquirement of the self-learning ability. A total

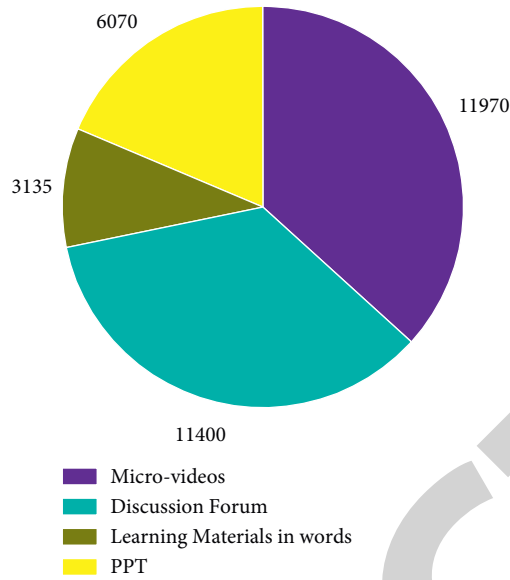


FIGURE 3: A total number of clicks on each learning resource per semester.

TABLE 3: Positive responses (options 4-5) of students to course evaluations in both types of courses.

Items	SPOC		Conventional	
	<i>n</i>	%	<i>n</i>	%
The course has a clear curriculum objective	132	88.00	85	86.73
The course has rich teaching resources	135	90.00	82	83.67
The content design of the curriculum is very good	142	94.67	76	77.55
The course assessment is reasonable	130	86.67	77	78.57
The completion effect of course tasks	132	88.00	85	86.73
The help of course process assessment to master the course content	128	85.33	80	81.63
The interactive part of the course helps to improve learning	145	96.67	77	78.57
Master the ability that the course needs to cultivate	131	87.33	82	83.67
Interest in study has been improved	142	94.67	77	78.57
Self-study ability has been improved	144	96.00	83	84.69
Problem solving skills has been improved	145	96.67	83	84.69

Note. All items were rated on a 5-point Likert scale with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Only the positive responses (options 4-5) are shown.

TABLE 4: Comparison of the SPOC-based teaching mode and the conventional teaching mode.

Item under comparison	Blended teaching based on the SPOC platform	Conventional teaching mode
Classroom performance	Active in class and feeling free to discuss	Lack of vitality, communications and interactions in class
Completion of the theme-related task	Satisfactory completion of the theme-related task	Less satisfactory completion of the theme-related task
Test-based evaluation	High average performance score	Low average performance score
Learning hours	High motivation to learn, with fragmented learning encouraged and facilitated	Shorter learning hours after class
Attainment of the problem-solving ability	Problem-solving ability satisfactorily attained	Problem-solving ability less satisfactorily attained
Achievement of learning outcomes	Learning outcomes satisfactorily achieved	Learning outcomes less satisfactorily achieved
Acquirement of the self-learning ability	Self-learning ability very much improved	Self-learning ability less effectively improved
Acceptance of the learning method	Welcome among the students	Boring learning method

of 248 copies of the questionnaire were distributed and retrieved. The positive responses of students to the evaluation of the two courses (options 4–5) are shown in Table 3. It is easy to see that SPOC courses have a situational design for the content, provide richer teaching resources, and make the task assessment more reasonable and the course objectives more clear. Compared with the traditional course, the interactive part of the course is helpful to improve the learning. About 95% of the students think that the learning mode based on SPOC has improved their learning interest, autonomous learning ability and problem-solving ability, which is much higher than the assessment of traditional courses. The comparison results are shown in Table 4. As shown by the comparison, the effect of SPOC-based teaching is very much improved. The classroom atmosphere is more animated and lively, and the self-learning ability of the students is more effectively trained.

4. Conclusions

The empirical study on the mixed teaching mode of Tianfu College of Southwestern University of Finance and Economics shows that it is necessary to establish a set of mixed teaching mode to cope with the changes in teaching means and information transmission after the outbreak of the epidemic. Of course, first of all, it should conform to the learning situation of most students. Student-centered and output-oriented concept is the core of the design of mixed teaching mode. In order to fully improve students' initiative and sense of participation in learning, teachers need to reconstruct course organization. Students' learning efficiency has been improved, the learning effect is also very obvious, and the ability training has been achieved. Our empirical study has shown that the online and offline blended teaching mode based on the SPOC platform efficiently improves the overall teaching quality.

The COVID-19 pandemic has brought about unprecedented challenges to teaching and broken the conventional teaching pattern. It is time that we think about the future trend in teaching development. As to the teaching contents, the students have easy access to massive, high-quality online learning resources, which is helpful for expanding their scope of knowledge. As to process organization, the online teaching platform offers various interaction tools, including bullet screen, online discussion, and quizzes. The students are more active in class, and the teachers can analyze and respond more rapidly. This feature makes up for the defects with conventional offline classes and improves teaching efficiency. As to teaching evaluation, the online platform provides intact online learning data to track students' completion of assignments and learning hours. Therefore, the teachers can assess the teaching effect and teach the students according to their aptitude more conveniently. In the postpandemic era, the teaching concepts such as individualized and exploratory learning have taken roots along with the rapid development of the mobile Internet. Teachers and students have widely accepted the online and offline blended teaching mode based on the SPOC platform due to its school-based, mobile and fragmented features.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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