JOURNAL OF INFORMATION PROCESSING SYSTEMS JIPS

Signal Processing and Development Process Based on "MOOC + SPOC + Flipped Classroom"

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Abstract

The hybrid teaching approach of "MOOC + SPOC + Flipped Classroom" overcomes the constraints of time and space that are typically associated with traditional teaching methods, thus compensating for the shortcomings of traditional approaches. These changes in education are driven by the "Internet+" wave and the growing popularity of online teaching. The "MOOC + SPOC + Flipped Classroom" hybrid teaching mode can successfully compensate for the drawbacks of traditional teaching methods, thereby overcoming their restrictions. By defining relevant concepts, one can distill the key characteristics of the "MOOC + SPOC + Flipped Classroom" hybrid teaching mode. Formative assessment was employed to thoroughly evaluate the effectiveness of this teaching approach. By leveraging the advantages of massive open online course (MOOC), small private online course (SPOC), and flipped classroom, the "MOOC +SPOC + Flipped Classroom" teaching mode incorporates real-time student assessment through peer evaluation, computer-aided evaluation, and teacher evaluation. This mode promotes the simultaneous development of theoretical knowledge and practical skills, helping students to establish strong foundations while fostering their practical abilities. While the traditional teaching method remains fruitful, the convenience of today's network allows the teaching profession to continually evolve. The traditional teaching mode heavily relies on teachers, making it impossible to conduct lessons without them. However, the development of MOOC enables students to seek knowledge online from their preferred teachers, rather than solely relying on their assigned instructors.

1. Introduction

1.1 Outlook and Advantages

With massive open online course (MOOC) resources as the content and small private online course (SPOC) as the platform, this study adopts a new teaching model called the flipped classroom teaching method. Before introducing other new concepts, the corporate training community first proposed e-learning in the early 90s. However, its effectiveness was general, so blended learning was proposed in 2003. Initially, it was narrowly interpreted as "blackboard + slide" teaching. MOOCs represent a broader definition of blended teaching, while SPOC and flipped classrooms represent a narrower interpretation of blended learning. The theoretical foundation of blended teaching is constructivism, which emphasizes

the construction of learning scenarios, environments, and interaction methods, through the use of technology.

1.2 Article Introduction

The presentation of knowledge has undergone significant changes due to advancements in modern science and technology, which has introduced new challenges in classroom instruction [1]. In traditional classroom setting, teachers lecture while students listen, with teachers assuming a leadership role and students acting as followers. However, this approach has not effectively nurtured students' creativity for an extended period [2]. As information technology continues to advance, universities are experimenting with different approaches to enhance educational development. Consequently, there is a gradual transition from conventional teaching techniques to a "computer–assisted computer-assisted + classroom" model [3]. Given this situation, the advantages of online education platforms have become more apparent.

In recent years, MOOCs, an emerging online teaching platform [4], have attracted significant attention and exerted a profound influence on traditional teaching. The question of whether MOOCs can replace conventional classrooms has become a hot topic in the field of education. However, an analysis of the MOOC platform reveals that it offers only one teaching mode, limiting teachers' ability to adapt their lesson plans to specific circumstances. Additionally, collaborative and personalized learning is not emphasized in MOOC instruction. As a result, the use of MOOCs to teach higher-level vocational education remains challenging. On the other hand, SPOC classes are tailored to specific audiences and well-suited for hybrid teaching methods. SPOC instruction can accommodate students' abilities and learning preferences by employing a blended teaching model [5]. Moreover, it can fully utilize the strengths of the teacher. Therefore, SPOC is more relevant than MOOCs [6].

This teaching research introduces the new teaching mode of "MOOC + SPOC + Flipped Classroom" through a reform in general education on innovation and entrepreneurship. This approach maximizes the respective advantages of each mode and cultivates innovative talents that align with the realities of local colleges, universities, and related industries and professions. It serves as a reference for local colleges and universities in finding suitable teaching practice and can be utilized as a resource for identifying models that align with their unique development characteristics. Simultaneously, this teaching research not only promotes the integration of educational technology and instruction but also drives innovations in instructional strategies and learning philosophies. Additionally, it opens up possibilities for the modernization of higher vocational and technical colleges. Ultimately, it successfully captures students' interest in learning, fosters their independence, and equips them with the necessary tools to develop lifelong learning habits.

1.3 Advances in Research

Flipped teaching subverts the traditional "teacher teaching + student homework" mode by allowing students to choose their preferred learning method. This approach deepens students' knowledge absorption in the classroom and transforms teaching into a "process of independent learning + answering questions," thus enhancing students' learning efficiency. Additionally, flipped teaching changes the dynamics between teachers and students, with teachers assuming the role of learning guides and students transitioning from passive to active in the classroom. Furthermore, it enables personalized learning, allowing students to tailor their learning experiences to their individual preferences. In contrast,

traditional classroom teaching follows a teacher-centered, book-centered, and classroom-centered approach, where knowledge mainly originates from the teacher's instructions. In this mode, all teaching activities are initiated by the teacher, and students can only acquire knowledge according to the predefined teaching steps.

1.4 Introduction to the Process

Section I provides an introduction to the article, while Session II elaborates on the design concept of blended teaching. Following that, Section III introduces the teaching model, and Section IV focuses on pattern design. Lastly, Section V provides a summary of the overall design.

2. Concept of Hybrid Teaching Model Construction

2.1 Use "MOOC" Well

Many participants, unlimited learning opportunities, shared learning resources, and independent learning are the four main characteristics of a MOOC, officially known as a "massive open online course" [7]. Online learners can complete the course on their own. Online communication is a valuable addition to the course's extensive resources, which include videos, courseware, supplementary materials, assignments, quizzes, and discussions with the instructor and fellow students. There is limited interaction between teachers and students, resulting in a low completion rate, and posing difficulties for teachers to identify issues and ensure high-quality instruction. Furthermore, MOOCs offer a wide range of instructional resources of varying quality. In order to facilitate the sharing of quality teaching across campuses, learn from and absorb their peer's excellent teaching experiences, and further optimize their classroom resources, teachers should fully utilize the MOOC platform.

2.2 Build a Good "SPOC"

SPOC is the acronym for small private online teaching, small limited online teaching, or small private online teaching [8]. SPOC is a highly customized online course with a small enrollment of only a few dozen to several hundred students. It is designed to provide classroom-like instruction within schools, filling the gap in MOOC education. SPOC offers the advantages of being focused, collaborative, and audience specific. It enhances traditional classroom instruction by combining MOOC and conventional campus course learning, effectively boosting students' motivation, participation, and learning outcomes [9]. By integrating online open courses with traditional on-campus education, SPOC can cater to students' educational backgrounds, career goals, subject characteristics, and current situations in nearby higher vocational institutions. In doing so, it can overcome the challenges in MOOC teaching through the principles of customization and adaptability.

2.3 Doing "Flipped Classroom" Well

The teaching process, mode, and methods in a flipped classroom are reversed [10]. In this approach, the teacher prepares the instructional materials in class, imparts the essential knowledge, and then facilitates consolidation outside of class. On the other hand, in a flipped classroom, the teacher prepares

the knowledge focus of the course through video teaching, pre-class discussion, pre-class investigation, and research activities. In class, teachers and students collaborate on experiments, discuss and learn together, etc. This shift allows students to actively acquire knowledge points instead of being forced to accept them, enabling continuous internalization of knowledge points. The teacher's role also evolves during this process, transitioning from initial instruction supervision and knowledge transfer to that of a mentor and facilitator. However, the pre-work completed by students in the learning process has some drawbacks related to their operation level and learning capacity. To address these drawbacks, a novel instructional approach called the "flipped classroom" promotes both teacher-led and student-led learning [11]. It is crucial to strengthen monitoring of student learning progress and improve feedback mechanism to better manage the pre- and post-phases of the "flipped" classroom. Furthermore, it is important to ensure that the "flipped" classroom instruction is effective and enhances instruction quality. In summary, to enhance teaching effectiveness in higher education institutions, it is important to fully utilize various teaching techniques, means, and methods, taking into account their strengths and weaknesses.

3. Characteristics of the "MOOC + SPOC + Flipped Classroom" Hybrid Teaching Model

3.1 Teaching Flow Conversion

The traditional method of instruction consists of two parts: first, teachers impart knowledge in the classroom, and second, students are free to continue their education after class. The teacher imparts the knowledge in the classroom, where it is then fully understood and absorbed through practice, review, and exercises. The previous teaching approach, in which students could learn and think independently by viewing texts, course materials, and videos provided by the teacher before class to achieve knowledge absorption, is disrupted by the hybrid teaching approach of "MOOC + SPOC + Flipped Classroom" [12,13]. When answering challenging and important questions, the teacher will organize and direct the class to help the students deepen their understanding in a variety of ways (group discussion, reporting, collaboration), and after the lesson, the knowledge will be further expanded and sublimated through practice. The online and offline teaching organization and sharing systems are presented in Fig. 1.

3.2 Changing Roles of Teachers and Students

In the traditional teaching method, the "full classroom" approach renders students passive, while the hybrid teaching model of "MOOC + SPOC + Flipped Classroom" has completely transformed the roles of teachers and students.

The teacher assumes the roles of designer, organizer, and instructor of instruction. Firstly, prior to the class, the teacher ought to diligently prepare various materials, such as teaching videos. High-quality educational resources have the potential to stimulate students' interest in learning, ignite their motivation, and enhance their overall learning performance. This model empowers teachers to develop teaching plans while broadening their range of choices. Teachers often create targeted micro-lessons that cater to their specific teaching needs, rendering them the designers and researchers of these micro-lessons. Secondly, the hybrid teaching mode of "MOOC + SPOC + Flipped Classroom" primarily manifests itself through the interaction between teachers and students within the classroom. Teachers play a guiding role in the

teaching process, while students actively participate, comprehend, and internalize knowledge through collaborative inquiry and mutual communication. The creativity exhibited during classroom instruction and the level of student engagement are significantly associated with the final outcome of the teaching process. Hence, teachers, as the primary facilitators of teaching activities, should design, organize, participate, and guide the entire teaching process. Outside of regular class hours, teachers should assign students extracurricular assignments or additional homework, and provide appropriate assistance to address questions, facilitating students in summarizing, reflecting, expanding, and reinforcing what they have learned.
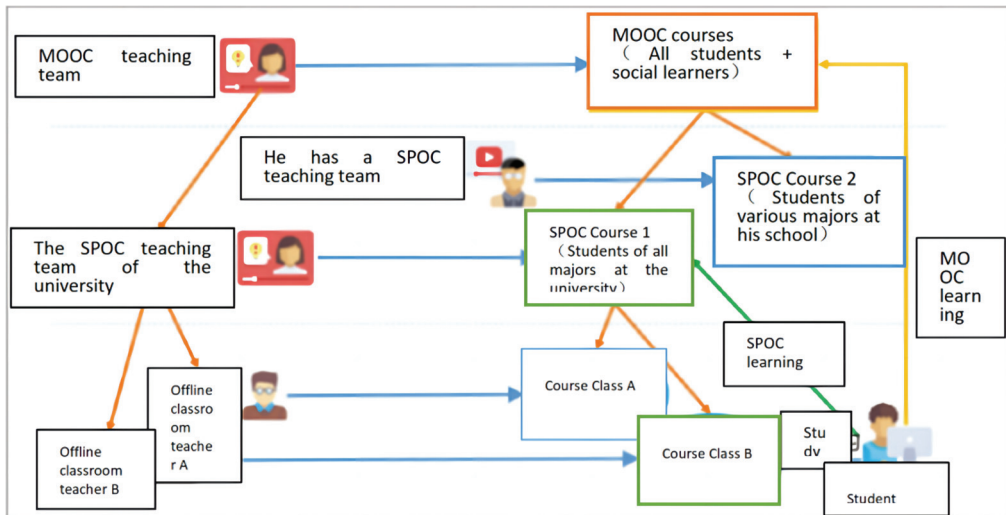
Fig. 1. Online and offline teaching organization and sharing system.

3.3 Change of Teaching Management Style

The roles of teachers and students have changed in the "MOOC + SPOC + Flipped Classroom" hybrid teaching approach, altering how teachers oversee their classes. The management and control of the classroom by the teacher are more flexible in this teaching model, and the teacher's deliberate provision of teaching resources supports students' independent learning in the classroom. Teachers must be more adaptable and respective to the specific circumstances since the exact format and content of classroom inquiry, discussion, and debriefing are uncertain.

4. Blended Teaching Model Design

4.1 Design a Teaching Content System Applicable to Multiple Platforms

Multi-platform refers to the inclusion of various educational platforms, such as the flipped classroom platform, MOOC platform, and SPOC platform. This section encompasses three essential modules: interactive activity module, a learning content module, and a basic course information module. Its purpose is to serve as a comprehensive teaching content system that caters to the unique learning characteristics and needs of higher vocational students.

4.1.1 Course basic information design

The foundational material for the course should be designed with a clear understanding of the needs of the students because there is a wide range in the backgrounds of students in vocational and technical colleges. Each item should be presented in as much detail as possible to capture the student's attention. The course outline, an explanation of the objectives, time constraints, knowledge requirements, grading standards, and criteria for awarding credit and certificates are all included in the course basics module. The learning objectives and course syllabus are structured to be brief, and understandable, adhering to the instructor's design process for teaching activities. Care is taken not to mix them with lecture material. It is important to teach students in a reasonable time frame and in a way that better reflects their learning styles. To ensure that learners can prepare their knowledge in advance according to their needs or select the learning path most appropriate to their abilities, the necessary knowledge reserve should be stated as completely as possible. Additionally, evaluation methods and criteria should be developed in a timely and scientific manner so that learners can better understand their learning status and make appropriate adjustments promptly.

4.1.2 Learning content design

According to the book *How People Learn*, the most significant modifications to the idea of learning have been made in the following areas: memory and knowledge structure, problem-solving and expert analysis, early foundations, metacognitive processes, and self-regulation skills, cultural experience, and community involvement. These five themes should be integrated into the content design, with some teaching taking place on the SPOC platform and an outline that focuses on concepts, memory, and structural knowledge. The goal of the flipped classroom is for students to learn more effectively. The core teaching strategies for the subject matter include problem-solving, inquiry, recall, cultural experiences, and cultural experiences. The course material is created to meet students' learning needs while also offering specific solutions and answers in a flipped classroom, thereby boosting motivation among the students.

4.1.3 Interactive activity design

To enhance students' personalized growth and foster their ability for self-directed learning, the implementation of the interactive activities' module on the SPOC platform is imperative. The interactive activities proposed for teachers encompass forum interactions on the SPOC platform, asynchronous and synchronous engagements facilitated by other interactive tools (e.g., microblogs, discussions, QQ groups, public accounts on WeChat, wikis, BBS), and peer-to-peer support, etc. Moreover, it is essential to establish effective communication channels among teachers and students, students themselves, and between teachers and students, as well as with learning resources.

4.2 Designing Personalized Learning Strategies

Learning strategies are intended to assist students in controlling their learning so that information can be effectively stored and retrieved. The diversity of students' learning pathways, participation rates, and learning outcomes in higher education institutions depends on the variety of their learning motivations and learning environments. To cater to each student's unique needs and promote their diverse

participation and learning, personalized learning strategies should be implemented throughout the learning process.

4.2.1 Personalized learning style selection

Students can learn whenever they want on the SPOC platform, and the system will keep track of their progress and record the learning time and place for subsequent lessons. The instructional design of the flipped classroom is becoming more diverse on the SPOC platform. In the MOOC stage, Li et al. [14] suggested various approaches such as "independent learning," "blended learning," "hybrid learning," "blended learning," and "collaborative learning." In this paper, we propose the application of these instructional design approaches to different classroom teaching modalities and the development of a blended learning model based on these two modes, allowing learners to actively participate in the classroom or observe remotely.

4.2.2 Personalized learning path selection

As part of the individualized learning process, students independently select their study topics, and learning goals, create their own learning schedules, and devise unique learning paths based on their prior knowledge and experiences. While teachers offer students the necessary learning resources, students have the freedom to decide whether they wish to learn based on the existing learning environment, revisit or construct knowledge they already possess, and personalize their learning paths by designing and implementing learning programs that specifically cater to their knowledge, aptitude, and learning objectives.

4.2.3 Knowledge network building personalization

Combining theoretical knowledge with practical skills, relating past experiences to current knowledge, creating a network of personal knowledge, and conceptualizing knowledge are all examples of this phenomenon. Throughout this process, students have the ability to utilize various learning resources in diverse learning environments, gather information, and engage in communication with SPOC classes, peers in the classroom, and teacher-student interaction. These interactions facilitate the processing, organization, and sorting of the gathered information, ultimately leading to the formation of a knowledge network that will be used for future knowledge integration and construction.
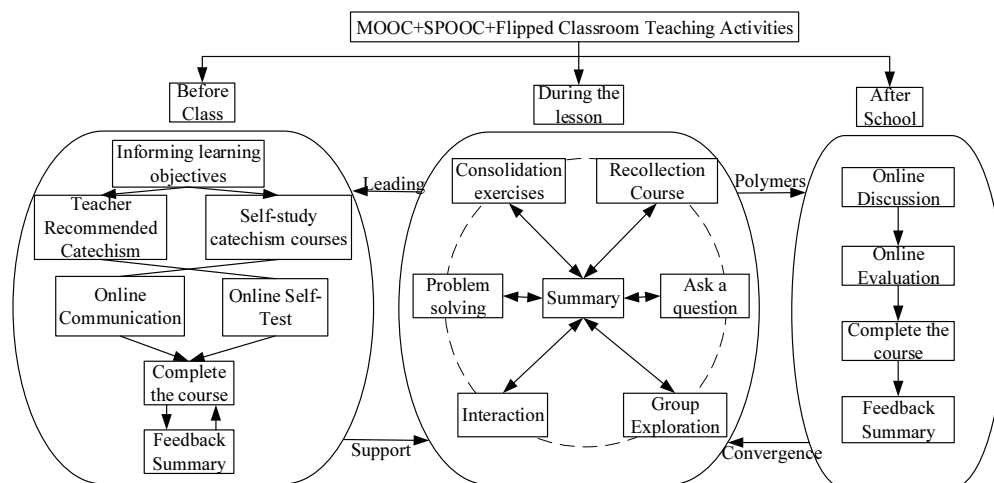
4.3 Designing Diverse Teaching Activities

"Teaching activity" refers to the collaborative learning between teachers and their affiliated research teams to target a specific teaching goal or outcome. The model consists of two primary sections, as shown in Fig. 2, which encompass the teaching activities on the SPOC platform, MOOC platform teaching activities, and flipped classroom teaching activities. The teaching activity within a flipped classroom occurs during the class session, while the SPOC and MOOC platforms entail teaching activities that transpire prior to and subsequent to the class.

4.4 Designing a Diversified Teaching Evaluation System

A multifaceted assessment system, supported by learning analytics technology, encompasses process

and summative assessment, with formative assessment being its primary component. Learning analytics technology is utilized to develop a personalized support system for higher education, which analyzes educational data to identify trends and patterns [15,16]. Assignments, unit tests, group activities (primarily using activity level, peer assessment, etc.), classroom assignments, and performance in those activities (primarily using the teacher's and students' assessments) are all examples of formative assessments. The learning behaviors of students are analyzed qualitatively to extract pertinent data. To effectively intervene with students, teachers, educational administrators, etc., the quantitative clustering of learner similarities is used based on this. Second, while summative assessments are carried out through online learning tests and conventional school final exams, game-like quizzes or inquiry-based tests related to the course content can be designed to improve learning guidance so that students can better master and apply what they have learned. This variety of learning assessment techniques can accurately reflect students' performance in the learning process, encouraging students to actively engage in learning.

Fig. 2. A model for the design of diversified teaching activities.

4.5 Analysis of Practice Results

An evaluation scale and questionnaire were created during the semester of mixed teaching in order to reflect the actual circumstances of the students. To ensure a fair and accurate evaluation, the questionnaire and interview were combined to obtain a comprehensive understanding of the effectiveness of the internship. The process has significantly improved, as shown in Table 1, in terms of the development of theoretical knowledge and abilities. For this study, a questionnaire and pre-test questions were designed to assess aptitude, primarily to understand the participants' learning foundation and learning style. Based on survey results and the principle of differentiated grouping, the subjects were divided into nine groups each electing a team leader, responsible for organizing offline learning activities, online problem-oriented learning project practice, and group member evaluations. Personalized teaching tasks were assigned to each group based on their level, leading to a layered teaching approach. In terms of experiential flipped classroom organization, this study incorporated a 3-hour pre-class online Q&A session every week using SPOC forums, WeChat groups, QQ mailboxes, and other tools to enhance the effectiveness of students' independent and cooperative learning.

Table 1. Student learning effectiveness evaluation

Projects	Very helpful	More helpful	General	No help
Mastery of theoretical knowledge points	37 (62)	14 (23)	9 (15)	0 (0)
Problem-solving skills	30 (50)	16 (27)	14 (23)	0 (0)
Learning interest enhancement	29 (48)	28 (47)	3 (5)	0 (0)
Communication and presentation skills improvement	22 (37)	27 (45)	11 (18)	0 (0)
For their future development	19 (32)	26 (43)	15 (25)	0 (0)

Values are presented as number of participants (%).

5. Conclusion

Although blended teaching has been widely used today, there are still some disadvantages. For example, the application of the Internet can make it difficult for many students and their parents to control their behavior effectively. Additionally, some students become overly reliant on the Internet, leading to a decline in their memory capacity when there are no physical textbooks as a reference. They may rely heavily on online resources for their memory needs. Moreover, teachers face numerous challenges when implementing hybrid teaching strategies aimed at enhancing overall student quality. In order to improve the general standard of education for their students, teachers in MOOC+ SOPC+ Flipped classrooms must be proficient in instructional design, instructional control, and information technology. To fully support the implementation of the flipped classroom approach, schools should adopt various reform measures, starting from the external environment and addressing teachers' internal needs. This will enhance the effectiveness and long-term development of student learning. The combination of SPOC and MOOC teaching promotes the online learning effect of intensive education, micro-course education, niche teaching, and traditional classroom teaching. This approach makes offline learning activities more efficient and flexible, ultimately improving the quality of classroom teaching. It effectively promotes the integration of classroom teaching with online learning, independent learning, cooperative learning, and interactive communication among teams.

Acknowledgement

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