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Article

Biomechanical analysis helps innovation and application of ideological and political teaching model of SPOC flipped classroom for biopharmaceutical majors in universities

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Abstract: With the rapid development of artificial intelligence and modern educational technology, the traditional classroom teaching model can no longer meet the requirements of today's higher education for the comprehensive quality training of students. Especially in interdisciplinary majors such as biopharmaceuticals, relying solely on traditional teaching methods is no longer sufficient to improve students' professional ability and social responsibility effectively. In this context, the deep integration of ideological and political education with professional course teaching has become an important issue in education reform. In response to this demand, this paper proposes a teaching model that combines the SPOC (Small Private Online Course) platform with the flipped classroom, aiming to enhance student's learning interest, professional ability, and social responsibility through the combination of online self-learning and classroom interactive discussion. This study selected 40 biopharmaceutical students from Wuhan East Lake University as the research subjects and used the literature data method, questionnaire survey method, teaching experiment method, and classroom observation method to comprehensively explore the application effect of the teaching model based on the combination of the SPOC platform and the flipped classroom in the ideological and political education of biopharmaceutical majors. The results show that 90% of the students support this model, believing that it can effectively stimulate learning enthusiasm and help students better understand the core knowledge of the major, especially in the fields of drug development, molecular biology, and bioengineering, and enhance the penetration of ideological and political education.

Keywords: SPOC platform; flipped classroom; teaching design; teaching practice; ideological and political education; biology

1. Introduction

With the rapid development of information technology and the continuous advancement of education reform, the traditional teaching model has been unable to meet the needs of modern higher education, especially in interdisciplinary majors such as biopharmaceuticals. The teacher-centered teaching method in traditional classrooms often neglects the cultivation of students' independent learning ability and thinking and also fails to effectively integrate ideological and political education into professional courses. However, the biopharmaceutical major not only requires students to master solid subject knowledge but also needs to cultivate students' innovation ability, social responsibility, and professional ethics. How to balance professional knowledge and ideological and political education in the teaching process has become an important issue in the current education reform.

Based on this, this study explores the teaching mode combining the SPOC platform and flipped classroom. SPOC, as a personalized online learning platform, can achieve flexible and autonomous learning; while flipped classrooms encourage students to take the initiative to learn by transferring traditional classroom teaching content to extracurricular activities, and using more classroom time for interactive discussions and problem-solving. Applying this model to biopharmaceutical professional teaching can better help students master core knowledge, such as drug research and development, molecular biology, and bioengineering, and at the same time help to strengthen the penetration of ideological and political education and cultivate students' social responsibility and professional ethics [1].

So that our university and other institutions can theoretically support each other in resolving common issues, the teaching mode of modern educational technology experiment courses is built by the features of the subject. Based on the current state of IPE (Ideological and Political Education) at Wuhan Donghu University and utilizing the flipped classroom as a teaching model, this study developed the flipped classroom teaching approach for colleges and universities based on the existing state of IPE in our university and with the help of the flipped classroom teaching concept. It offers theoretical direction for college instructors to modify their pedagogical approaches.

The new teaching model of flipped classrooms has greatly changed everyone's study life. DeRuisseau uses a flip model to allow students to watch a 20-minute lecture outside of class 2 days a week. He compared cross-curricular forms of problems through Bloom's classification. There are many uncontrollable factors in his research [2]. Asiksoy aims to determine the impact of the flipped classroom approach applied to physics courses on student achievement, motivation, and self-sufficiency. His research involves 66 students and is divided into two physics courses. His research is not accurate enough [3]. The purpose of Cotta's research is to compare the effects of using the flipped teaching method and the traditional teaching method to teach drug calculation courses. His research lacks innovation [4].

This study explores the application of the teaching model based on SPOC combined with flipped classrooms in the ideological and political education of biopharmaceutical majors, aiming to provide a useful reference for the education reform of colleges and universities and the training of biopharmaceutical professionals. The characteristics of the teaching resources that learners pay attention to and their learning expectations for the course are explored to provide a basis for the design of teaching resources and the recommendation of personalized learning resources. Through the exploration of this model, students' professional abilities can be improved, their ideological and political literacy can be enhanced, and compound talents with innovative ability and social responsibility can be cultivated.

2. SPOC and flipped classroom

2.1. The relationship between basic biomechanics theory and biopharmaceuticals

As an interdisciplinary subject, biomechanics mainly studies the mechanical behavior of biological systems at the cell, tissue, and organ levels, explores the

mechanical properties of the internal structure of organisms and their functional relationships, and provides a unique perspective for understanding the physical basis of life activities. In the field of biopharmaceuticals, biomechanics not only helps to understand how drug molecules are transported and function in the body but also provides a scientific basis for optimizing drug development strategies. The goal of biopharmaceuticals is to develop drugs that can effectively treat diseases. This process involves the interaction between drug molecules and organisms, and biomechanics helps to reveal the physical mechanisms of these interactions.

At the cellular level, biomechanics focuses on the study of cell morphology, movement, and its interaction with the surrounding environment, especially how cell mechanics affects the absorption and mechanism of action of drug molecules. For example, the fluidity of the cell membrane and the stability of the cytoskeleton are directly related to whether drug molecules can effectively enter the cell and function. Through biomechanical analysis, the absorption efficiency of drug molecules can be predicted more accurately, thereby optimizing drug design and delivery mechanisms. This provides scientific support for drug development in biopharmaceuticals, especially in the study of the interaction between drug molecule size, shape, and cell membrane, where mechanical properties are crucial to the biological activity and effect of drugs.

At the tissue level, biomechanics further studies the mechanical response and adaptation mechanism of tissue structure, which has a profound impact on the fields of bioengineering and biopharmaceuticals. The mechanical properties of tissues not only affect the design of biomaterials but are also directly related to the delivery and efficacy of drugs. For example, in biomaterial design, by simulating the mechanical environment of tissues, implants, and drug carriers that are more in line with the physiological needs of the human body can be developed; and in the process of drug development, understanding the mechanical response of tissues to drugs can help optimize drug delivery methods and improve therapeutic effects. Through biomechanical analysis, it is possible to study how drugs are transported through different tissue levels in the body and adjust the drug release method according to the mechanical properties of tissues to further improve the therapeutic efficiency of drugs.

In addition, the application of biomechanics is not limited to the mechanical properties of drug molecules and tissues but also includes bioengineering practices in the field of biopharmaceuticals. For example, when designing drug delivery systems and developing new drug carriers, biomechanics can provide simulations of the mechanical environment to help optimize the biocompatibility and efficacy of drug delivery systems. Through in-depth research on the mechanical properties of tissues and cells, biomechanics provides strong technical support and a theoretical basis for drug development.

In short, the role of biomechanics in biopharmaceuticals cannot be ignored. It not only provides a mechanical basis for drug development, but also has important application value in drug delivery, optimization of therapeutic effects, and biomaterial design. Integrating biomechanics into the teaching of biopharmaceuticals not only helps students to deeply understand the physical mechanism of drug development but also cultivates students' scientific research ability and innovative thinking, which is of

great significance for improving students' comprehensive quality and promoting technological progress in the field of biopharmaceuticals.

2.2. SPOC teaching mode

The core significance of a flipped classroom lies not only in building an appropriate learning platform, but also in the classroom between teachers and students, face communication, thinking collision, emotional resonance, and hands-on practice in the classroom, which is the key process to promoting the internalization and application of knowledge. However, the realization of these aspects completely depends on Teachers' accurate grasp of the teaching situation of the teaching class. When calculating the mixing parameters *a* and *b*, the rules used are as follows [5,6]:

$$a = \sum_{i}^{c} \sum_{j}^{c} x_i x_j a_{ij} \tag{1}$$

$$b = \sum_{i}^{c} x_i b_i \tag{2}$$

where,

$$a_{ij} = (a_i a_j)^{\frac{1}{2}} (1 - \overline{K}_{ij}) \tag{3}$$

where $\overline{K}_{ij}$ is the dual interaction coefficient? *A* and *b* are mixed parameters.

SPOC integrates online resources with offline interactions, allowing students to watch teaching videos, engage in self-study, and participate in group discussions. This model promotes deeper understanding and memory retention, while offline components encourage face-to-face communication. Unlike MOOC (Massive Open Online Course), SPOC is more tailored to independent learning and aligned with the flipped classroom approach. It offers a more personalized and effective learning experience, supporting theoretical study, practical problem-solving, and collaborative exploration. Lessons from top universities' SPOC practices should inform and enrich university teaching methods, enhancing both theoretical and practical learning outcomes.

It is necessary to deeply understand the connotations, characteristics, and advantages of SPOC, and draw lessons from and summarize the practical experience of SPOC courses in top universities at home and abroad. This research process will help enrich the theoretical basis of SPOC and university course teaching. On the SPOC platform, students can obtain teaching video resources through the network, watch these teaching videos repeatedly online, and self-study theoretical knowledge offline, so that learners have enough time to solidly study theoretical knowledge; The process of teachers' teaching knowledge in class is not only an exercise for students' ability to solve practical problems, but also can deepen the memory of knowledge. Students have online group discussions and complete the exercises of pre-class test questions. The learning and exploration path will be recorded on the platform to facilitate teachers' later analysis and sorting of data. Most SPOC courses are interspersed with offline parts, and students and teachers can also learn and communicate face-to-face offline. Compared with MOOC courses, SPOC courses are more suitable for students

to carry out independent learning. Combined with the current practice and in-depth flipped classroom teaching, SPOC is closer to the teaching process of colleges and universities, and this teaching mode should be actively promoted in college courses. Substitute the P-R equation and the above mixing rule into the following formula:

$$RT\ln(\frac{f_i}{y_i P}) = RT\ln\varphi_i = \int_1^{\infty}[(\frac{\partial P}{\partial n_i})_{T,V,X_i} - \frac{RT}{V}]\,dV - RT\ln z \tag{4}$$

The enthalpy of an ideal gas is:

$$H^{\cdot}(T) = H(298) + \int_{298}^{T} C_P dT \tag{5}$$

In the formula, $H^{\cdot}(T)$ the gas enthalpy of the pure component in T is an ideal state [7].

The deviation enthalpy is the deviation of the enthalpy of the actual gas and the ideal gas, which can be solved by the P-R equation.

$$\Delta H = RT[z - 1 - \frac{1}{2\sqrt{2}B^{\cdot}}\ln(\frac{z + 2.414B^{\cdot}}{z - 0.414B^{\cdot}})] \tag{6}$$

In the formula, ΔH is the enthalpy of deviation, and R is the gas constant.

The control parameters of the fuzzy controller are as follows:

$$U = (E \times Ec) \circ R(E, Ec, U) \tag{7}$$

The enthalpy of the actual gas phase is:

$$H_i^{v}(T) = H_i^{v}(T) + \Delta H \tag{8}$$

In the formula, $H_i^{v}(T)$ is the gas phase enthalpy at T of the pure component i.

The actual gas enthalpy is:

$$H^{V}(T) = \sum_{i=1}^{\varepsilon}[H_i^{v}(T)x_i] \tag{9}$$

The enthalpy of the actual liquid phase is:

$$H_i^{L}(T) = H_i^{\mathrm{v}}(T) - \Delta H_i^{\mathrm{v}}(T) \tag{10}$$

In the formula, $H_i^{L}(T)$ is the liquid phase enthalpy of component i at T.

$$x = \frac{X_{\min} + X_{\max}}{2} + k(X' - \frac{X'_{\min} + X'_{\max}}{2}) \tag{11}$$

$$k = \frac{X_{\max} - X_{\min}}{X_{\max}^{t} - X_{\min}^{t}} \tag{12}$$

where $X_{\max}$ is the maximum value of X, and $X_{\min}$ is the minimum value of X.

$$\ln r_i = \ln r_i^C + \ln r_i^R \tag{13}$$

$$\ln r_i^R = \sum v_k^i [\ln \Gamma_k - \ln \Gamma_k^{(i)}] \tag{14}$$

$$\ln \Gamma_k^{(i)} = Q_k [1 - \ln(\sum_m \theta_m^{(i)} \psi_{mk}) - \sum_m \frac{\theta_m^{(i)} \psi_{km}}{\sum_m \theta_n^{(i)} \psi_{nm}}] \tag{15}$$

Among them, $\theta_m^{(i)}$ is the surface area fraction of group m in component *i*.

The five-dimensional mix of SPOC teaching is shown in **Figure 1**. This reflects the hybrid nature of SPOC teaching [8]. In this way, for most students, mastering the learning content can be done and the teaching goals can be achieved [9].

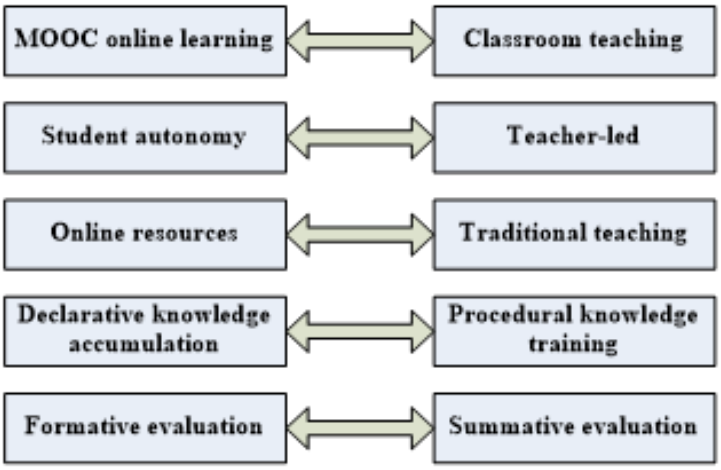

Figure 1. SPOC teaching five-dimensional mix.

On the SPOC platform, we provide a variety of teaching resources for students majoring in biopharmaceuticals, especially biomechanics-related content. These resources include cell mechanics experimental demonstration videos, mechanical simulation animations of drug delivery, etc., which are designed to help students deeply understand the operating mechanism of biological systems from a mechanical perspective. Students can obtain these teaching video resources through the online platform, watch the teaching videos repeatedly online, and learn theoretical knowledge by themselves so that learners have enough time to learn theoretical knowledge. By watching the cell mechanics experimental demonstration, students can intuitively observe the response of cells under different mechanical stimuli, thereby deepening their understanding of the principles of cell mechanics. The mechanical simulation of drug delivery shows how drug molecules pass through different tissue barriers in the body and the various mechanical factors that affect this process, providing students with a new perspective on drug development.

When guiding students to use these resources for self-study, we pay special attention to combining biomechanical knowledge with biopharmaceutical expertise. For example, when explaining the drug development chapter, we not only introduce the chemical structure and mechanism of action of the drug but also show the diffusion process of drug molecules in the body through online videos. In the video, from the perspective of biomechanics, we will analyze in detail the various factors that affect the diffusion of drug molecules, such as the size and shape of the molecules, and the mechanical properties of the tissues they pass through. This combined teaching method enables students to master professional knowledge while also having the ability to analyze and solve problems from a biomechanical perspective, laying a solid foundation for their future research and career development.

2.3. Flipped classroom

The "flipped classroom" teaching mode emphasizes the cultivation of students' self-learning awareness and innovative awareness in terms of the organization of teaching resources, the design of classroom teaching activities, and the support of the teaching environment. These characteristics indicate that the "flipped classroom" teaching model is in line with the current national training goals for innovative talents.

Compared with the past, the requirements of the new society for students are more diversified and require flexible learning and use of knowledge, which is completely reversed from the traditional teaching mode [10]. The mode of turning the classroom is the need of the development of the times. Students can watch and learn repeatedly when they are self-learning teaching videos before class, and their learning activities will be recorded and saved by the platform. Flipped classroom teaching is adopted in classroom teaching. Teachers can collect students' information before class and then give personalized guidance to students according to this information [11].

The integration of blended learning leads to the complexity of its learning environment. The analysis of the learning environment must focus on the external environment of teaching activities [12]. Teachers pre-evaluate SPOC teaching resources, including teacher evaluation and student evaluation. Through the statistical analysis function of the teaching platform, the effectiveness, breadth of knowledge, interest, method of delivery, and level of video production of the educational material are all examined by the students. The underlying principle and cornerstone of in-depth learning is preliminary analysis. By enhancing the features and procedures of the SPOC teaching platform and stepping up the promotion of educational concepts, teachers can help students develop a harmonious, constructive, and healthy learning culture, spark their interest in learning, and build a solid foundation for in-depth learning [13].

In the implementation of the flipped classroom, special attention is paid to combining relevant knowledge of biomechanics and organizing rich and colorful discussions and practical activities. In classroom teaching, teachers can raise some challenging questions, such as "How to design a drug delivery system based on the mechanical properties of tissues to improve drug efficacy"? Such questions can stimulate students' thinking and guide them to explore new strategies for drug delivery from the perspective of biomechanics. Students can discuss in groups and explore the

application potential of biomechanical principles in drug delivery through case analysis [14].

The post-class review session should not be ignored. To consolidate and expand students' learning outcomes in class, teachers can assign some homework or projects related to biomechanical applications. For example, let students analyze the mechanical properties of a new type of biomaterial and explore how these properties affect its application effect in tissue engineering. Such homework can not only deepen students' understanding of biomechanical principles but also exercise their practical and innovative abilities [15].

2.4. Ideological and political teaching design

The traditional way of instruction mode is classroom centralized learning, which belongs to "synchronous learning", but this way can not achieve the "synchronization" of the learning effect. It can not reflect the differences between students in specialty, region, learning ability, and learning characteristics. Students with high basic levels need more knowledge; For students with low basic levels, they need to study longer and more time, while the traditional teaching methods can not flexibly meet these needs of students. According to the cognitive load theory, the traditional classroom "synchronous learning" will increase the cognitive load of students with low basic levels, thus affecting the learning effect of students [16].

The learning resources provided by students' autonomous learning before class can be exchanged and discussed with the help of a network platform. Teachers summarize and analyze students' problems and design solutions to common and individual problems. The teacher should timely throw out discussion questions for the students to speak and discuss, and record the students' discussion. The process evaluation of this link is mainly the evaluation of the student's learning progress, the number of clicks or downloads of learning resources, network communication and discussion, etc. In particular, teachers can grasp the course situation, learning situation, and performance situation in real-time through the statistical function of Xuetong, and adjust the teaching content and teaching strategies in time by analyzing the course operation report to improve teaching effectiveness.

In practical teaching, different students have different sensitivities to different teaching resources. Therefore, teachers should try to consider the personalized learning needs of students, select teaching resources, and enrich the presentation form of resources as much as possible. This teaching model helps to improve students' enthusiasm, cultivate students' ability of independent exploration, cooperative communication, problem analysis, and problem-solving, and achieve teaching objectives. At the same time, it can also promote the cultivation and improvement of contemporary college students' innovation and creativity. Teachers can interact with students in live broadcasts, create group discussion circles, and activate classrooms through interactive controls such as rush answers, voting, and topic discussions on the platform to create a warm ideological and political classroom.

Firstly, the knowledge level of college students is still uneven. The flipped classroom teaching mode provides students with pre-class learning resources. Students can learn independently according to their knowledge level and understanding, to lay

the foundation for the next classroom learning. According to the cognitive load theory, this method can reduce the internal cognitive load of students, narrow the cognitive gap between teachers and students, make it easier to reach a consensus, and reduce the difficulty of teachers' educational model and students' learning to a certain extent. Secondly, college students are relatively mature, have a certain concept of right and wrong and the ability to analyze and judge, have active thinking, like to express their views, and like an active classroom atmosphere. The flipped classroom teaching model can meet the needs of students, give students more time and opportunities to communicate and discuss, and also provide students with the right to express and think. The process of the development of the Chinese Revolution history makes the students have a relatively strong interest and desire to explore. In the era of high development of information technology, students are more inclined to use the Internet to meet their knowledge needs through multiple channels.

On the one hand, the pre-class self-study link of flipped classroom teaching mode has high requirements for students' self-discipline ability, which requires students to give full play to their subjective initiative to complete the pre-class learning task. On the other hand, with the development of the information age, the technology level of students has generally improved, but some students still have low information technology levels, such as students with low development levels in the western region and remote mountainous areas. Therefore, when making videos in groups, teachers need to consider the differences in students' information technology levels and combine the professional characteristics of different disciplines to achieve reasonable grouping.

In the ideological and political teaching design, special emphasis is placed on the introduction of biomechanical cases, to cultivate students' professional knowledge while shaping their correct values and social responsibility. By introducing the outstanding contributions of biomechanical research in solving global health problems, such as vascular mechanics research in the treatment of cardiovascular diseases, students are guided to deeply understand the close connection between professional knowledge learning and social development. These vivid cases can not only stimulate students' interest in learning but also prompt them to think about how to apply what they have learned to solve practical problems, thereby enhancing their sense of social responsibility.

In addition, make full use of the interdisciplinary characteristics of biomechanics to cultivate students' innovative thinking and comprehensive analysis ability in the teaching process. By organizing group discussions, case analysis, and other teaching activities, students are encouraged to think about problems from different angles and propose innovative solutions. This teaching model not only helps to improve students' professional literacy, but also meets the requirements for the all-round development of students in ideological and political education, and provides strong support for the cultivation of biopharmaceutical professionals with innovative spirit and social responsibility.

3. Application experiment of flipped classroom teaching model

3.1. Teaching environment design

Teaching organization forms are divided into individual teaching, class teaching, guidance system, group teaching, open teaching, collaborative teaching, on-site teaching, and multiple teaching. Through the online teaching platform, students can learn independently, cooperate and exchange, share learning experiences, etc.; teachers can issue notices, post teaching tasks, share course resources, and design learning interactions.

3.2. SPOC platform structure design

The structure design of the SPOC platform is shown in **Figure 2**. In this space, students can select the necessary auxiliary learning materials and various teaching resources according to their learning progress, and conduct directional self-practice and follow-up tests.

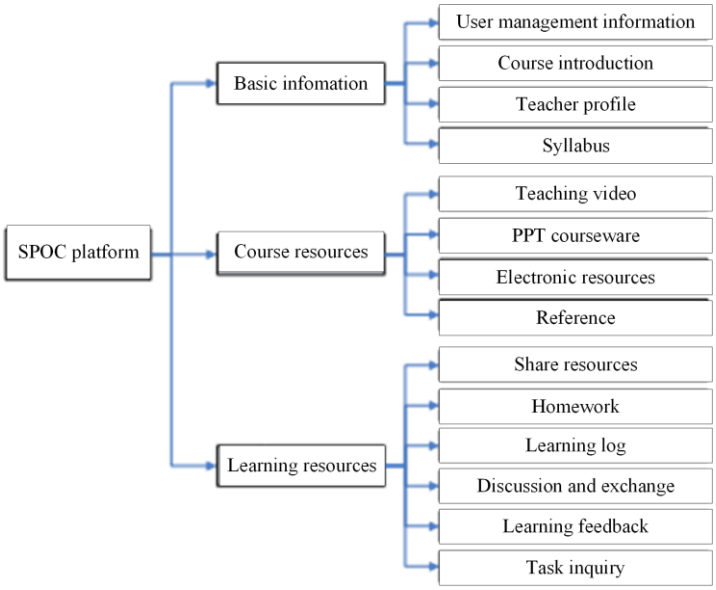

Figure 2. SPOC platform structure design.

College students and existing students are the two main target audiences for SPOC. A mixed learning paradigm that blends in-person and online instruction is used in the first scenario. To deploy flipped classroom teaching, online resources that have been evaluated for their pedagogical applicability and related evaluation capabilities are used, such as video MOOCs, in college courses. The standard procedure is for teachers to give students access to these online learning resources as homework (such as videos or interactive courseware), then have students ask questions during physics class instruction to determine what they already know and what they still need to learn, and finally work with students in class to complete homework or other assignments. Build a hybrid collaborative development model of "three subjects, three spaces, and three links" for pre-employment and post-employment learners based on SPOC to promote learners' communication and collaboration and improve learning efficiency.

3.3. Course basic information design

The implementers of this part of the activities are mainly teachers. After-school learning is based on the SPOC teaching platform as the main classroom learning as a

supplement, through extended learning, complete the process of knowledge consolidation. The process evaluation under the flipped classroom teaching mode runs through the whole learning process. When conducting process evaluation, teachers should make specific designs according to the teaching content and subject characteristics. Information technology is a double-edged sword. When facing the opportunities and challenges brought by the information age, the ideological and political courses in colleges and universities need to assess the situation, always maintain the concept of advancing with the times, and continuously promote the two-way integration and development of information technology.

3.4. Design of teaching activities

In the teaching mode of flipped classrooms, effectively designing teaching activities is crucial to improving students' learning effects. Especially in the ideological and political teaching of biopharmaceutical majors, integrating biomechanics content can not only enhance students' professional knowledge but also stimulate their innovative thinking.

In the pre-class knowledge preview stage, teachers not only publish preview content related to ideological and political theory but also deliberately add cases or problems related to biomechanics, such as how cell mechanical properties affect the transmission efficiency of drugs so that students can conduct preliminary analysis by consulting materials and self-study. In this way, students have a certain understanding and thinking of relevant knowledge before entering the classroom. In classroom teaching, teachers organize students to conduct biomechanical experimental demonstrations, such as simulating the uptake process of drug molecules in a cell mechanical environment, and guide students to have an in-depth discussion of the experimental results. Through these experiments and discussions, students can intuitively understand the principles of biomechanics and explore the application potential of these principles in the field of biopharmaceuticals. In the post-class knowledge consolidation stage, teachers require students to combine the ideological and political theory and biomechanical knowledge they have learned to write a review or short paper on the application of biomechanics in the field of biopharmaceuticals. This task not only deepens students' understanding and application of knowledge but also exercises their scientific research writing and comprehensive abilities.

3.5. Subject

This study selected sophomores or juniors majoring in biopharmaceuticals at Wuhan Donghu University as the research subjects, a total of 40 students, were randomly divided into two groups, 20 in each group. One group adopted a teaching model based on a combination of SPOC and flipped classrooms, and the other group adopted a traditional teaching method. The sample screening criteria are: All students are students majoring in biopharmaceuticals and have no special health or academic problems to ensure the consistency and representativeness of the sample. By random grouping, the differences in gender, academic ability, etc. between the experimental group and the control group are minimized, thereby improving the comparability and scientificity of the research results. In addition, the selected students have a certain

professional foundation, which can ensure the effectiveness of teaching intervention and provide a reference for the teaching reform of biopharmaceutical majors in other universities.

3.6. Experimental process

The teacher should design the test questions. After class, students consolidate their learning content and further internalize their knowledge by watching learning resources or completing the tasks assigned by teachers. Students' feedback on the teaching resources, teaching design, learning effect, and other contents of this section. Teachers collect students' feedback and suggestions, view the download amount of learning resources in real-time, modify and improve learning resources and teaching design, and reflect and summarize teaching. In this link, teachers can conduct a process evaluation, mainly on the feedback of students' learning effect, the enthusiasm of putting forward suggestions, and the learning resources made by students.

3.7. Statistics

After the experiment, the final scores of the two sets of final tests and the relevant data of the MOOC backstage were counted. It can be seen from the data in the MOOC context that the teaching strategy proposed in this article can significantly increase students' learning effectiveness when compared to traditional instruction.

4. Impact of flipped classrooms on students

During the implementation of flipped classrooms, the introduction of biomechanical analysis has an impact on students' learning interests and initiative. Through vivid and interesting biomechanical cases and experiments, students are deeply attracted, their curiosity and desire to explore are fully stimulated, and they are more actively involved in learning. At the same time, in the process of participating in the biomechanics project, students need to jointly design experimental plans, collect and analyze data, and collaborate to solve various problems encountered in the experiment. This process not only exercises their teamwork skills but also significantly improves their teamwork ability. Improved their ability to solve complex problems.

4.1. Application effect of flipped classroom teaching mode

Table 1 displays a comparison of the test findings. The ability of flipped classrooms to increase students' problem-solving and collaborative skills is a significant benefit. which has been verified in the preliminary implementation of Jukui Middle School. However, the nonsignificant improvement of test scores involves the problem of evaluation methods, so it is difficult to evaluate from this aspect. In addition, under the baton of the college entrance examination, many teachers only pay attention to examination-oriented knowledge and are indifferent to the cultivation of other abilities, which also makes these teachers unwilling to implement flipped classrooms. Under the action of various factors, many teachers hesitate to implement the flipped classroom, and the incomplete transformation of teachers' ideas will inevitably lead to an imperfect teaching design, which will affect the teaching effect. This shows that modern educational technology has not been integrated into the

ideological and political courses of colleges and universities, the network teaching position has not been fully developed and utilized, and it is inconsistent with the teaching concept of "students as the main body, teachers as the leading" advocated in the field of modern education.

Table 1. Comparison of test results.

Topic	1	2	3	4	5
Pre-test	57%	62%	38%	48%	65%
Back side	91%	89%	86%	82%	90%

It can be seen from the table that the pre-tests on five different topics are mostly lower than 65%, while the backside is higher than 80%.

The analysis of learners' attitudes towards evaluation methods is shown in **Figure 3**. It can be seen that this teaching method avoids the situation of sudden learning and coping tests. Under the flipped classroom teaching mode, students' dominant position is highlighted. Teachers create situations before and during class, ask questions, give students more time and opportunities to communicate and discuss, and give students the right to think and express. Especially when the cases or problems provided by teachers are highly related to students' learning and life, the improvement of students' enthusiasm and participation in classroom activities is more obvious, and the classroom atmosphere is active.

Additionally, through interviews with instructors and students and a questionnaire survey of students engaging in the flipped classroom teaching mode, teachers and students said that the traditional teaching mode's evaluation process is comparatively straightforward. The flipped classroom teaching method is therefore determined through teaching experience to be feasible in the IPE in colleges and universities and to enjoy high levels of recognition from both teachers and students. This style can enhance student engagement and excitement for learning, as well as the effectiveness of instruction and students' all-around skills.

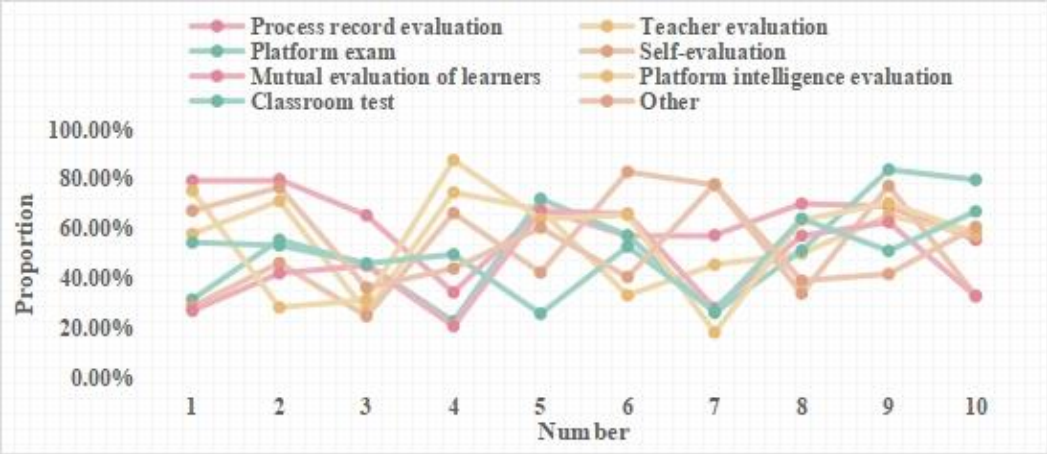

Figure 3. Analysis of learners' attitudes towards evaluation methods.

Table 2 shows the results of the questionnaire survey, reflecting the impact of the teaching model combining SPOC and flipped classrooms on the students in the

experimental class. The data show that, overall, students have made significant changes in learning atmosphere, group learning attitude, and personal growth. Among the five indicators A, B, C, D, and E, multiple data items show great progress, especially in learning atmosphere and learning attitude. In addition, the data changes in the table also reveal significant changes in students' personal growth and progress, showing that this teaching model can effectively promote students' improvement in multiple dimensions.

Table 2. Questionnaire survey results.

	A	B	C	D	E
1	0.25	0.63	0.19	0.03	
2	0.5	0.3	0.2		
3	0.36	0.58	0.06		
4	0.6	0.3	0.1		
5	0.7	0.25	0.05		
6	0.45	0.3	0.2	0.05	
7	0.03	0.1	0.56	0.31	

4.2. Changes in student attitudes

Table 3 and **Figure 4** display the statistical findings. It demonstrates that although some students have adjusted, the majority anticipate the emergence and teachers can utilize new techniques to structure instruction in the classroom. When teaching in a flipped classroom, students practice their abilities to learn independently by watching videos before class; Teachers can encourage independent problem-solving by setting up scenarios and setting out problems for students to explore, analyze, and solve; The communication and discussion of the network platform, the design of classroom activities and the cooperative exploration between groups have exercised the students' expression ability, team cooperation ability and innovation ability. In addition, students said that the production and collection of teaching resources have exercised and improved students' information technology application ability. It can be seen that it is one of the important tasks of the current teaching reform of ideological and political courses in colleges and universities to enhance the attractiveness of ideological and political teaching and actively innovate teaching forms according to students' learning needs and suggestions.

Table 3. Statistical results.

	A	B	C
1	0.40	0.45	0.05
2	0.60	0.30	0.10
3	0.5	0.35	0.10
4	0.6	0.40	0.05
5	0.7	0.45	0.35
6	0.45	0.20	0.30

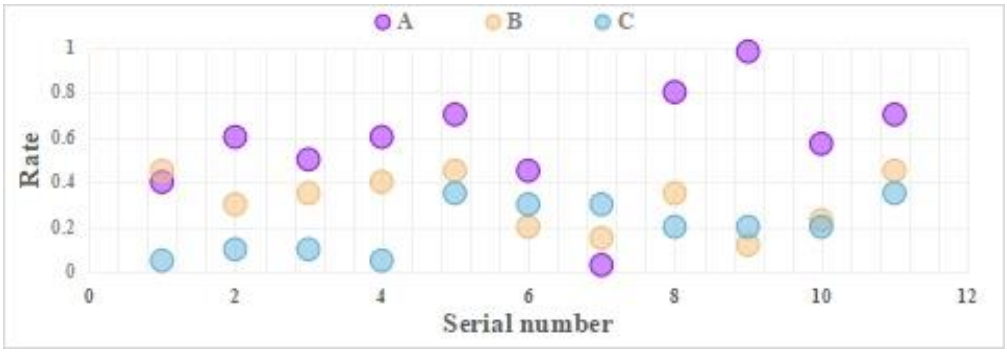

Figure 4. Statistical results.

The SPOC curriculum is self-study and inquiry, with two main events to capture the learner's attention and inform learning goals, and to understand learning through early self-examination or staged testing. Questions that arise during the learning process are automatically recorded and provided by the system. Students participate in online communication and online problem-based inquiry activities, and then teachers and students give flipped classroom problem solutions or solutions, allowing students to complete the knowledge transfer process. The results obtained by the students' deep learning situation are shown in **Figure 5**. The average values are 3.419, 3.102, and 3.115 respectively.

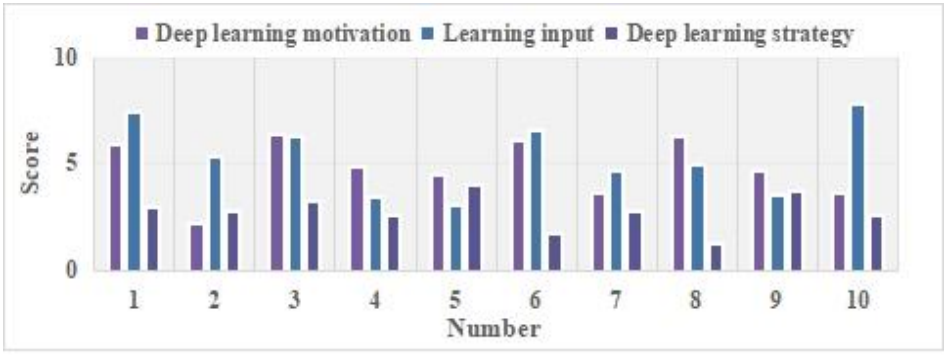

Figure 5. Comparison of changes in students' deep learning status.

Teaching evaluation is the last but indispensable activity of teachers in education and teaching activities. Whether the setting of teaching evaluation is reasonable or not is related to whether the evaluation mechanism can play its regulatory role, that is, to regulate the participation enthusiasm of classroom participants. If the classroom evaluation of a flipped classroom only meets a few particularly active students in the group, it is bound to reduce the participation of other students. Therefore, teachers' evaluation of group members should also positively stimulate each student as much as possible. As can be seen from **Figure 6**, most students think SPOC can be used in teaching, while 31% think it is ok. There is no big difference between SPOC and SPOC, and 9.76% of students are against this kind of teaching combination.

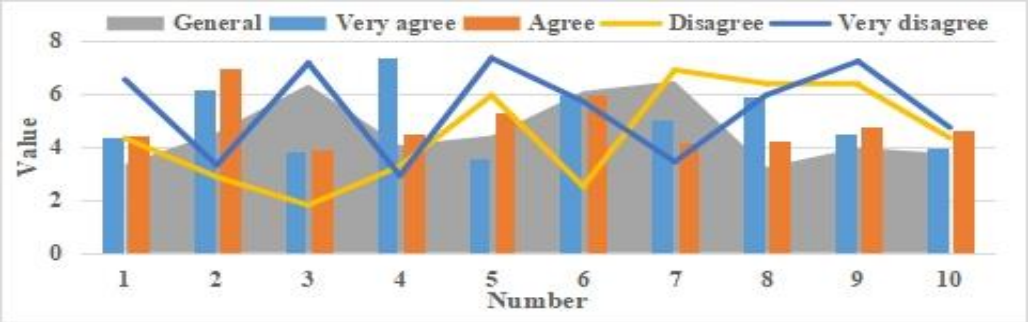

Figure 6. Data about learning motivation.

4.3. Validity analysis

Table 4 shows the comprehensive test results. It can be seen from the results that the *P* values on the three indicators are 0.219, 0.453, and 0.567 ($P > 0.05$).

Table 4. Comprehensive test results of various indicators.

Basic situation	Experimental group (n = 40)	Control group (n = 40)	*T* value	*P* value
Learn degree	1.83 ± 0.37	1.93 ± 0.36	−1.041	0.219
Learning level	1.26 ± 0.44	1.4 ± 0.56	−1.013	0.453
Like	2.4 ± 0.62	2.4 ± 0.67	0.000	0.567

The online learning satisfaction survey is shown in **Table 5** and **Figure 7**. From the learning behavior data recorded on the SPOC platform, we can see that all students have finished their course selection after nearly a month.

Table 5. Online learning satisfaction survey.

Very much agree	Agree	General	Disagree	Strongly disagree
30.77%	21.15%	32.48%	15.60%	0.00%
23.08%	46.15%	20.42%	10.35%	0.00%
20.16%	45.42%	25.73%	8.69%	0.00%
15.38%	38.46%	34.83%	9.08%	2.25%
18.54%	54.12%	13.52%	10.68%	3.14%
24.44%	30.56%	37.28%	7.72%	0.00%

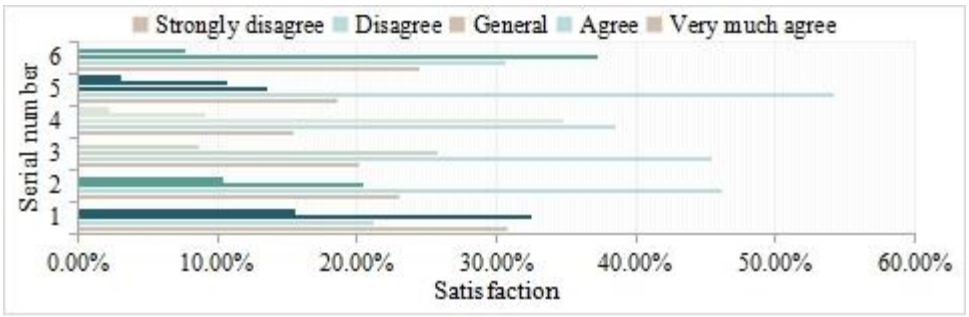

Figure 7. Online learning satisfaction survey.

The results of the reliability analysis are shown in **Table 6** and **Figure 8**. It can be seen that the overall internal consistency reliability reached 0.921, and the

reliability of each research variable was 0.595–0.824. Using the SPOC platform for learning will produce a large number of data records. The frequency, time point, interactive communication, homework completion, and performance feedback of students logging in to the SPOC platform reflect students' learning exploration path and affect students' learning effect. Sorting and analyzing the data in time and urging teachers to modify the teaching design and learning content in time will more effectively improve teachers' classroom teaching efficiency. This is in line with the student-centered idea of contemporary information technology education, reflects the individualization of teaching, improves teachers' professional skills, and promotes the transformation of teachers' roles and functions. From the evaluation of the overall teaching effect, the multi-subject, diversified, and multi-level teaching assessment method can more comprehensively and effectively feedback on the overall situation of the teaching process, and it is also convenient for teachers to adjust the teaching progress in time and promote the realization of teaching goals.

Table 6. Reliability analysis results.

Dimension	Mean (M)	Standard deviation (SD)	α coefficient
Good teaching	4.22	0.626	0.793
Clear goals and standards	4.18	0.658	0.760
Proper pressure	3.61	0.616	0.629
Appropriate evaluation	4.18	0.631	0.742
Learning input	3.76	0.568	0.753
Learning environment	4.21	0.576	0.820
Deep motivation	3.46	0.689	0.824
Deep strategy	3.57	0.552	0.597
Shallow motivation	2.39	0.658	0.595
Shallow strategy	2.78	0.734	0.638

Figure 8. Reliability analysis results.

Compared with traditional teaching methods, the teaching model based on SPOC and flipped classroom emphasizes student self-learning and classroom interaction, enabling students to master theoretical knowledge more flexibly through online

platforms outside of class and deepen their understanding and application of knowledge through group discussions and practical activities in class. The implementation of this model helps to stimulate students' interest in learning, improve their initiative and participation in learning, and thus may promote students' improvement in academic performance and comprehensive ability. When students' self-study through the SPOC platform, they can adjust their learning rhythm according to their progress, improve the personalization and depth of learning, and thus improve their ability to master complex concepts.

In addition, changes in students' learning motivation and attitude may also be affected by teaching content and students' characteristics. Under the new teaching model, students can get more feedback and support in a more interactive and practical classroom environment, which helps to enhance their self-confidence and positive attitude towards learning.

5. Conclusions

The teaching model based on SPOC and flipped classrooms has a significant effect on improving students' academic performance, learning interest, and initiative. Especially in courses such as medicinal chemistry and pharmacy, students can have a deeper understanding of complex pharmaceutical knowledge through the combination of online learning and classroom interaction, and improve their comprehensive application ability. At the same time, this model also shows different impact characteristics for students from different backgrounds. For students with a good foundation, the new teaching method helps them master the course content more efficiently and further stimulates their innovative thinking and autonomous learning ability. For students with a weak foundation, the SPOC platform provides more personalized learning opportunities, enabling them to master knowledge according to their learning progress, thereby consolidating weak links after class, and ultimately improving their academic performance.

The disadvantage of this article is that the experimental data is not large enough to support the point of this article. The next article will focus on data collection and analysis, and then improve the design of this article so that it can be used in teaching in the future. At present, SPOC is still in the marginal exploration stage in the field of education, and the educational value of information technology still has great room to play, not only as a tool and means to solve a certain problem in education but more importantly, to improve the quality of education and promote students to connect. All-round development of teachers.

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