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The Design and Application of Problem-Oriented Teaching in Flipped Classroom Against the Backdrop of Improving the Digital Literacy of the Entire Population

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Abstract

Flipped classroom has attracted more and more attention of educators to improve the effective instruction in higher education, especially when connecting online teaching to classroom teaching. Problem-oriented instructional design plays a supporting role in the learner-centered teaching design. Through cleverly designed problems, teachers can control the pace of students' learning. The paper will state the principles and results in designing problem-oriented flipped classroom through an experiment of two classes in Southwest Petroleum University, which has been applied to the teaching reform involving over five-thousand freshmen and in a style of SPOC in the past term. With the Flands' Interaction Analysis System, the result showed that problem-oriented teaching design can improve the activity of students' studying and it was a baton for the teacher to control the class. The study addressed teaching challenges and our solutions that most universities of science and technology might have. Hopefully our work can stimulate more researches in the area.

Keywords

Problem-Oriented, The Zone of Proximal Development, The Flipped Classroom, SPOC

1. Introduction

In February 2024, the Cyberspace Administration of China, the Ministry of Education, the Ministry of Industry and Information Technology, and the Ministry of Human Resources and Social Security jointly issued the "Key Points for Improving the Digital Literacy and Skills of the Whole People in 2024". To enhance the digital literacy and skills of the entire population, it is necessary to cultivate digital talents and continuously strengthen the digital talent team. Especially, it is essential to cultivate a large number of high-level, innovative, and versatile digital talents who can adapt to the requirements of the digital age. To comprehensively enhance the digital literacy and skills of teachers and students, improve the level of digital education in schools, comprehensively promote the construction of digital campuses, strengthen the construction of digital technology related disciplines and majors in ordinary universities, enhance the deep integration of professional construction and digital technology, and promote the popularization and application of information technology in various majors through the trial and application of new teaching methods (CAC, 2022).

MOOC is an imported product from the West. It began as an open course project launched by MIT in 2001 and gradually matured after the establishment and development of three major platforms: Udacity, edX, and Coursera. Subsequently, various platforms collaborated with universities to launch a "credit certification" program, which was gradually promoted. However, the high participation rate and low completion rate of MOOCs cannot guarantee the completion of education. After the MOOC craze faded, researchers calmly regarded MOOCs as a teaching aid. Since 2013, various teaching forms derived from MOOCs have been widely applied in teaching and have achieved substantial results. However, there is still no way to combine MOOCs with traditional classrooms. Professor Zhu Zhiting (2014, cited in Li et al., 2014) provided a detailed description of several forms of online learning in the post-MOOC era in his article, including Meta MOOC (Super MOOC), DLMOOC (Deep Learning Open Online Course), MOOL (Massive Open Online Laboratory), DOCC (Distributed Open Collaborative Course), PMOOC (Personalized Open Online Course), and MOOR (Massive Open Online Research Course). The author summarizes it as follows: 1) Meta MOOC and DLMOOC can be merged into the same category, mainly suitable for large-scale cross school collaborative teaching between schools. In 2014, Davidson (2014) launched a Meta MOOC online learning mode on Coursera, with more than 20000 participants. Not only did many students spontaneously participate in the discussion activities, but teachers also actively engaged in discussions and exchanges; 2) DOCC and PMOOC can be seen as collaborative learning online learning models. In 2013, FemTechNet conducted research on the DOCC model (Devlin, 2013), while Freedrink M. Hurst from Northern Arizona University proposed the "Personalized Learning Project" and attempted to study the PMOOC model. These two types value students' acquisition learning and are very helpful in improving personalized and collaborative learning; 3) Gillet et al., (2013) conducted a MOOL (Massive Open Online Laboratory) teaching experiment, which focused on combining online virtual experiments with offline experiments. The advantage of this experiment is that it can manipulate real laboratory equipment online, and its realistic simulation effect and immersive experience greatly increase students' participation enthusiasm. 4) Professor Pavi Pavna (2013, cited in

Gillet et al., 2013) from the University of California conducted a course on Coursera called Bioinformatics Algorithms, which took the form of a MOOR. The main features of this course are: a focus on de specialization, problem orientation, and full utilization of learning support environments. The perfect combination of abundant learning resources and meticulous teaching design creates a learning atmosphere of active exploration and efficient interaction for students, significantly improving their learning enthusiasm; 5) The SPOCs teaching model has been recognized by many scholars for its own characteristics. This "small-scale (generally less than 500 people)" and "restrictive admission conditions" mechanism effectively compensates for the shortcomings of MOOCs and has become the preferred mode for universities to combine online teaching with traditional teaching. The three mainstream teaching platforms in China: China University MOOC, Xuetang Online, and Good University Online, have all adopted this intercollegiate MOOC + on campus SPOC format to implement university alliances. The founder of SPOCs, Armando Fox, believes that MOOCs can only serve as a supplementary means of classroom teaching but cannot completely replace it. When MOOCs develop to enhance students' classroom participation, output, innovation ability, and effectively reduce teachers' workload, this model can be called SPOCs (Wang et al., 2024). The SPOCs model has become an effective combination of online teaching platforms and traditional classroom teaching. This model can share excellent online teaching resources and provide timely classroom tutoring. It conforms to the network teaching theory of associationism, focusing on providing students with a "pipeline" to carry knowledge, allowing them to choose teaching resources that meet their personalized learning needs in a timely manner, and thus build their own knowledge system. Many schools in China have tried to verify that the SPOCs teaching model has a significant promoting effect on meeting students' personalized learning and improving their participation.

Basic Concepts

The Flipped Classroom, some scholars used to call it "upside-down classroom", just as its name implies, it is an overturn of our traditional classroom. In this teaching methods the process of the students to adsorb knowledge and the teacher to impart knowledge is reversed (Wang et al., 2024). According to the traditional, the former happens on the class and the later occurs after the class. But in the flipped classroom, it is quite the opposite. Since this kind of teaching model is introduced to China, it was adopted by many different school. Some schools are public for this teaching model, such as, JuKui junior Middle School in ChongQing Province and NanShan Experimental School in Shenzhen. Of course, many other schools have adopted the teaching methods. The subjucts that can be in support of it covers engineering science, economics, medical science (Xing et al., 2024). To different schools have different situations and will employ different methods, but the flipped classroom is the main style. The results show that the flipped classroom teaching methods not only increase the activity in the classroom, but also reduce the burden of the teachers from the long-term view. The time of the flipped classroom has came, and the best contents of it is due to occur.

The concept of problem-oriented teaching model shows up before long. At the first, the people are not conscious of its existence as though it is there, apparently, it is not defined as a teaching methods. In fact, Socrates' the art of intellectual midwifery，Dewey's teaching method via asking question and discovery of Bruner study theory, all include in this concept. The problem-oriented methods was not accepted until it is came up with by American neurology professor Howard barrows in 1969 in McMaster University Medical School in Canada. It is first defined as a concept and methods in the field of medicine. Since then, it is often used by scholars in different fields. To its definition, different scholars have different views from different level. Some think it is a course, some have a view of that it is a methods. Some people pay attention to its value, some people say that its characteristic is the most important. To generalize the above views, problem-oriented teaching methods can be defined as approaches that start with problems, combining independent study and cooperative learning, focused on solving questions. They aim to enhance student activity, develop critical thinking, and improve real-life problem-solving skills under teacher guidance.

2. Implementation Process

2.1. Target

Based on the problem-oriented flipped classroom teaching mode, we want to achieve the aim is to improve the frequency of effective classroom teaching behavior, mobilize the enthusiasm of the students to participate in the activities in the classroom, train students use their own hands, brains to seek knowledge, train students' divergent thinking and practical operation ability, achieve the real learner-centered teaching model. At the same time, it can make the teachers realize that teaching is no longer redundant, the students' brainstorm sometimes can offer a powerful and unconstrained perhaps for their research, and in the long run the flipped classroom methods is preferable.

2.2. Problem Setting Principles

In the process of the flipped classroom, what is the key is that how to set the problems. It is a guarantee of the whole running. The magic of the model involves in that the instructor guide the learner from the current development to the potential development with questions but not answers. First of all, we should divide the whole course into knowledge elements. Then to find the connection among them. Usually, the first part of a course wants to tell the learning "why learning". In the aspect, a lot of interesting and real cases are set to attract the students' interest. Some instructors think that it is not important. In fact, it is a good chance to train the students' ability of logical thinking. You can ask them to collate relevant summaries to develop the custom to summarize. In the second part, "learn what" is usually offered. In the stage, the instructors should strengthen attention to the connection of the whole process. When they set problems, the ones before the class should preview the content, in the class should dig the depth of the knowledge. After the class, the problem should be set to consolidate what we learn on the class. In the third part, "how to learn" occupies main. At the stage, the students have mastered the basic knowledge, the problems should be set to open their mind and to seek widely. Figure 1 can express it vividly as follows.

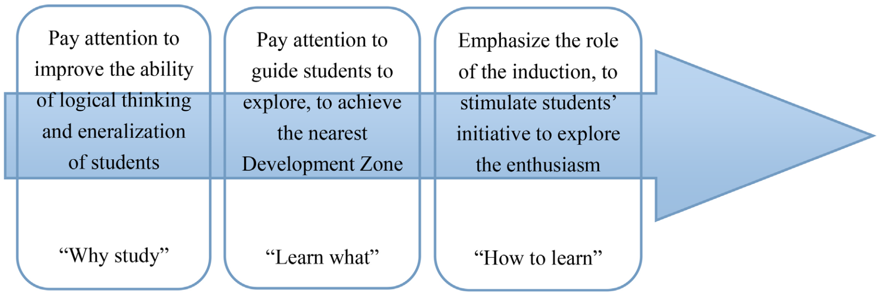

Figure 1. Problem setting in different stages of the course.

In order to achieve the students' potential development, the difficulty of problem of one knowledge element should be set in a trend of rise first then fall. When students to explore a topic, appropriate difficulty can stimulate their interest. But the difficulty should be decrease along with the time to keep the interest. It can be express in Figure 2 as follows.

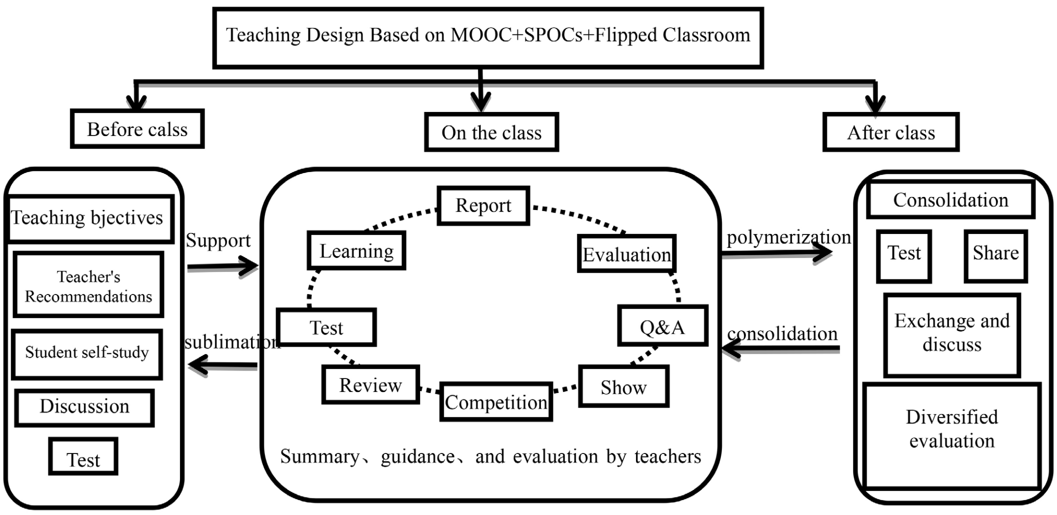

Figure 2. The teaching design based on MOOC + SPOCs + Flipped classroom.

In the above figure, the SPOCs course teaching design is mainly divided into two stages and three parts, namely online and offline stages, pre class, in class, and post class. In the pre class section, students watch videos recommended by the teacher or search for videos based on personalized learning according to the teaching objectives given by the teacher. When you don't understand or encounter difficulties during testing, you can explore through discussion. Pre class preparation is the foundation and support of in class learning, while in class discussion is the improvement and sublimation of pre class learning. SPOCs course teaching essentially belongs to online teaching, and the relational network learning concept can play a role here. Teachers use problem oriented teaching methods and design various teaching activities to set up "nodes" in the "knowledge pipeline" for students. Students, guided by teachers, gradually break through themselves and achieve a leap from the "real development zone" to the "zone of proximal development". After extracurricular activities are the consolidation and supplementation of in-class activities, while in class activities are the condensation and refinement of after-class activities. Students consolidate their knowledge learned in class in a timely manner through after-school activities, and the output results of their learning process in class provide a basis for evaluation after class.

2.3. Teaching Effectiveness

American educator Flanders designed a topic analysis system in the 1960s, which was named Flanders Interaction Analysis System (FLAS). FLAS is an important feedback tool in the classroom, which can be used to observe the language interaction between teachers and students. It consists of three parts: teacher language, student language, and classroom silence or chaos, including 10 codes of interactive behaviors; Standardize the coding steps for observing classroom teaching by the way in which data is decoded, analyzed, and presented. After further empirical research, Gu Xiaoqing and others from East China Normal University believe that FLAS has some shortcomings. For example, in classroom teaching, the use of information technology by teachers and students can generate rich interactive activities; The silence in the classroom is also quite complex, and if it is simply classified into one category, it cannot reflect the real classroom situation. On the basis of improvement by Professor Gu Xiaoqing's team, the author has designed a Flanders interactive analysis system based on the SPOCs teaching mode. The system consists of five parts: teacher language, student language, silence, and interaction between teachers and students using information technology. It includes 16 types of interactive behavior codes, as shown in **Table 1**.

We use the FIAS classroom interaction analysis method for analysis. The FIAS analysis system has the following regulations when used: 1) Collection code: In classroom observation, the Flanders interaction analysis method uses time sampling. Generally, every 3 seconds, observers record the corresponding codes according to the above classification. In this way, a 40 to 50 minute class has approximately 800 to 1000 codes, which reflect a series of events that occur in chronological order in the classroom. These codes are connected in chronological order to present the structure, mode, and style of classroom teaching; 2) Processing data: Form an array of each code and its adjacent code in the collected code. Except for the first and last codes, which are used only once, each remaining code is used twice. After sorting, obtain the Franz Classroom Interaction Analysis Matrix. **Figure 3** is a 16*16 transfer matrix used in this article.

Table 1. The code of Flanders interaction analysis system in the teaching model.

Classification		Code	Content
Teacher language	Indirect Effect	1	Teachers accept emotions
		2	Teachers encourage and praise
		3	adopt an idea
		4	Ask open-ended questions
		5	Ask closed ended questions
	Direct Impact	6	Teach
		7	Instruct
		8	Criticize
Students Language		9	Response (passive response)
		10	Dialogue (proactive response)
		11	Proactively ask questions
		12	Group discussion
Silence		13	Silence or confusion
		14	Ponder a problem
		15	Do exercises
Applied information technology		16	applied information technology

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	sum
1	3	10	32	4	2					3		1					55
2	5	18	40	5	1					8		6	1	2	4	12	102
3	5	23	30	17	2				1	20	10			2	7	11	128
4	10	8	3	0						5	4						30
5	2	6	1			4						1				2	16
6	1	1	1		1					20	4				9	5	42
7	1	2		1							1						5
8																	0
9	2									2							4
10	10	8	11	1	5		3			36	10	2	1	7	2	25	121
11	2	6	2		3	10				12	16	10		10	20	9	100
12	6	4									16			6		16	48
13				1							1					1	3
14	2	5									13	3		2	5	7	37
15		1		1		2					10	8		4	6	29	61
16	6	10	8		2	26	2		3	15	15	17	1	4	8	31	148
sum	55	102	128	30	16	42	5	0	4	121	100	48	3	37	61	148	900

Figure 3. The Transfer matrix used in this article.

We selected three classes from the same major for three experiments and used a heterogeneous model to analyze and compare classroom interaction. Here, we represent traditional classrooms using CT, while flipped classrooms under SPOCs teaching mode are represented using ST. After processing, we obtained the data analysis chart shown in the following as Table 2.

Table 2. Processing results of the Flanders classroom interaction coding system.

Variable	ABBR	Formula	ST1	CT1	ST2	CT2	ST3	CT3	Flipped Classroom Summary	Summary of Classroom Comparison
Teacher language ratio (%)	R1	[XW1 + XW2 + ··· + XW8]/Total	56.4	59.3	35.2	49.7	40.9	71.1	44.5	58.0
Student language ratio (%)	R2	[XW9 + W10 + ··· + XW12]/Total	18.0	8.9	25	24.0	37	12.3	28	15.3
Effective silence ratio (%)	R3	[XW13 + XW14 + XW15]/Total	26.9	35	37.8	25.2	20.0	18.0	23.4	25.7

American psychologist Rogers pointed out through research that in traditional classrooms, the proportion of teacher language is much higher than that of students. On this point, American educator Belek reached a consistent conclusion through a large amount of data and data modeling. Data modeling reflects that in a normal teacher-student interaction class, teacher language accounts for about 68%, while student language accounts for about 20%, with a ratio of 3.4/1. According to BlackRock's data analysis model, we analyzed the processing results of data collected from the classroom and obtained the following conclusions:

1) From the data in the table, it can be seen that the language ratio of teachers in problem oriented SPOCs course teaching is mostly lower than that in the control classroom, indicating that teachers have realized to transfer more of the classroom discourse power to students and form student-centered teaching.

2) The ratio of R1 and R2 values in the SPOCs teaching classroom summary is 1.7:1, indicating that the teacher has reduced classroom teaching to half of its original level. However, from the R2 values in the reverse classroom and traditional classroom, it can be seen that the proportion of students effectively discussing, communicating, and speaking in the classroom has greatly increased.

3) The values in the table show that compared to traditional classrooms, the language ratio of teachers in flipped classrooms has decreased by 14.7%, while the language ratio of students has increased by 12.0%, indicating a significant change in the language ratio between teachers and students in flipped classrooms. And from the other two data points, the changes in the ratio of teacher behavior to student behavior still indicate that teachers are giving more control to students, allowing them to showcase themselves perfectly.

3. Conclusion

Through the specific teaching design, we hope to make an example for the related universities. More communication and cooperation are needed for us. Some advanced methods are expected to be used to get to the final destination to improve efficiency of teaching.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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