

The Application of Flipped Classroom in Colleges and Universities Experimental Course—an Example of the Comprehensive Experiment of Pulp and Paper Making

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Abstract. Flipped classroom has gained wide attention in the field of education in recent years. While there is few research in experimental course. Most of the experimental courses is the same as other subjects. The traditional class limits students' freedom to explore and innovate. This paper analyzes the present situation of experimental course in Colleges and Universities, the process of flipped classroom and teaching effect using flipped classroom in comprehensive experiment of pulp and paper making, the greatest benefit using flipped classroom method in experimental course is that students have good learning initiative and better teaching effect.

Introduction

At present, most of the experimental courses in colleges and universities are taught in following model: Firstly, teacher's telling, showing and explaining are the order of class, and then the students follow the repeated verification experiment. The spoon-fed teaching method is difficult to stimulate the learning initiative and enthusiasm. The whole process of learning is a process of imitation, which is difficult to cultivate students' exploration and innovating spirit.

In recent years, with the wide application of electronic technology in colleges or university classroom, the traditional teaching mode is gradually reformed to multi-mode. In which, micro-course and flipped classroom have been rapidly developed and applied in foundation course in primary and middle schools and colleges. Micro-course is a episodic and concise little video designed for a knowledge point or a teaching step with micro-teaching video as the carrier, Which is lasting about 5-10 minutes. Micro-course encourages students to study by themselves anytime and anywhere. The emergence of micro-course breaks the rigid learning mode of fixed time and fixed place in traditional education mode, which makes the learning process of students more active and flexible. Flipped classroom is a kind of new form of organization of classroom teaching, which breaks the traditional teaching mode: preview – telling and explaining- exercises. The existing materials indicate that the basic teaching process of flipped classroom is to review the learning materials released by the teacher in advance - simultaneous direction by the teacher during doing some exercises in class - summary and improvement. Flipped classroom is very different from traditional classroom in teaching design and teaching organization. In flipped classroom, teachers can provide some education content which needs students to understand and remember before class, and encourage then to study by themselves. The learning materials are always in the form of micro-course, video, PPT and other forms study materials.

In the process of classroom practice, students will analyze and even innovate using the knowledge they have learned before the class. At the same time, teachers will play the role of guidance and assistance, helping each student to realize the internalization and improvement of the knowledge they have learned. According to Bloom's education targeting taxonomy, he divided the goals of the knowledge domain into six different levels: remembering, understanding, applying, analyzing, evaluating and creation. Obviously, flipped classroom puts low-order target of memorization and understanding content before class, enables students to learn independently, and puts the content of

application, analysis and evaluation in the class for key training and guidance, and this mode promotes students' internalization of knowledge and the cultivation of innovation ability, which is more in line with education law than traditional classroom mode. The purpose of the experimental course is to train students' application and innovation ability of the professional knowledge learned, and laid a good foundation for independent scientific research in the future. The comprehensive experiment of pulping and paper making is a collective experiment course for the undergraduates who are majoring in pulping and papermaking. Focus on training students to apply and innovate using learned professional knowledge, while the traditional experimental teaching methods spent much class time in the interpretation of the experiment principle and the simulation of experiment process, there is no time to do the experiment plan design, to discuss the process parameters and to analyze the experiment result and to improve their experimental skill. In this context, we apply the flipped classroom to the comprehensive experiment of pulp and paper, and two aspects of students' learning effect and students' acceptance of flipped classroom are studied in this paper.

Instructional Design

What education concept decides the behavior, and teachers must have a full understanding of flipped classroom, so that the traditional classroom can be thoroughly reformed instead of just picking at it. Teachers should not equate video-course with flipped classroom, and video-course is just a kind of assistant aid that we can use in the traditional classroom also, and that's not the key to making the distinction between flipped classroom and traditional classroom.

Flipped Classroom is translated from "flip Classroom" or "Inverted Classroom", and also translated as "reverse Classroom". It means to readjust the time inside and outside the Classroom, and transfer the decision of learning from teachers to students. The teaching process of flipped classroom has undergone essential changes, as shown in figure 1.

Using the flipped classroom mode, the valuable time in the class is mainly used for students to focus on active study based on problems and applications, and to research and solve problems jointly during the process of pre-learning and practice in-class, and this mode contribute to a deeper understanding of learned knowledge. Flipped mode class, the teacher won't take any more of class time to tell informational and comprehensive knowledge which belong to the lower levels of learning goals for students. They can see the micro-video, listen to lectures and read relevant electronic data by themselves before the class, and they can also discuss with other classmates or with teachers in the network. Students can plan their own learning content, learning method and learning process by themselves before class, and teachers explain with targeted goal in class and individual direction according to the needs of students, and to promote personalized learning. This teaching model can make learning process more flexible and active, and enable students to have higher and stronger participation.

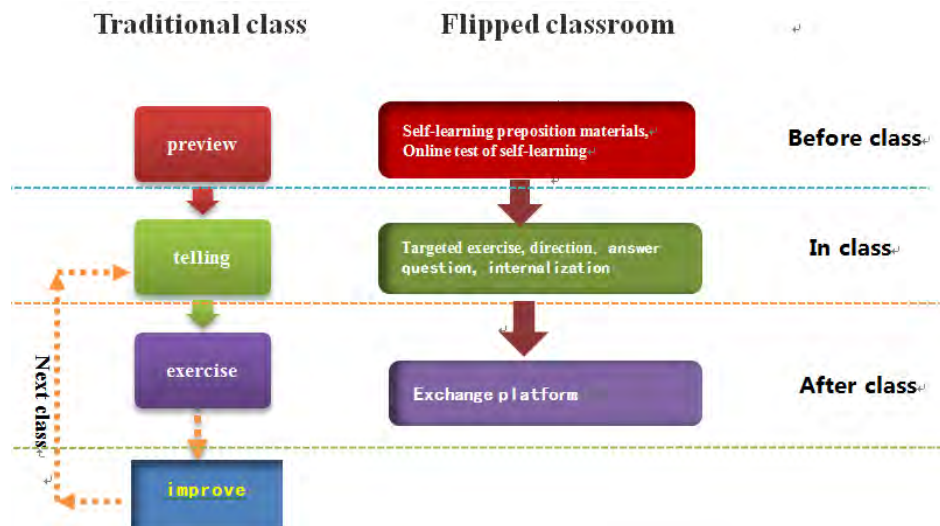


Fig. 1, Comparison between traditional classroom and flipped classroom teaching process

Flipped classroom teaching model is not only the change of teaching process, but also the role of teachers and students has also changed a lot. If teachers and students cannot change their role in time, flipped classroom will have only its appearance and no effect. In flipped classroom, teachers are not only limited to delivering knowledge, but also to create learning platforms, to stimulate learning initiative and interest, playing the role of guide and facilitator in the learning process of students.

Design of Prepositive Learning Material

In order to ensure more effective pre-learning for students, the pre-learning materials should be well designed, including the selection of micro-course, recording video and other relevant materials, which must be enough, that is, enough precision and sufficient support for corresponding teaching contents. All of these require teachers to spend energy on studying teaching content and students' autonomous learning, laying a foundation for targeted and personalized teaching process design in class.

The comprehensive experiment of pulping and papermaking mainly includes four parts: preparation experiment of raw materials, pulp cooking experiment, bleaching experiment and physical test experiment. According to the teaching object, content and previous experience, prepare PPT and record micro- video. The length of video is controlled within 5-10 minutes. Make up a pre-class learning guide, which includes the main learning content of the next class, what materials to see and what assignments to do, how to ask for help. Learning guidance can help students to clarify the content and requirements of autonomous learning, and improve the initiative of autonomous learning. Compile an online test item, which should reflect students' mastery of learning materials published before class. Teachers can master the learning situation of students before class, so as to design the teaching content and method in class, while considering strengthening and discussing targeted of difficult problems.

Design of Teaching Process

In order to implement the "flipped classroom", many teachers focus on making video, which is actually a mistake. Video is naturally important, but even more important than video is how you spend the extra time in class. The traditional classroom learning content is proposed, design of the teaching process in class becomes more important, which is also an important part of flipped classroom. Teachers need to make careful preparation and timely feedback on homework before class. The success of the "flipped classroom" teaching owing to the benefits of the "internalization"

of students' learning process are enhanced by the targeted discussion in class. Before preparing class contents, teachers should also make analysis and summary of students' pre-class learning, mainly including the effect and process of independent learning, and adjusting teaching strategies accordingly. In class, teachers give targeted exercises, give on-site guidance, answer questions, and organize discussions on common problems. Teachers play a role to motivate them to explore and discover mysteries independently.

Take cooking experiment as an example. The experiment took about 5 hours, and the teacher could not fully demonstrate it to the students in class. Therefore, the experiment principle of key operating points and matters needing attention were made into micro-course, which allowed students to watch and study in advance. In the micro-course, the key parameter of H-factor is illustrated in the form of diagram. H-factor is a combination of two variables of cooking time and cooking temperature. Cooking time and cooking temperature are two correlated parameters of cooking. at the same pulp quality, if the cooking temperature is low, the cooking time is controlled longer; otherwise, if the cooking temperature is high, the cooking time can be reduced. After watching the micro-course, students may lay out cooking experimental parameters directly according to h-factor in class. In the process of experiment, students can continue to watch micro-course, video and conduct targeted. This teaching method has great flexibility in learning time and place, and is very suitable for students to use fragmented time for independent learning.

Learning Effect

Two classes of paper grade 15 were selected for the control study. The experimental class was paper grade 15-1, and the parallel class was paper grade 15-2. The two classes had equal Numbers of students, both of whom were 36, with equal foundation. A comparative study of flipped classroom and traditional teaching was conducted focusing on the four experimental courses in the experimental class and parallel class. The study was mainly conducted through the analysis of students' experimental reports and the tests after-class.

The posttest results of the four experiments were compared between the experimental class and the parallel class. Figure 2 indicate that the posttest average score of the experimental class was higher than that of the parallel class. And the experimental class learned micro-course in advance, then their learning in class became more effective, and with the adaptation to flipped classroom, the difference in scores of the two classes gradually increased. The study shows that with flipped classroom mode, students have a deeper understanding of the experimental principle and behavior more enthusiasm and initiative of the class teaches process.

The above test is an online test based on objective questions, which is basically based on the principle of experiment, experiment method, experiment steps and matters needing attention. The content of the examination is rather comprehensive knowledge points; we mainly evaluate high-level learning goals such as evaluation, application and innovation through the four experimental reports of the experimental class and the parallel class. Table 1 show that the accuracy of experimental class is slightly higher than the parallel class on the item of experimental principle and experimental steps which mainly examine the low order learning objectives. In terms of experimental design and the accuracy of data processing, the experimental class is obviously

Better than the parallel class. The two projects mainly test students' deep understanding and internalization of experimental principles and relevant professional knowledge, and the experimental class is significantly higher than the parallel class in these two projects. The analysis and improvement of the experimental results in the Table1 mainly check the students' ability of application, evaluation, innovation and individualization. The largest difference between the experimental class and the parallel class appeared in these two objects, with about 20 people in the experimental class scoring in these two items, while the parallel class was basically fixed with 4-5 people scoring in these two items. The experimental class scored about 15 more students than the parallel class on these two projects.

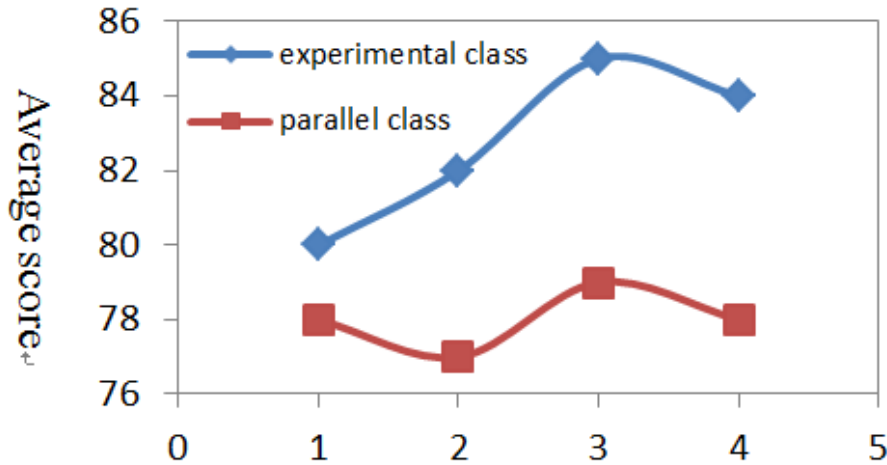


Fig. 2, The four posttest test results of two classes

Table1, The evaluation index of the experimental report

objects	Experimental class	Parallel class
① Clear experimental principle	80.5%,83.3%,86.1%,88.9%	77.8%,75.0%,80.5%,77.8%
② procedure correct	94.4%,91.7%,94.4%,97.2%	91.7%,88.9%,91.7%,94.4%
③ experimental design reasonable	88.9%,91.7%,91.7%,94.4%	75.0%,77.8%,75.0%,80.5%
④ data processing correct	86.1%,88.9%,91.7%,94.4%	77.8%,75.0%,80.5%,75.0%
⑤ analysis with personal opinion	61.1%,63.9%,58.3%,66.7%	13.9%,11.1%,13.9%,13.9%
⑥ propose improvement suggestions	55.6%,58.3%,58.3%,63.9%	11.1%,13.9%,11.1%,13.9%

Note: The table lists the statistical values of the four experiment reports, and the experimental class and parallel class are 36 people

Figure 2 and Table 1 indicate that the flipped classroom model applied to the comprehensive experiment of pulp and paper has achieved significant improvement in the application, evaluation and innovation of higher-order learning objectives. Results of questionnaire survey conducted in class showed that 97.2% of the students believed that flipped classroom improved their enthusiasm for learning and they liked this teaching model. Only one student believed that flipped classroom resulted in more learning pressure and felt uncomfortable.

Summary

The flipped classroom with micro-course provides students with refined instructional video, which makes students' learning flexible. And they can learn in advance or in the experiment process, this is benefit to reduce the mistakes and to enhance students' confidence in their operational ability.

This study show that flipped classroom can be used in experimental teaching in colleges and universities, and is conducive to arousing students' initiative in independent learning, which greatly improves students' participation in the whole teaching activities and makes them masters of learning. In this mode, teachers can give more targeted guidance and answer questions to students, or give personalized guidance, so as to truly help students in accordance with their aptitude.

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