Using *flipped classroom* as the teaching mode in a *Computer Network* course

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ABSTRACT: Along with the integration of information technology in the curriculum, *flipped classroom* as a teaching design pattern that provides a new direction for the further development of teaching and learning. The flipped classroom turns the class upside down and reverses knowledge imparting and knowledge internalisation in the traditional classroom, which truly reflects the student-centred education philosophy. Computer network courses have a strong practice element and place a high demand on the classroom training. This article describes the introduction of the flipped classroom teaching mode into a *Computer Network* course, according to which students can study theories and actual projects before class, thus, enhancing students' their thinking ability, practical ability and innovation ability, thereby, improving the effect of classroom teaching.

INTRODUCTION

With the rapid development of computer and network technology, network applications have become one of the more important fields in computer application. In order to develop talent with computer network application knowledge, most universities have introduced a *Computer Network* course. New developments in computer network technology, the computer network architecture, computer network protocol levels, network security, etc, are widely taught, aimed at the various levels of students and according to different emphases [1].

However, because the computer network course is an abstract one, emphasis is being placed on practice and application. Moreover, in the traditional teaching mode, teacher-oriented teaching is still the main teaching mode, simple configuration and verification experiments are arranged only at the experimental stage, so most students feel this course is rather abstract and distant from real life. They do not understand it, are not able to fully grasp this course and find it difficult to use in their future work [2].

Aimed at tackling the above mentioned problems, it seems that a flipped classroom teaching mode is appropriate in the teaching of the computer network course. Students study theories and practical projects individually before class, and all the students receive so-called personalised education, which can greatly improve their practical ability and innovation ability. The seamless docking between the demands of industry and talent training in colleges and universities can ultimately be realised [3].

THE PRESENT TEACHING SITUATION OF COMPUTER NETWORK COURSE

The *Computer Network* course is a compulsory course for college computer and electronic professional majors, where students are engaged in network hardware management or network software development after graduation, so students must master the knowledge of computer networks [4].

However, even though students' initiative and enthusiasm are very high, the teaching effect is not very good; the teacher can teach with more vigour, but students still think that the computer network course is abstract and has too many knowledge points that are not necessary for them to learn, which forms a contradiction between teaching and learning. From the nature of the computer network course and teaching experience in recent years, there exist three main problems:

Properties of the computer network course determine that this course is very difficult to learn: there are to many knowledge points in the course, including some content on computer network development, network basic principles, network architecture and network equipment management, etc. Students can easily be confused by these knowledge

points and it is quite difficult to achieve the desired teaching goals. Furthermore, the course is an interdisciplinary subject and, as such, is a combination of computer hardware, software technology and communication technology. The knowledge is spread across several areas, which is makes it difficult to grasp. Practical work is also hard, so that it is hard to mobilise and maintain the enthusiasm of students. The course also lacks classroom interaction in the classroom teaching [5].

No solid experimental foundation available to students; it is difficult to convert theories into practice: experimental teaching is an important step in the teaching of computer networks. In the experimental teaching, the large number of students and insufficient experimental equipment lead to some of the students having no opportunity to undertake experiments (overcrowded classes), which directly causes difficulties for those students when abstract theories are converted into practice. Moreover, most experiments only verify some simple theories and the basic network model; students do not have the opportunity to *handle* the network hardware, hence, they cannot undertake any experimental work. Furthermore, the equipment type described in the teaching sometimes does not match the experimental equipment available, resulting in students being unable to understand various parts of the network protocol, commands and parameters, which have a direct impact on the cultivation of students' interest in learning. This eventually leads to the situation where converting the theory into application technology is difficult.

Combining theory with practice is not close enough: in the past few years of teaching the computer network course, the learning effect has not been very good because considerable portions of the content represent basic theoretical knowledge. When taught through the traditional teaching method, students seem to receive the knowledge mechanically. Moreover, all the theories of computer network are geared for solving practical problems in communication. However, due to the restricted class size, during the process of teaching, the amalgamation of theory and practice cannot be achieved completely; hence, students generally only master the theory, and their actual practical application ability is weak. Finally, the development of computer and network technology is rapid and the course content needs to be updated faster. At present, there is a gap between the requirements of network knowledge and students' learning in the classroom.

THE MEANING AND FEATURES OF THE FLIPPED CLASSROOM

In the last ten years, the idea of the flipped classroom has been accepted by more and more universities and colleges in North America, and gradually has become a new wave of educational reform. Even popular newspapers, such as the *Wall Street Daily*, *The New York Times*, *The Washington Post*, etc, and other mainstream media have shown interest, and presented positive coverage of the flipped classroom [6].

The so-called flipped classroom is a new teaching mode in the information environment, in which teachers provide teaching videos as the main form of learning resource, and where students complete the teaching video learning by watching before the class; teachers and students focus on homework answering questions together, conducting collaborative inquiry and other interactive communication activities [7].

From the point of view of the teaching process, the flipped classroom overturns the teaching process of teachers teaching and students doing assignments [8]. The traditional teaching usually includes the transfer of knowledge and knowledge internalisation, which occur during the knowledge transfer stage. The teachers complete the explanation of the course content in class, and students complete the course content. As part of the learning process, students complete assignments and exercises by using class-based learned knowledge to strengthen their understanding of that knowledge. But in the flipped classroom mode, students complete the course content learning before the class; the process of knowledge internalisation happens in the class. Most of class time is used to answer students' questions, and there is collaborative group inquiry and in-depth exchanges between teachers and students.

From the perspective of the role of teachers and students, in the traditional classroom, the teacher is the owner and communicator of knowledge, and students typically receive knowledge in a passive way. In the flipped classroom, the role of the teacher is converted into one of a facilitator of the teaching activities and, therefore, the teacher becomes the students' *coach*. Students are transformed from being a passive *audience* into being active participants in the teaching process. Students have more freedom in the process of teaching, but teachers do not allow students to go astray. However, as part of their scheduled overall progress, the students can arrange the learning process in light of their preferences and desires. The flipped classroom helps to realise student-centred teaching in accordance with students' aptitudes and learning styles.

From the perspective of teaching resources, concise teaching videos are the most important part of teaching resources in the flipped classroom. Teaching videos are usually on a particular topic, and can be viewed using the many functions of the media player, such as pause, playback and other functions. It is very convenient for students as it provides the opportunity to make notes and think during the learning process. Hence, it is conducive to the students' autonomous learning. When watching the teaching videos out of class, the learning atmosphere is more relaxed and students do not worry about missing any portion of the material. When they encounter problems, students can also communicate with teachers and peers by seeking help through the Internet. Another advantage of a teaching video is that it is convenient for the students to review and consolidate the learning even after a period of time.

Because the flipped classroom effectively provides an increase of class time, teachers and students have more time for enhancing classroom activities, such as discussion, experiments, interaction and project-based learning [9]. Therefore, the flipped classroom widely employs seminar-style and project-driven learning modes, which are suitable for emphasising practice and theories of the computer network course and are conducive to improving the teaching effect in the course. The teaching mode of the flipped classroom applied to the computer network course is shown in Figure 1, which is mainly composed of three interrelated processes that are video learning before class, class training internalisation and knowledge solidification after class.

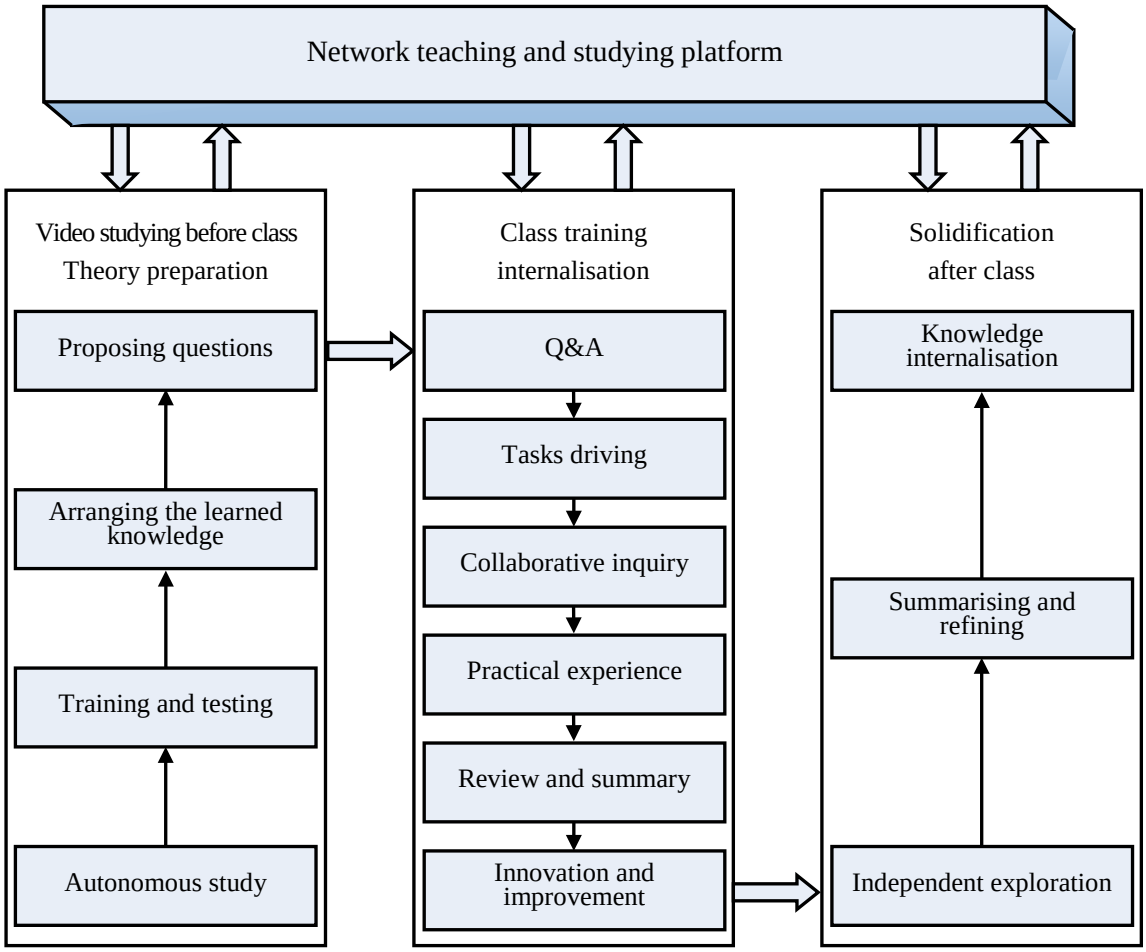

Figure 1: Teaching mode of the flipped classroom based on a computer network course.

Video Studying Before Class

Video studying before the class is the basic knowledge preparation stage of class training, where the learning effect has a direct impact on classroom training. According to the requirements of teaching goals and the knowledge system of the computer network course, teachers select appropriate cases for the course and arrange teaching activities.

The basic theoretical knowledge for each lesson is designed in accordance with the concept of the *anti-technology* sequence. The project development process is the most crucial part. Then, teachers put theoretical knowledge into a streamlined video production and upload these videos to the computer network teaching and studying platform, arranging for students to watch instructional videos and letting them complete the training and testing of knowledge points.

According to the learning tasks assigned by the teacher and combined with personal needs, every student can customise the rhythm and speed to study autonomously. Students with a good theoretical foundation can speed up the learning, whereas students with a poor foundation can slow the process down or repeat watching the videos. The teacher designs problems before explaining the knowledge points, allows students to watch the videos and asks questions as they search for answers.

After the end of playing each knowledge point, students complete the training tasks assigned by the teacher. Students may produce a lot of questions and organise training results, which are taken to the class or communicated with the teacher through the network teaching platform.

Class Training Internalisation

As Figure 1 shows, the phase in class training internalisation includes questions and answers (Q&A), task driving, collaborative inquiry, practical experience, review and summary, innovation and improvement. To realise and implement these sub-processes, several measures should be taken:

Designing Classroom Activities

The key to success of the flipped classroom lies in maximising knowledge internalisation students. For classroom teaching of the course, teachers design classroom activities around knowledge of the basic theory of computer network and computer network experimental projects. Different experimental projects have different requirements and foci, and the design of classroom activities must meet the curriculum goals. According to the workload and the length of time taken up by computer network experimental projects, curriculum objectives can be divided into term targets, unit targets and class targets.

Undertaking Classroom Training

First of all, the teacher explains the relevant knowledge points for students, reacting to the questions raised by students before class or according to the feedback from the students' theoretical knowledge test before class. Then, in accordance with pre-designed classroom activities, the teacher briefly introduces the lesson's objectives and guides students towards understanding the project objectives and tasks. Moreover, enterprise simulation project development teams are put together, consisting of four to six students each. Each group elects a group leader and project group leaders are responsible for task assigning, progress tracking and quality control. The teacher checks on the progress status of each group.

In the project training process, students gain experience and are able to understand new knowledge. When questions are asked, students can learn from each other and discuss ways in which to solve the raised questions, and they can also communicate with the teacher on how to solve the problems. For the common problems raised by students, teachers can demonstrate the solutions for all the students at the same time. When teachers answer students' questions and explain the theory, the process of guiding students to think about deeper problems can occur.

In this way, students constantly improve in the process of training by studying and discussing, coming with innovative solutions, and generally improving. After introduction of the flipped classroom mode, the interaction between the teacher and students is increased and the amount of personalised contact time also becomes much longer. The classroom is converted into a place in which students execute project training and solve related problems. Eventually, the students can understand and apply theories, learn new theories, and maximise the internalisation of knowledge during the process of *learning by doing*.

Presenting Activity Results

After the end of each class, group leader students submit activity outcomes on behalf of the group. When completing some part of the network experiment process, the experiment result document is tabled and presented. All activities results or the development document should be submitted through the network teaching and studying platform. The teacher can instantly summarise and evaluate whether students have met the objective of each lesson and unit goals and, then, arrange for the learning content of the next class.

Solidification After Class

After class, each student reviews errors and innovations that occurred in the process of project training, and they can reflect on the summary and evaluation from the classroom, check and modify the submitted documents, and even resubmit documents through the network teaching and studying platform.

CONCLUSIONS

The computer network course is a strong theoretical and practical course, hence, the flipped classroom is very suitable for the teaching of this course. Through the use of the flipped classroom mode in the computer network course, the knowledge imparting and knowledge internalisation of the traditional classroom can be reversed, which truly reflects the teacher's leading role and the principal status of students. This enables students to master the theoretical knowledge of computer networks and develop strong practical abilities to meet the professional and social demands for network technology professionals. This, in turn, improves the promotion of the reformed course's outcomes.

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