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Flipped classroom teaching that integrates learning, guidance, practice and application

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ABSTRACT: The flipped classroom is a new teaching model that is highly advocated for the teaching reform of colleges and universities in China. To make the student the real learning subject and enhance the teacher's guiding role in effective teaching, the authors propose a flipped classroom model that integrates *learning, guidance, practice* and *application*. Moodle was used in this research, to form an integrated platform to cover the entire process of before-class, in-class and after-class teaching that integrates teaching, guidance, practice and application. With an example course on Sensors and Detection Technology, a corresponding teaching model was designed. The results show that flipped classroom teaching enhanced the learning performance of students, stimulated their learning motivation and improved their creativity. Therefore, the flipped classroom teaching model can be used effectively in teaching engineering courses at colleges and universities.

INTRODUCTION

Improving teaching quality is a constant objective of universities and colleges. In China, the Teaching Quality and Educational Reform Project of the Institutions of Higher Learning was conducted by the Ministry of Education in 2003. Every year thereafter, the improvement of teaching quality has been identified as a core task. This reflects the importance that higher education practitioners in China have attached to this goal.

At present, the quality of teaching in China has significant room for improvement. Studies show that more than one-third of students often chat, play with mobile phones or listen to music while in the classroom. Sixty-one percent of students believe that teachers do not integrate their own knowledge into classroom teaching, but just repeat what is in books and papers. Moreover, students perceive teachers as not linking theory to practice and not communicating with the students. Hence, class is considered *very boring* [1].

Students fail to take responsibility for their learning, since they only attend classes because they are required to do so. At the same time, teachers fail to interact actively with students and only provide lessons because they, in turn, are required to do so. These conditions affect the teaching and weigh against the development of both teachers and students. Therefore, the teaching at colleges and universities in China need to be reformed and teachers need to explore new instructional modes that are more effective than the traditional approaches.

As a new form of teaching, the flipped classroom repositioned the role of teachers and students in the classroom. It satisfied the need for teaching reform in China, was well received by teachers and contributed to the exploration of new and more effective ways of teaching. Chinese academicians have presented theories based on the framework of the reverse model. They have applied these models to practice and achieved positive results [2][3].

The authors of the present study believe that the flipped classroom is a process that involves not only before-class and in-class elements, but also after-class aspects. Moreover, the flipped classroom needs a special environment that can guarantee the development of teaching for both the teachers and students. Thus, using a course on Sensors and Detection Technology as an example, the authors have proposed a flipped classroom model that integrates guidance on learning with practice and application. Moodle (modular object oriented dynamic learning environment) was used for the reformed teaching. A teaching plan was developed based on the model, which was implemented and the effect verified.

INTEGRATED FLIPPED CLASSROOM TEACHING MODEL

In applying the flipped classroom to practical teaching, many scholars have proposed various teaching models. Talbert described an implementation structure for the flipped classroom. He believed that the flipped classroom should include before-class and in-class stages. In the former, the students watched teaching videos and performed specific exercises, while in the latter, the students quickly completed a few tests and, then, internalised the knowledge by solving problems and, finally, presented summaries and feedback [4]. Using Talbert's model, Zhang proposed a new flipped teaching model that included the before-class part of video making and targeted exercises, as well as the in-class part of problem identification, independent exploration and co-operative learning [5]. Zhong and Song proposed a similar model [6].

Following the view of Saltman, Zhen Zeng drew an *inverted* teaching diagram and pointed out three key steps in inverted teaching: 1) learning before watching videos for the purpose of discussing and proposing questions; 2) learning while watching videos for the purpose of finding answers to the questions; and 3) learning of applications of the lesson and solving problems for the purpose of exploring problems in depth [7].

Existing theoretical models provide strong guidance, but some fail to show the interaction between students' learning and teachers' teaching; others have limitations in before-class and in-class learning. After summarising and reviewing these models, the authors proposed a flipped classroom teaching model that integrates learning, guidance, practice and application (see Figure 1).

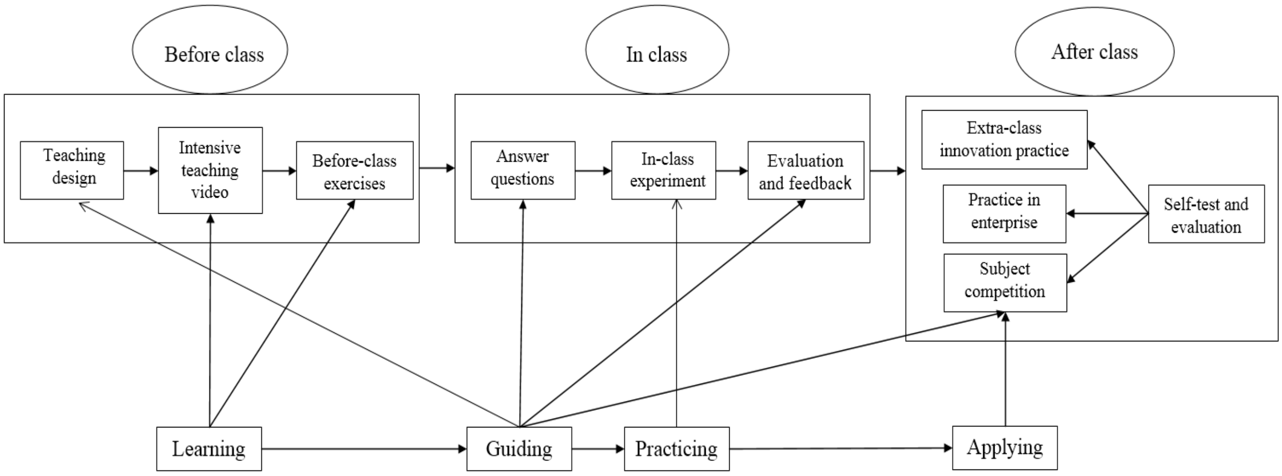

Figure 1: Flipped classroom teaching model integrating learning, guidance, practice and application.

The model can be analysed from several aspects:

- First, the flipped classroom teaching model is a complete process that includes three parts: before-class, in-class and after-class. The parts combine organically to form effective classroom teaching.

- Second, this model is an interactive process between teachers and students, in which both are indispensable. In flipped classroom teaching, the students are the centre of learning and the core of instructional activities. However, the teacher is not replaced by the video, but plays the role of a guide, organiser, participator and promoter in learning. Both the teachers and students form an actively interactive community.

- Third, the flipped classroom needs to be supported by information technology. The Moodle environment is a supportive one for implementing the flipped classroom model.

- Fourth, flipped classroom teaching is an integrated process of *learning, guidance, practice* and *application,* which is the core of the model. Learning is at the heart of the entire process.

Problem-based learning proceeds with a focus on *who will learn, what to learn, how to learn* and *what to gain* [8]. In *who will learn,* the student has the principal role. So, teaching innovation and practice should focus on the students. Learning also involves the teachers who guide and link the teaching, as well as the students in the classroom, using questions and answers that arise during discussions. Therefore, *who will learn* refers to the mutual learning of teachers and students.

With regard to *what to learn* and *how to learn,* courses should be implemented in accordance with the objectives based on the nature of the students, enterprise needs, major features of the discipline and educational objectives. Finally, *what to gain* means that students should learn how to learn, co-operate and innovate.

Guidance refers to the role played by the teachers in guiding and directing activities, such as teaching theory, integration of main points, setting of research and discussion subjects, as well as the arrangement of reports. Guidance addresses questions such as *What project?, What to do?* and *What applications?* Guidance aims to enhance students' interest in learning and their initiative to participate in the learning.

Practice refers to experimental activities. For the example course on Sensors and Detection Technology, the teachers combined the current applications and developments in sensor technology to set up eight open, real-life innovative projects. Students can undertake these projects using the open, innovative laboratory.

In the area of applications, enterprise engineers are invited to deliver lectures, to provide practical training. Students have the opportunity to visit enterprises rather than being limited to classrooms or laboratories. Students also are encouraged to participate in contests, such as the National Intelligent Car Competition and the Electronic Design Competition, to help develop their practical skills.

TEACHING EXAMPLE USING THE INTEGRATED, FLIPPED CLASSROOM TEACHING MODEL

The example course, Sensors and Detection Technology, is presented in this section, to illustrate the teaching based on the integrated, flipped classroom model.

Teaching Implementation

The focus of the Sensors and Detection Technology course is on the general knowledge of sensors. This includes where and how to use them, what to pay attention to and the different levels of applications. This is in contradistinction to contents, such as the mathematical model of sensors and related formulae, internal structure and manufacturing techniques, complicated system designs, and an emphasis on the system. The course design changed the traditional arrangement of teaching content by dividing the textbook content into eight intensive sessions for the teaching of theory, eight in-class experiments and eight sessions of extra-class open innovation practice.

- Before-class teaching:

  In the before-class teaching, the teachers are the directors that are the carriers of knowledge. The teaching design is modular and project-oriented. Each module is composed of several projects and each project relates to a specific sensor application design. The teaching process enables students to gain knowledge of modern sensor and detection technologies, and familiarises them with model selection, basic operating principles, basic application circuits and the application of sensors. It develops their ability to independently build a basic detection control system from an engineering perspective.

  The teacher makes a video or micro-lesson of the eight intensive theoretical teaching units before the class. Students undertake on-line learning via the Moodle teaching platform and submit questions on-line to communicate with the teacher or other students or to check answers that have been discussed. Students can deepen their understanding of theoretical knowledge through before-class exercises. This entire process is characterised as *learning*.

- In-class teaching:

  First, the teacher answers common questions raised by students, explains specific points or provides individual guidance. Then, the students complete in-class experiments through group co-operation and upload the experiment results to the teaching platform. The teacher randomly selects group members to introduce their experimental design and, then, evaluates the projects and provides feedback (i.e. guidance).

  When the in-class experiments have been completed in accordance with the before-class video, students start working on their projects. This involves identifying sensor parameters, designing specific circuits, analysing the operating principles of the circuits, and explaining the production and debugging of the circuits. The process emphasises operational and collaborative ability, i.e. the *practice*.

- After-class teaching:

  To enable extra-class practice, students are trained to develop and apply the knowledge they have learned in class. Professional engineers are invited to participate in teaching, and students are given the opportunity to learn from, and participate in, practical enterprise projects. Students are also encouraged to participate in competitions. This process, in which the teachers also play a guiding and directing role, is called *application*.

Teaching Platform

The entire process of course teaching relies on the Moodle teaching platform. Moodle is free open-source software that is low-cost, safe, modular, has good functionality and a convenient user interface. The platform is composed of several modules, including course management, homework, chat, vote, forum, test, resource, questionnaire and interactive evaluation [9]. This teaching platform can satisfy a variety of learning needs and provides a number of management modes. Moodle allows uploading of intensive teaching videos, publishing of teaching activities, teaching-learning interactions, learning evaluation, homework grading and final examinations.

Evaluation of the Teaching

Evaluation is conducted by process evaluation rather than summative evaluation, as in the past. The evaluation includes the final examination and independent study/process performance, each accounting for 50% of the total evaluation.

- Final examination:

  The question bank includes elective and compulsory content. The compulsory content is mainly about the application circuits of typical sensors. Specifically, it deals with the typical project application examples of circuits, including identification and function description of circuit components, qualitative analysis, function and application notes.

  The elective examination contents include the basic knowledge of sensor and testing technology, basic application principles of typical sensors, application scenarios and notes, and common knowledge on typical application cases. The examination is a computer-based test, with 34 questions selected randomly from the question bank and should be completed by a student within 90 minutes.

- Independent study/process performance:

  This part is composed of independent-based and process-based learning evaluations, which account for 80% and 20%, respectively of the independent study/process performance evaluation. Independent-based study includes pre-class video viewing and pre-class exercises, BBS (bulletin board system) assignments, answering questions and discussing reports, and on-site experiment performance and quality. These account for 20%, 30%, 30% and 20%, respectively of the independent study evaluation.

  Process-based learning includes attendance, group discussion and reporting, answering questions, on-line communication and discussion. These account for 50% of the process performance evaluation. After-class discussion, BBS assignments and others, account for 20% of the process performance evaluation. After-class innovation-based open practice project, corporate internships and awards in competitions and others account for 30% of the process performance evaluation.

EFFECT OF THE INTEGRATED, FLIPPED CLASSROOM TEACHING

Basing on the Moodle teaching platform, the researchers proposed integrated, flipped classroom teaching for the course, Sensors and Detection Technology. The results show that the teaching has been significantly improved.

Performance Improvement

The authors conducted a contrastive experiment for the course by randomly selecting 30 students from two classes of the same grade. The control group received the traditional form of teaching, i.e. teaching and after-class exercises, while the experimental group used the teaching model that has been proposed in this article. The students took an examination two months later. Figure 2 shows a graph of the performance of the students in the two classes, ranked from high to low. The overall performance of the experimental group was higher than the control group. The average marks were 83.5 and 77.0, respectively, with a difference of 6.5 points.

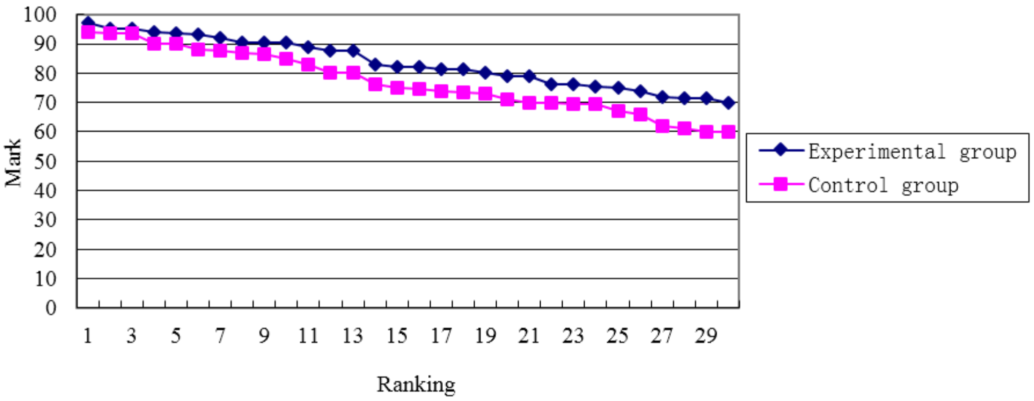

Figure 2: Comparative graph of student performance.

Student marks were divided into four intervals of 10 points each, as shown in Figure 3. The proportion of students in the four intervals were 33%, 30%, 37% and 0% for the experimental group and 17%, 27%, 30% and 27% for the control group. In the two intervals 100-90 and 69-60, the experimental group showed much higher proportions than did the control group by 16% and 27%, respectively. In the other two intervals, the differences were comparatively small.

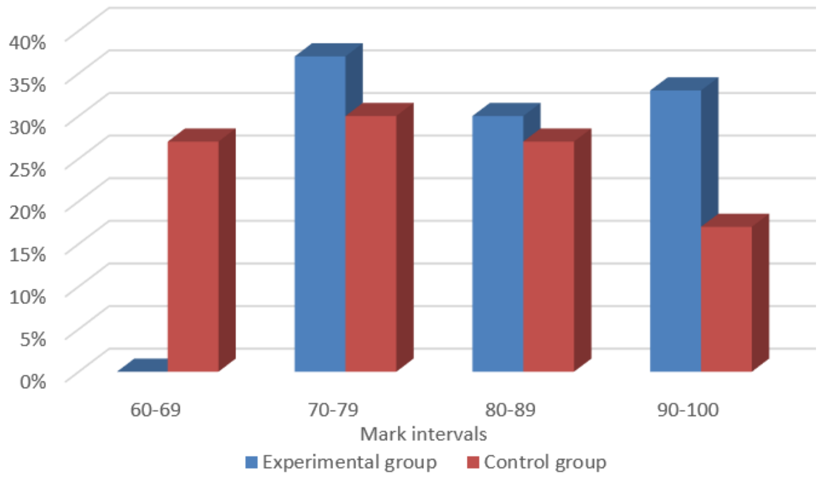

Figure 3: Comparison of student marks distribution.

Students' Self-evaluation

A self-evaluation of students in the experimental class was conducted by questionnaire. The qualitative analysis showed several interesting results:

- The flipped classroom teaching stimulated students' learning motivation and enhanced their in-class participation. Among all students, 96% said that they did not receive knowledge passively, but learned how to understand, process and use knowledge. The learning depended on normal activities of thinking, discussing and practising, which exerted less pressure on the students. As well, the class members studied an on-line course, which enabled them to learn anytime and anywhere. The students became interested in learning and developed significant learning motivation. Thus, they became active in class, which emphasised their role as the learning subjects.

- The new learning mode enhanced students' creativity. In the past, students listened only, but now they had to learn to ask and think, as well as to solve problems independently. Using the teaching platform, the students can interact with their teachers and other students, pose questions and seek solution strategies, present their views on operating principles and applied design concepts, as well as present their own ideas and comment on the existing designs, suggesting ways to improve them. Hence, students develop their creativity during the learning process.

CONCLUSIONS

The essence of the flipped classroom is not simply one of using high technology or information technology, but one of innovating on learning models. Certainly, no perfect teaching mode is suitable for all academic environments [6], but the flipped classroom model that integrates *learning*, *guidance*, *practice* and *application* can be used effectively to teach the course on Sensors and Detection Technology, as well as other engineering courses. The applicability of this model to other disciplines has yet to be tested in practice.

REFERENCES

1. Ye, Q. and Li, M., An empirical analysis on the comparison of traditional teaching and flipped classroom of colleges and universities. *Modern Educational Technol.*, 25, **1**, 60-65 (2015).
2. Xu, C., Classroom flipping as the basis of a teaching model for the course *Mobile Application Development. World Trans. on Engng. and Technol. Educ.*, 11, **4**, 537-540 (2013).
3. Liu, G., Zhang, Y. and Fan, H., Design and development of a collaborative learning platform supporting flipped classroom. *World Trans. on Engng. and Technol. Educ.*, 11, **2**, 82-87 (2013).
4. Talbert, R., Inverting the linear algebra classroom. *Primus Problems Resources & Issues in Mathematics Undergraduate Studies*, 24, **5**, 361-374 (2014).
5. Zhang, J., The research on flipped classroom teaching mode. *J. of Distance Educ.*, 30, **4**, 46-51 (2012).
6. Zhong, X. and Song, S., Research on teaching design based on flipped classroom idea in the informational environment. *Open Educ. Research*, 19, **1**, 58-64 (2013).
7. Zhen, Z., Characteristics, practice and problem of inverted education. *China Educational Technol.*, 4, **7**, 114-117 (2012).
8. Yeh, R.C., Chen, Y-C., Kuo, S-H. and Chung, P., The effect of problem-based learning on enhancing students' workforce competence. *World Trans. on Engng. and Technol. Educ.*, 9, **4**, 239-245 (2011).
9. Chen, Y. and Zhao, C., Teaching design and applied research based on the flipped classroom mode. *Modern Educational Technol.*, 24, **2**, 49-54 (2014).