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Flipped Classroom Combined with Project-oriented Teaching Practice of Internet of Things Technology under TBL Mode

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Abstract: *In the new teaching model, flipped classroom and team-oriented learning (TBL) are both student-centered models. Combining the advantages of these two models, students are no longer passive indoctrinate knowledge, but participating in interesting teaching activities before class and in class to achieve active learning. We applied the flipped classroom and TBL teaching model to the Internet of Things technology course, and carried out a series of exploration and practice in combination with virtual projects. The results show that students' learning initiative is significantly improved, their interest surges, their learning depth increases, and the classroom discussion atmosphere is stronger. Students' ability of expression, communication, teamwork and critical thinking has been significantly improved, and satisfactory teaching results have been achieved.*

Keywords: *Internet of Things technology; Team-oriented learning (TBL); Flipped classroom; Teaching practice*

1. Flipped classroom combined with TBL teaching mode

Team-based learning (TBL) is based on the constructivist learning theory, and uses the essential process of how people learn and the feature that they can learn more effectively through teamwork as a starting point to design the learning process.

This method was proposed by American educator Michaelsen in 2002 on the basis of problem-based learning (PBL) reform and innovation. And a new adult teaching model is gradually emerging, which is helpful to promote learners' teamwork spirit and pay attention to people's creativity, flexibility and practical characteristics[1].

The Flipped Classroom is a model of instruction that originated in the United States in the late 20th century and made substantial progress in the early 21st century.[2] "Flipped classroom teaching mode" means that students complete knowledge learning before class, and the classroom becomes a place for interaction between teachers and students and between students, mainly to answer questions and solve problems such as knowledge application, so as to achieve better teaching effect[3]. The spiritual meaning of flipped classroom mode is to strengthen the central position of students, reflect the idea of deep learning, highlight the advantages of blended learning, and promote personalized learning practice[2].

Relevant references at home and abroad[4-6] shows that the combination of flipped classroom and TBL teaching mode can complement each other and realize the advantage of 1+1>2.

Flipped classroom and TBL teaching mode are both new "student-centered" teaching mode. Practice has proved that both of them can achieve ideal teaching effect, but at the same time, both have certain limitations. Combining the two, according to the "learning pyramid" theory[4], learning through "teaching others" and "applying it now" can achieve the best learning results. The comprehensive application of flipped classroom combined with TBL teaching model [5] is a new "student-centered" teaching model. Students are no longer passive learning groups infused with knowledge in class, but subjects who actively participate in various interesting teaching activities before class and in class, and actively learn relevant knowledge through "teaching others" and "immediately applying the knowledge". It can better cultivate their own independent learning ability and cooperation ability, so as to obtain better learning effects.

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2. The application of flipped classroom combined with TBL in IoT technology courses

The course of "Internet of Things Technology" is the basis for Internet of Things engineering students to effectively solve problems in their future study, work and life, and is the basis for students to develop themselves in their future jobs. This course covers a wide range of areas and is highly practical. The content of this course cannot only be learned through lectures, but needs to be guided by engineering projects to train students' practical ability of various technologies in the Internet of Things technology. Students need to learn to analyze real engineering projects and solve real problems. This course is a combination of theory and application, and theory and practice complement each other to improve students' ability to understand and solve problems.

In view of these problems, combined with the actual situation of Qingdao City University, this paper explores the construction of flipped classroom and project-oriented Internet of Things technology teaching system under TBL mode, uses effective engineering project cases for course design, and utilizes the advantages of high-impact teaching mode flipped classroom and TBL mode to stimulate students' interest in independent learning and improve students' practical ability. We need to cultivate students' comprehensive qualities such as critical thinking and problem-solving ability, communication and cooperation ability.

The course teaching mode of classroom flipping combined with TBL adopts pre-class theoretical self-study, classroom group theoretical explanation, project-driven, case teaching, group collaboration, and result display to cultivate students' critical thinking and problem-solving ability, paper writing ability, and team communication and cooperation ability. The specific methods are as follows:

(1) The teaching content is gradual, and theory and practice complement each other and penetrate each other

Teaching content delivers from simple to deep, so that students can learn knowledge fully and gradually. Using virtual project engineering case teaching, the theoretical knowledge is decomposed into engineering cases. With the rapid development of Internet of Things technology and the emergence of new technical methods, it is necessary to understand the methods at all levels of Internet of Things technology from multiple perspectives and learn various theoretical knowledge in the three-layer architecture of the Internet of Things. Since students in private colleges and universities generally lack theoretical knowledge, when making teaching plans, we need to interweave theoretical content into the practice process. By practicing after learning theory, so students can exercise their practical ability on the basis of understanding the theory and further deepen their understanding of the theory in the process of practice.

(2) Designing project cases for teaching

The teaching method of virtual project engineering case is adopted. Three types of project cases are designed, the knowledge points are distributed in the practice of the project, and the theoretical basis is further explained in the process of practice, so as to combine theory and practice and students can deeply understand the key points of Internet of Things technology. The case project information is shown in Table 1.

Table 1: Case item information

Case name	Knowledge point decomposition
1.IoT awareness system	1. Sensor characteristics and selection
	2. Automatic identification technology analysis
	3. RFID technology principle
2. IoT communication systems	Bluetooth technology principle and networking application
	ZigBee technology principle and networking application
	WiFi technology principle and networking application
3. IoT application system	1. Agricultural greenhouse air humidity control system
	2. Home lighting control system.
	3. Home intelligent security system

The above cases are used to explain the technical knowledge and practical application in each layer of the three-layer architecture of the Internet of Things. We need to organize effective pre-class preview, class group theory explanation, class activities, discussion, and stimulate students' thinking.

(3) Organizing students to form teams, carrying out classroom flip design, and enhancing students' project work experience

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The teaching design is based on classroom flipping combined with TBL mode, the teaching is driven by virtual project cases, and students are led to explore and solve problems in virtual project tasks, and learn by means of autonomy, cooperation, discussion, PPT presentation and paper writing.

In the process of the project, the group design is carried out, and the team members have a reasonable division of labor to cultivate the team cooperation ability and cooperate to carry out the project. We need to guide students to develop their interests and strengths and teach them how to work as a team. At the end of the project, each team will submit their project results, and one team member will be selected to summarize the project and demonstrate the project results, summing up the experience in the project, and the team members will answer the questions respectively to further deepen the understanding of theoretical knowledge.

In the later stage of the course, team members will work together to complete the design and implementation of a system, summarize the design and implementation process, write the implementation paper, and analyze the problems encountered and solutions. In the final defense, students need to give comprehensive PPT presentation and question defense. TBL teaching mode aims at solving problems and attaches importance to the learning process of solving problems. The TBL teaching model aims to solve problems and emphasizes the learning process of problem-solving. Compared with traditional teaching, TBL teaching is more advanced and efficient, which can fully mobilize students' learning enthusiasm and better realize the teaching goal of learning and growing in cooperation.

(4) Flipped classroom combined with TBL, comprehensively improving students' comprehensive literacy

Through flipped classroom plus TBL teaching, the projects realized in actual practice will be summarized and displayed in a group way, training students' critical thinking, training students' ability to summarize, classroom expression, and thinking ability to answer questions on the scene. This way can also cultivate students' communication ability to internalize and absorb knowledge and then output and express the whole process.

3. Flipped classroom combined with TBL in the Internet of Things technology course practice and effect analysis

Taking "Internet of Things Application Technology" course of a semester as an example, we briefly introduce the project-oriented teaching practice process under the classroom flipping plus TBL model. This course is designed to carry out process assessment. The students in the class are divided into 8 groups with 3-4 members in each group. Tasks are decomposed before class. The key points of every course are decomposed, as shown in Figure 1. Each group will preview before class and explain the theory after class, and draw lots to determine the order of each group. Curriculum evaluation is divided into teacher evaluation and group members mutual evaluation. Teacher evaluation accounted for 80% and intra-group evaluation accounted for 20%. Intra-group evaluation is used to rank the final scores of the members in the group.

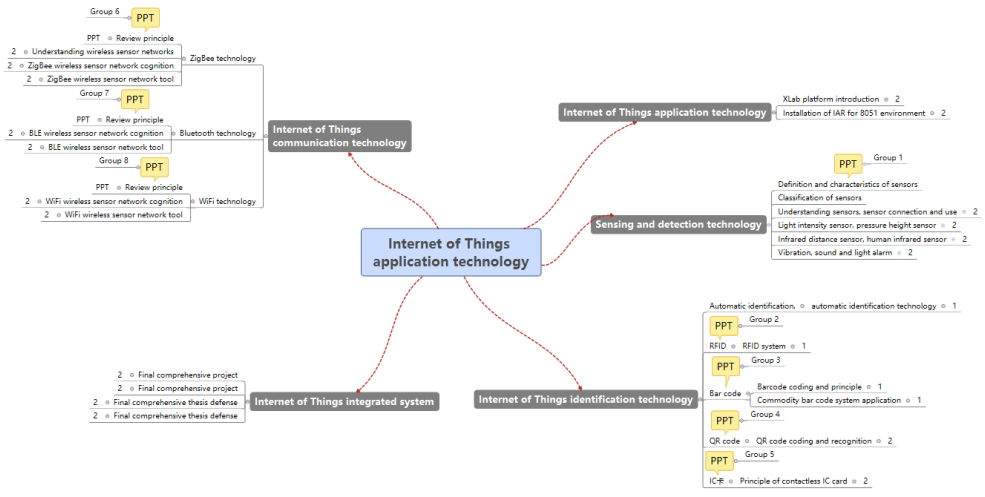

Figure 1: Internet of Things application technology course knowledge points decomposition

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The specific course design is shown in Figure 2.

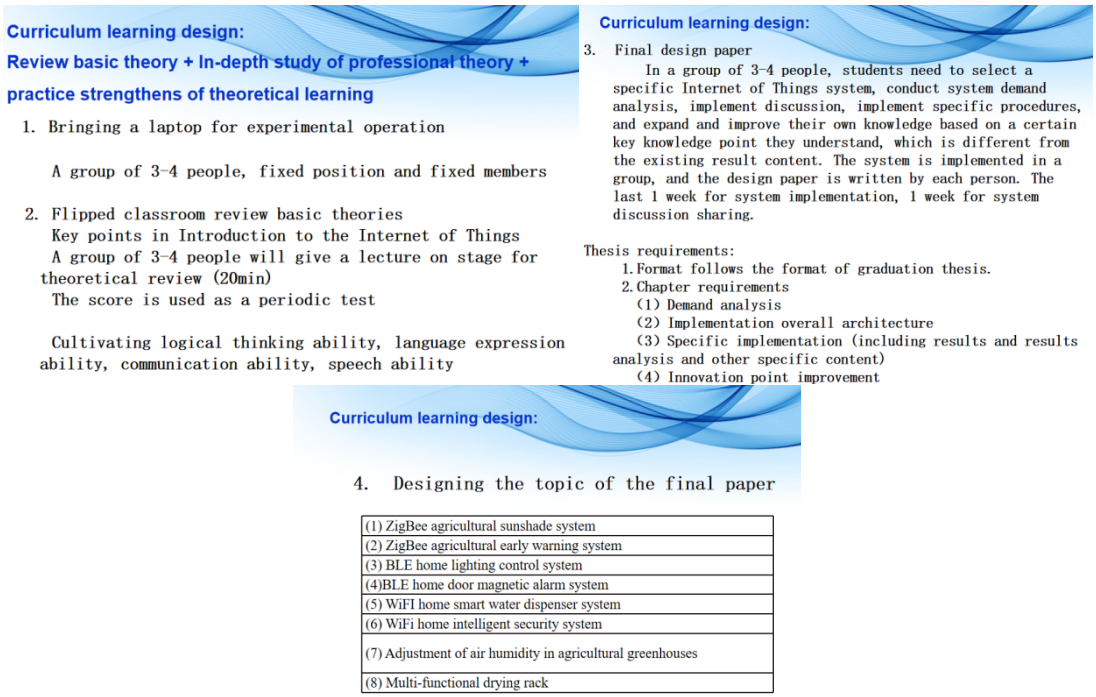

Figure 2: Learning design of IoT application technology course

The project learning process of TBL mode is carried out under project orientation.PPT presentation in classroom flipping is shown in Figure 3.

Figure 3: Classroom flip PPT presentation of IoT application technology

Project defense in classroom flipping is shown in Figure 4.

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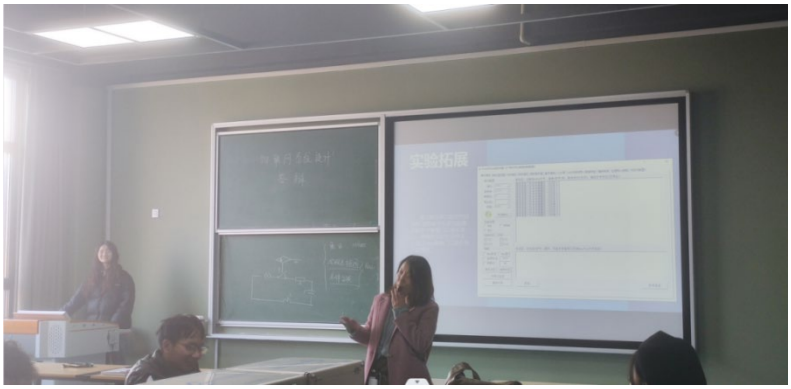

Figure 4: Defense presentation of IoT application technology classroom flipping project

The cooperation among students in group cooperation is shown in Figure 5.

Figure 5: Group collaboration of IoT application technologies

4. Conclusion

The project-oriented teaching practice in classroom flipping plus TBL mode can greatly improve students' learning initiative, and students' learning interest is high. Almost all students actively participate in various teaching activities from pre-class preview learning, PPT preparation, classroom questioning and discussion, and group learning in class. Moreover, students' learning depth is significantly increased. Most of the students have a deeper understanding and knowledge of the theoretical content of the textbook, and are no longer just memorizing the textbook content. And most of the students make PPT system well with deep thinking. In the whole teaching design, the classroom discussion atmosphere is strong, students actively ask questions, and the students who make PPT presentations are fully prepared before class. Some of them also have in-depth thinking about environmental protection and human nature, etc. Teachers guide students to interact and communicate, so that different viewpoints put forward by students are summarized, exchanged and collided, which promotes the thinking and learning of students in various groups. In this process, students' ability of expression, communication, teamwork, references review and critical thinking has been greatly improved. The team members in Figure 6 are just a scene picture that they uploaded happily after getting the result because they did not get the result in class and asked to work overtime to do the experiment. It can be seen that this mode has obvious teaching advantages. In the future, we will continue to conduct in-depth research on the project-oriented teaching method system of classroom flipping combined with TBL to form a model that can be promoted.

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Figure 6: The joy of the success of the initiative overtime experiment in the Internet of Things application technology course

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