The practice and exploration about the teaching model of “connecting project and education, integrating theory and practice”

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ABSTRACT

Aiming at the characteristics of cultivating talents in the higher engineering education, this paper proposes adoption of the teaching model of “connecting project and education, integrating theory and practice”. This teaching mode can change the previously teaching mode that students are passive to get what they have been taught. It can also construct a new mode of students’ active participant, autonomous collaboration, exploration and innovation. At the same time, it is committed to enhance the comprehensive ability and quality of students, cultivate their initiative spirit and practical ability, and better guarantee that the students for batch training can achieve the basic teaching requirements. Meanwhile, enough opportunities and space for their personalized development can be provided.

KEYWORDS

Teaching mode, Connecting project and education, Mechatronics, Practice exploration

1. INTRODUCTION

With the rapid development of society and technology, the people’s ways of learning, thinking, working and living have changed greatly with each passing day. Those put forward higher requirements for the engineering education of higher teaching mode, and will also have a profound influence on education teaching reform. Especially in the twenty-first century, the rapid development and the process of globalization come up with higher demands for engineers’ quality and ability, which include the ability of lifelong learning, excellent communication skills and team spirit, understanding and control ability about this profession, industry and even the large system of the society, history, culture, environment, etc. However, for the idea of traditional higher education, all the above-mentioned capabilities are not contained. The idea of traditional higher education mainly embodies fives aspects as follows. Firstly, it emphasize too much about academic on curriculum provision and teaching content. More attention are put on theory except practice so that the students’ practice ability is weak. Secondly, traditional lessons are often formulated according to teaching requirements, and students only study what teachers teach. That ignores the existence of students as subjectivity, making their autonomy poor. After that, in the traditional classroom teaching, the scope of knowledge is narrow, the knowledge structures are unreasonable, and also lack in communication and writing skills training. Then, it’s so short of training for students teamwork and professional ethics education that they have a poor ability of communication, and lack
Aiming at the characteristic of students’ poor autonomy, weak practical ability, larger training scale and scarce experiment teaching resources, our course team do active exploration and practice for many years to achieve all-round innovation, within the limited class hours and limited resources. We put forward and adopt the teaching method of "project lead, to teach, to do, to learn one". What’s more, we also explore and construct new teaching mode of the active participation of students, collaboration, exploration and innovation. The purpose of all the above measures is in order to better promote the teaching reform of the ‘Mechatronics’ course.

2. THE RAISING AND CORE IDEAS OF COURSE TEACHING MODE

Since entering new century, the curriculum reform in many countries around the world pay more attention to change the way of learning and emphasizes the actively practical patterns, in order to better cultivate the students’ engineering consciousness, practical ability and innovative spirit. Europe and the United States have been advocating activities about thematic exploring and designing learning to fully mobilize the enthusiasm of students, making the conversion from passive to initiative learning education in the direction of education. In Japan, the setting up of integrated learning time in the new curriculum system, is for better developing students’ ability to design system, and improving the comprehensive quality of students. The German federal vocational education makes the whole learning process decomposed into a concrete project or event and designs a project of teaching program, which not only teach students theoretical knowledge and skills, but is more important to cultivate students’ professional ability. The ability not only includes knowledge and professional ability, but also covers the ability of how to solve the concrete problems: acceptance ability to learn new knowledge, collaboration and the social ability and consciousness of project execution (including project negotiation, quotation, contract drafting, contract signing, production organization, after-sales service). Nowadays, the domestic various universities also attach great importance to the ascension of the teaching quality, the setting of inquiry learning, the changes of learning mode about students’ simple acceptance what teachers’ knowledge transfer and the construction of opening learning link. Meanwhile, students can be provided a variety of channels of knowledge and opportunities to apply what they learned.

To meet the requirements of higher education in the new century, and combine with the scale and bulk of training mode in the domestic higher engineering education especially the mechanical discipline, our course team design the course mode of "connecting project and education · integrating theory and practice". We also adopt integration of teaching methods "Teachers in the teaching, Team-based interactive discussion teaching, Team-based curriculum research project" and implement them specifically through the evaluation index system of the whole process of multi- aspect course. The course teaching mode of "connecting project and education · integrating theory and practice" advocates the teaching idea which makes students’ actively learning and practicing to be the core of "learning by doing" as the guiding principle. The core idea is as follows: On the teaching philosophy, it puts more emphasis on students’ self-learning and exploration, and more focus more on
students’ self-learning ability; On the teaching content, instead of using the "theory of
knowledge" as the teaching clues, this mode gives full consideration to the student's
acceptable ability and the social needs of students’ qualities and abilities. It transforms the
cue of well-organized curriculum theory into team-based training mode practice teaching
project to meet greatest degree of compliance with different students' cognitive
characteristics and try to keep students' knowledge with the times; In the teaching process,
what to learn is expended according to the curriculum task, it changes passive recipients of
knowledge into actively seeking knowledge. It also changes the traditional view of learning of
students, enabling students transform from being taught to learn and further to be willing to
learn. On capacity-building, this mode draws more attention to students' innovative spirit and
team spirit. In the process of completing the project, students will think and explore actively.
Though everyone's thoughts are different, teachers can guide them to make discussions and
exchanges, and give them appropriate reviews and encouragement so that they learn from
each other. It not only stimulates the student's enthusiasm, but also cultivates their
innovative spirit and sense of cooperation.

3. THE DESIGN PRINCIPLES FOR THE TEACHING MODEL

The teaching model of “connecting project and education, integrating theory and practice”
is mainly manifested in shifts of there centers. Firstly, the theoretical inculcation as the center
is changed into project guiding as the center. Secondly, the teacher "passive" teaching as
the center is transformed into students "active" participation as the center. The last, teaching
by using textbook as the center is turned into learning by doing as the center. Furthermore, in
the implementation process of the course teaching mode, we should draw attention to the
following design principles.

3.1 Adopting the advanced teaching methods and carrying forward the advantages of
classroom teaching model

The classroom teaching mode is the teaching mode with the center of the teacher and
classroom, whose main theory is based on the theory of learning and teaching. The theory
was came up with Ausubel, a psychologist from America in the 20th century. In the
classroom teaching mode, teachers communicate with students face to face, which is
conducive to play the leading role of teachers, and is easy for teacher to organize and
monitor the whole process of teaching activities. Besides, it helps to impart scientific
knowledge system. In a word, its main advantage is the high efficiency of theoretical teaching.

Carrying out the course teaching model of “connecting project and education, integrating
theory and practice”, does not mean discarding the exiting classroom teaching mode
completely. Students are still in the stages of learning knowledge and laying the foundation
of study. Some of the theoretical classroom knowledge and ability training are necessary for
students to grow. Without a certain knowledge gained from theory teaching, carrying out the
project can only be like water without a source, or a tree without the root. The course
teaching mode of “connecting project and education, integrating theory and practice” uses
practical project as the guide, and combines with superb theory lectures. Meanwhile, it
adopts the advanced teaching methods, such as heuristic teaching and inductive teaching. It
can enable students to create the concept of the system quickly. Then, it can strengthen the
students' comprehensive ability of integrating theory with practice through practical training
programs. Task training consists of basic and expanding task training. Basic task training is
the exercise and homework of the textbook as the main body of the task, this part of the task
sticks to the basic theory and basic concepts. Students’ solid foundation is achieved by focusing on conceptual questions and drilling important exercises repeatedly.

3.2 Opening communication, adopting interactive discussions and teamwork, to enhance the students’ team consciousness and communication skills.

In the process of project implementation and theoretical teaching, students make up several groups voluntarily and complete a project for each group. Group members have different division of labor and led by the group leader, they organize to learn related resources and collect material initiative. When having a problem, they can solve them by discussing. If they still can’t work out, they could ask for help to their tutors. Such form not only can develop the students’ ability of acquiring information, transmitting, processing and applying, but also can develop the ability of team cooperation and communication. Meanwhile, the interactive discussions run through the whole teaching process. Aiming at the key issue which exists in the teaching process about the project implementation and the theory, students determine the discussion topics. At the same time, through the links of consulting data, group discussion, giving a lecture, asking a question and replying, they participate in teaching actively, experience the whole process of teaching and share the fun of learning and achievements. All links stimulate students’ interest in learning and arouse their enthusiasm and initiative. Thus, students become masters of the classroom. As shown in Figure 1, is the scenes of the group-based interactive discussion.

![Figure 1. Scenes of group-based interactive discussion](image)

3.3 Careful preparation, paying attention to the scientificty of project implementation

The content of the project should have levels. Good tutors need design course projects elaborately and consider them from the views of students. It is also important to draw attention to the students’ differences in personality characteristics and the ability of accepting knowledge for tutors. They must give full consideration to the students’ existing bases, cognitive abilities and interests, etc. At the same time, tutors should design each module depending on students’ actual level. Aiming at the different extent of students, tutors can design the different levels of practice, namely having hierarchy to design different subprojects. Meanwhile, they should carefully organize teaching content of project and guide the implementation of the project before it begins, as well as in the process. Thereafter students can successfully complete course project.

The project topic should be sufficient and appropriate. Teaching content and training works are treated as the foundation and the objective, respectively. Combining students’ practical situation, it should not only include the basic knowledge of teaching, but also mobilize the enthusiasm of students to solve the problems. Meanwhile, the targets established by topic should be able to fully stimulate students’ learning potential. It also put attention to the time and energy that teachers and students spent on. We should control them reasonably in case of an excessive burden on students and teachers.
Give full play of students’ personality in the process of project. Project teaching should concentrate on the development of students’ individuality and respect the special needs of students’ development. What’s the most important of this project is the cultivation of innovative ability. It’s impossible to make all students quickly have strong ability of innovation, especially for the students who contact with fewer engineering projects. In the particular embodiment of the process, we should try our best to stimulate their innovative consciousness and innovative spirit. When students encounter difficulties in the process, the instructors should provide guidance timely. However, the guidance should be just right, try our best to make “teach him how to fish, instead of the fish”.

The practicality of the heuristic project teaching. The biggest difference between the heuristic project teaching and the existing theoretical teaching in the class is that the former does not purely initiate students into academic book knowledge, but allows students to practice themself and to obtain the capability which is necessary in the information age. This is the fundamental purpose of setting up the project teaching. Project emphasizes the practical training where the students can gain practical ability. From the view of ability training, the teachers must pay attention to arouse the enthusiasm of students and cultivate their innovation spirit and cooperation consciousness. In the teaching process, in order to improve the attention of students and the efficiency of learning, we should guide them to participate in actively.

The autonomy of project teaching. Project teaching is exploited and implemented based on students’ direct experience. It can realize the integrated use of subject knowledge. At the same time, it is also beyond logical system on the subject. In the process of the development and implementation, we encourage students to choose and explore autonomously. We put students’ requirements, motivation and interest in the core position, so as to create space for the full development of personality.

The course teaching mode of “connecting project and education, integrating theory and practice” is based on the team discussion interactive teaching and curriculum research project, which can provide students with the equal opportunity to participate actively in the teaching. The opening research projects add the implementation of the teaching team elaborately designing and specific detailed project implementation plan, assisting the way of the whole process and all-round course examination. That ensure all students who get through efforts are able to acquire the basic ability, and also provide students who are interested and talented with "infinite" ability to play and development space. This mode and method, not only guarantee the mass cultivation of qualified engineering talents, but also achieve a student-centered and personalized training. It fits the actual situation of domestic higher engineering education, scientific and practical, feasible, and can be great maneuverability and portability.

4 THE CONCRETE IMPLEMENTATION PROCESS

4.1 The structure of the teaching model

The aims of curriculum research project are to deepen and strengthen students' understanding of course content and application, making the students have the independent consciousness, concepts, and the ability of engineering design, and better developing the students' professional ability and comprehensive quality. Curriculum research project is put in the process of teaching, and several students will be divided into a group. According to the
teaching content, students select the type of hands-on practice study, develop plans and complete the study. Certainly, they must report their content in the form of PPT and demo within the specific time. Blow, mechatronics system designing course will be taken as an ensample, concretely illustrating the process of carrying out about the teaching model of “connecting project and education, integrating theory and practice”. This course includes four parts, which are theoretical teaching, curriculum project, class discussion, and experimental class, respectively. Module sequence and the corresponding period are shown in Figure 2.

![Figure 2. The structure and hours of course teaching](image)

Theoretical lectures make students establish a systematic design ideas and apply the knowledge to analyze or design so that students have an initial design capacity of mechatronic systems. In the seminar, using the links of group discussions, presentations on stage, questioning defense and so on, enable students to participate in teaching actively. Besides, discussion class also teach students how to solve the intensive and difficult problem in theoretical teaching and project implementation process. Implementation of curriculum projects makes students master the knowledge courses deeply. At the same time, it also improves their abilities of comprehensive application of existing knowledge to solve problems, writing and presentation skills and practical ability. The experimental lessons further strengthen training of students practice engineering ability and supplement some key knowledge modules that project implementation process does not involve. In addiction, it provides more opportunities for students to practice. Specific implementation process in project teaching is presented as follows.

4.2 The whole implementation process of the project

By organizing teaching team teachers to analyze carefully each covered knowledge module of the course, we determine “the design and manufacture of intelligent vehicle system” as the course projects’ topic, with the single-chip computer controlling technology as the core. The design, manufacture and motion control planning of intelligent car are completed by the project implementation. In project implementation process, students who are in their own groups, under the condition of given project tasks and requirements, need to do from data collection, programming, device design, assembly and commissioning to the project report writing. All is completed independently by the students. Specific project implementation process in teaching project is shown as follows:

4.2.1 Task arrangement
In the middle of the course teaching content, four students will be divided into a group in the form of curriculum team. Depending on the course content, they can select research topics and formulate the project specification.

4.2.2 Make plans

Each working group draws up plans and schemes, and design a detailed project plan. Then teachers audit the plan. In the plans, each team members are required that should have a report on the results of the task. Meanwhile, they should record the progress of the project in the program book so that teachers can check and guide at any time.

4.2.3 The project demonstration

Discussing the design of each group, each group send a student to clarify the goal of task and the implementation. Certainly, the teacher and classmates can ask questions and make exchanges.

4.2.4 Program improvement

After the exchange of teachers and students, problems are found in the program, then students perfect the program again.

4.2.5 Plan implementation

Under the plan, each team member begins to perform their tasks separately. By the ways of reading, selecting, and finishing materials, students design and verify the project tasks. Meanwhile, for the actual link of conducting actual assembling and debugging at the innovation laboratory, they will raise problems constantly, and then solve them through the way such as group discussion and asking tutors in order to finally complete project tasks. Throughout the implementation process, the students are subject, and the teachers are dominant. As shown in Figure 3, is scene of the practice of project task.

4.2.6 Report reply

Students should analyze the results of the study, form report, and prepare the PPT presentation. At last, a student is randomly selected in each team for project defense and showing achievements. In this stage, through the “students’ own self--assessment, peer’s estimate, teachers’ comments, and summaries of teachers and students” and other procedures, teachers complete an evaluation for the finished tasks of each group. Then, this evaluation will be a part of the project learning grade.

Figure 3. Scene of the practice of project task.
4.2.7 Project summary

Students need to conclude the project in order to make project combined with curriculum theory and form a relatively complete system of the project.

4.3 Allocating project hours

The main purposes of course research project are as follows. Master intelligent and automatic vehicle structure as well as the components and principles of control electronics unit; Master the method of the design about the sensing test system; Master the theory and use of common sensors; Master the basic circuit schematics and circuit connected chart; Master the use of programming software, simulation debugging and the procedure compiled of single chip microcomputer; Master the ways of selecting, driving and controlling for commonly used motor; Master single chip’s selection method and system lap; Master mechatronics system’s design, production and debugging methods. Knowledge modules and the corresponding hours of course research project "the design and manufacture of intelligent vehicle system" are shown in Figure 4.

![Figure 4. Curriculum research projects involving knowledge module and corresponding class hours](image)

The class hours of course project is mainly to guide and examine the nodes for the course project in order to grasp the progress of the project research. However, these periods can’t meet the needs of the curriculum project research. In the process of curriculum project research, the opening laboratory is opened to students around the clock, and the students attending the course project in their spare time can go to the lab for research projects at any time.

4.4 The implementation effect of the project teaching.
After nearly a semester, the students say: “I have benefited a lot from the project research, and it not only enhances our abilities of operation and cultivates the creative design ability, but also makes me more eager to learn knowledge”; “Curriculum research projects, including cross use ‘Mechatronics System Design’ as the main body of specialized knowledge, make our comprehensive quality greatly improved and the degree of mastering subject knowledge also reaches new heights”; “Curriculum project puts the group as a unit, and every group is equipped with special guidance teacher, which greatly inspires our learning interest and enthusiasm. For most people, this practice is the first time to make anything so close with the engineering practice that we have a deeper understanding of engineering design, and it is a very good experience for our study and work in the future”; “In the process of systematic study of electromechanical integration professional theoretical knowledge, the arrangement of curriculum research project is completely different from the previous study. Applying the theories to the practice is the ultimate goal of our learning knowledge, and makes us more profoundly grasp the basis of relevant knowledge on the ‘machine’ and ‘power’, which lays a foundation for our study and work in the future”; “we have benefited a lot from this semester curriculum research project. When the design is completed, everyone’s joy is palpable. Through hands-on practice, everyone makes the learned knowledge deeply root in the brain. In the practice, we begin to find that the learning can make people become so devoted”; “The settled seminars in the process of course teaching let us learn from each other and communicate with each other. Especially the learning research training project in the course arrangement process, greatly improves our practice capacity, makes us more firmly grasp the knowledge, and makes up for the shortage”.

5 CONCLUSION

Through the practice and exploration about the teaching mode of "connecting project and education, integrating theory and practice", we have the following reflection: for teachers, in the teaching process, they should treat students as the center and take into account students’ interests and personality. Meanwhile, they should also combine with student actual level and the actual level of the school's hardware, and carefully prepare curriculum projects. All of the above enable students to actively participate in the whole process of the search for knowledge, complete projects by themselves, master the basic methods and skills specific implementation projects, and even apply their knowledge. For students, this new model of teaching makes students happen major changes in learning, such as, their learning motivation improved significantly, active consciousness enhanced markedly, as well as integrated applications and innovative ability trained greatly; In addition, this teaching mode uses group working together to complete the project, and enhance teamwork by interactive discussions and helping each other.

The teaching mode of "connecting project and education, integrating theory and practice" brings changes to the relationship between the teachers’ way to teach and students’ way to learn. It also brings good teaching effect, but this teaching mode needs to be further developed and improved. As long as we do our best as follows, we must be able to improve the efficiency of classroom teaching. In the teaching process, we need to practice boldly, innovate bravely, and design carefully on the scientific "project". We should also strive to create a learning situation of interactive cooperation and exploration and innovation. Besides, we must achieve a fundamental revolution about teaching philosophy, teaching model, evaluation system and textbook structure. Then, it improves students' practical ability,
enhances students’ comprehensive ability and enable students to adapt to the needs of modern society.

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