Exploration and practice of anchored instruction in the plan of photoelectricity excellent engineer

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Abstract: Based on the constructivist learning theory, this paper adopts the anchor teaching method to construct the COME theory model which takes the classroom, viewpoint, method and elements as the main unit according to the requirements of the education and training plan for outstanding engineers. Through the exploration and practice of the education and training plan for the outstanding engineers in the specialty of optoelectronic information science and engineering, the result proves that the students can complete the self-study of "anchor" step by step under the guidance of teachers. Moreover, they can not only actively participate in the teaching and learning process, be willing to explore and work hard, but also will be able to gradually improve abilities of collecting and processing information, acquiring new knowledge and enhance the ability to analyze and solve problems.

Keywords: Constructivist learning theory; project excellence for engineers; anchored instruction; COME model; optoelectronic information science and engineering; photoelectric engineer of excellence

1. Introduction

In the keynote speech at the 2014 International Conference on Engineering Science and Technology, general secretary Xi Jinping stressed that "in the coming decades, a new round of scientific and technological revolution and industrial transformation will form a historic intersection with the development of human society and the progress and innovation of engineering science and technology will become an important engine driving the development of human society. Information technology has become the leading technology that penetrates into all fields of economic and social life. It will promote the transformation from the economic development mode based on material production and material services to the economic development mode based on information production and information services. The world is entering a new economic development period dominated by information industry. "[1] In order to implement the strategic deployment proposed by the party, such as taking a new path of industrialization with Chinese characteristics, building an innovative country, and building a strong country in human resources, the Ministry of Education put forward the "Excellent Engineer Education and Training Plan" (referred to as "excellent engineer plan")[2]. This plan plays an important role in training talents for the needs of society, adjusting the structure of talent training, improving the quality of talent training, promoting the reform of education and teaching, and enhancing graduates'
employability. However, there still exist problems of passive learning, rote memorization and mechanical training in universities of our country.

Therefore, this paper will lay emphasis on the undergraduates of excellent engineer class majoring in photoelectric information science and engineering. Since 2012, under the guidance of constructivist learning theory, anchored teaching method has been used to construct the education model which combines classroom, ideas, methods and elements as a whole unit to create a real training situation for engineers. Focusing on a real engineering technology problem, we will have to promote students' independent learning, create a good collaborative learning environment, observe and record students' performance to stimulate students to explore, discover and construct the meaning of what they have already learned on their own.

2. Theory and model

2.1 Core viewpoint of constructivism learning theory

Constructivism originates from the theory of children's cognitive development put forward by Swiss psychologist Piaget[3]. Since the individual's cognitive development is closely related to the learning process, the use of constructivism theory can better explain the cognitive rules of human learning process, that is, how learning occurs, how meaning is constructed, how concepts are formed and what major factors should be included in the ideal learning environment. Under the guidance of constructivism, a new set of effective cognitive learning theories can be formed and an ideal constructivism learning environment can be realized. The basic content of constructivist learning theory mainly involves two main aspects: what is learning and how to learn. In this process, teachers are helpers and promoters of meaning construction rather than providers and indoctrinators of knowledge. Constructivism believes that, in terms of student view, it emphasizes "student-centered, which refers to students' active exploration, discovery of knowledge and their active construction of the meaning of the knowledge they have learned". In terms of the concept of teachers, it believes that teachers should be supporters and promoters of students' independent inquiry rather than masters and indoctrinators of knowledge. In terms of learning view, constructivism holds that learning is not a passive acceptance of teaching but should be a process in which learners actively construct internal mental representations. Different people have different views on things and there is no single standard answer. In terms of teaching, it believes that teaching is the process of cooperative construction of the meaning of the world between teachers and students rather than the transfer of knowledge.

2.2 Basic elements of teaching mode

The teaching mode suitable for constructivist learning theory and constructivist learning environment is as follows: “Taking students as the center of the whole learning process, teachers play the roles of organizer, mentor, helper and facilitator in the whole teaching process to trigger students' initiative, enthusiasm and initiative spirit by learning environment elements such as situation, collaboration and conversation. What teachers' priority is to make students effectively realize the meaning construction of the current knowledge[6]. In this mode, students are the active constructors of knowledge meaning while teachers are the organizers, guides, helpers and promoters of the construction of teaching process. The knowledge provided by textbooks is no longer the content taught by teachers but the object of students' active construction of meaning. Media is no longer a means and method to help teachers impart knowledge but serves as a cognitive tool to create context, collaborative learning and conversational communication for the active learning and cooperative exploration of students. On such occasions, the role and relationship between teachers, students, teaching materials and media thus become a stable structural form of the teaching process, which are the teaching elements in the constructivist learning environment.

2.3 Anchored teaching method

Under the constructivist learning theory, there are mainly four methods as frame teaching[5], cooperative learning[6], situational teaching[7] and anchored teaching method[8]. Among them, the anchored teaching method refers to that teachers make students produce the needs of learning in a complete and real context with problems and enable them to
interact, communicate based on embedding instruction to experience the whole learning process of identifying problems, answering questions and finally realizing the target with their own initiative. Anchored teaching is characterized by authenticity, mutual assistance, disorder and situation\cite{8}, which goes through five main links, as shown in Figure 1.

Create situation → Determine problem → Independent study → Cooperative study → Effect evaluation

*Figure 1. Major links of anchored teaching*

Creating situations means situations in which learning can take place in accordance with reality; Identifying the problem means that teachers present the student with a real problem that needs to be solved immediately and choose the real event or problem that is closely related to the current subject as the central content of the study. The selected event or problem serves as the "anchor" and the function of this link is "anchoring". Autonomous learning means that teachers provide students with clues that can help solve the problem (such as the need to collect data, what access to relevant information to solve the similar problems in the reality of exploring process, etc.). That can cultivate students' ability of how to define what they should learn, acquiring related information and materials, utilizing and evaluating data to study on their own. Collaborative learning means that, through discussion, communication and the exchange of different ideas, supplement and revision, students' understanding towards the problem can be deepened; Effect evaluation means to observe and record students' performance.

2.4 COME model

According to the constructivist learning theory, student-centered cooperative learning method is adopted to form the education model COME referring to Classroom, Opinion, Method and Element, as shown in Figure 2. Through this model, we can actively create a good environment for classroom learning of engineering practice. Conforming to the internal rules between students' view, teaching view, knowledge view and learning view, the functions and advantages among students, teachers, teaching materials and media are brought into play while infectious real events or real problems are established. Once learners see a problem situation, they will naturally try to understand the phenomena and activities in the situation with their original knowledge so that they can experience and think about problems with their own understanding.

*Figure 2. COME educational mode*
3. Teaching practice

3.1 Objectives of training

By using the basic knowledge and methods of light, machine, electricity and calculation, we have a complete and real understanding of the basic principle, technical design, manufacturing process, performance testing and market trend of photoelectric components. By studying theories of the photoelectric products and the whole embedding teaching course of process design, test demonstration, production process, performance test and the device packaging and other various stages, students can rely on their own initiative study with the interaction and communication between members and among the community. During the process, students can experience the process from identifying goals to rising up problems, finally achieving the targets of design, research and development, production, sales, service and maintenance in the field of photoelectric design with their own ability of active learning and generating learning. Moreover, they can also form a scientific, standardized, rigorous and efficient work style and improve the ability of innovative thinking, systematic thinking. In addition, students will be able to solve complex engineering problems in the field of optoelectronics through a comprehensive application of the scientific theory and engineering techniques they have learned to analyze and solve practical problems. After 5 years of graduation, they can become the backup talents of outstanding engineers in a certain field of optoelectronics.

3.2 Instructional design

According to the whole teaching plan from sophomore to senior, it will carry out a complete, real teaching design, mainly including five design links. The following is the teaching design with the development of high-speed BOX light module as the "anchor". First, creating the situation means to provide the scene of making high-speed BOX light module so that students can learn in a situation consistent with the real situation; Secondly, determining the problem means to determine the production of a cost-effective high-speed BOX light module so that students can choose authenticity issues closely related to the topic as the central content of learning; Thirdly, to guide students to learn independently: teachers can provide students with relevant materials, information and exploration process for solving the problem of developing a cost-effective high-speed BOX light module; Fourthly, to promote students' collaborative learning: teachers can organize discussions and exchanges among students and create an atmosphere of exchanges between different views to promote students' understanding of supplement, correction and deepening problems; Fifthly, to conduct effect evaluation: teachers should observe the performance of students in each stage at any time and make comment timely.

3.3 Anchor teaching and learning

The following is an example of making a cost-effective high-speed BOX light module for teaching and learning based on "anchoring".

Stage 1 (the third semester): to consult the Chinese and foreign literature in the field of optical communication module (at least translate foreign literature), participate in science and technology innovation team academic report, understand the basic theory of high speed light BOX packaging components as well as technology and testing process, participate in the panel discussion in order to throw the anchor which refers to "developing a kind of cost-effective high speed light BOX packaging components", finally determining the target and personnel division of labor.

Stage 2 (the fourth semester): to participate in academic and technical research seminar and discussion. With the utilization of laser micro-nano optics laboratory center, semiconductor technology laboratory, analysis and test center in campus and the experimental conditions provided by Sichuan Tianqintong Co., LTD., students can design the general plan of the subject to master the key parameters, technology and means of the two components AWG and MUX in the high-speed BOX. They should make clear of goals, timetables and roadmap of each member and confirm what they should cooperate with other team members.

Stage 3 (summer vacation of the fourth semester): to conduct research in research institutes and large Sino-foreign joint ventures in the field of optical communication and write research reports. Students will enter the production workshop of optical communication module to carry out engineering practice, learn and consult from relevant technical
personnel, master the production process and key technologies of AWG and MUX of high-speed BOX and eventually propose scientific solutions and summary reports to solve this subject.

Stage 4 (fifth semester): to decompose and design the high-speed BOX package optical components by means of computer, machinery, photoelectric and others, preliminarily grasp the characteristics and requirements of key components and finally submit the design report. Students are expected to conduct research based on research projects or corporate projects, publish academic papers and attend international conferences on optical communications in the county.

Stage 5 (semester 6): to design and develop product plans according to commercial standards through repeated tests based on the preliminary theoretical knowledge and certain engineering capabilities, propose feasibility quality reports, test commercial product standards and apply for invention patents.

Stage 6 (summer vacation of the sixth semester): to conduct sample trial, propose solutions to existing problems, revise sample indicators and put forward quality reports of qualified samples. To apply for provincial scientific research projects and participate in the international conferences on optoelectronics.

Stage 7 (the seventh semester): to compare the package, performance, function and cost of high-speed BOX’s AWG and MUX and provide corresponding analysis reports.

Stage 8 (the eighth semester): to learn effect evaluation (learning process evaluation, self-summary report evaluation and peer evaluation from the first to the seventh stage) and make graduation design defense.

4. Data and analysis

Since September 2012, Southwest University of Science and Technology (USTC) has been continuously recruiting undergraduates majoring in optoelectronic information science and engineering for seven consecutive years. A total of 139 undergraduates have been trained as outstanding optoelectronic engineers, among which 65 students have graduated successfully and 74 have studied in the university. In the past four years, the employment rate has reached 100% every year. The average rate of students who want to earn a master degree reaches 50% and employment rate in well-known photoelectric enterprises is 33%, as shown in Table 1.
<table>
<thead>
<tr>
<th>Year (YG)</th>
<th>No.</th>
<th>Learning effect</th>
<th>Graduation (person)</th>
<th>Employment (person)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Subject competition award (No.)</td>
<td>Innovation skills award (No.)</td>
<td>AP</td>
</tr>
<tr>
<td>2015</td>
<td>12</td>
<td>15</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2016</td>
<td>14</td>
<td>23</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>2017</td>
<td>15</td>
<td>30</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>2018</td>
<td>24</td>
<td>33</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 1. List of outstanding engineers of photoelectric information science and engineering from 2015 to 2018. (YG: Year of Graduation; Intl.: International; Natl.: National; Prov.: Provincial; AP: Academic paper; NW: Number of works (articles, volumes); NP: Number of patents (items); AAC: Attendance at academic conferences; EG: Exemption graduate; AGS: Admission to graduate school; GAS: Go abroad to study; PI: Public institution; PE: Photoelectric enterprise; E: Entrepreneurs)
From Table 1, the results show that after four consecutive classes of graduated students studying under implementation of anchored teaching method during three years of their study time, this method can not only make students actively participate in the study, explore scientific and technical problems diligently and correctly but also cultivate students in collecting and processing information, acquire new knowledge and resources as well as the ability and consciousness to analyze and solve practical problems. Moreover, it can help them quickly adapt to the new job or the learning environment and get a good development in the end.

Under the constructivist learning theory, anchored teaching can enable students to generate learning needs in a complete and real problem background. Through the interaction and communication between the members of embedding teaching and learning community in various stages, students can rely on their own initiative to learn, generate learning and personally experience the whole process from identifying the goal to proposing and achieving it. In this way, students can not only take the initiative to participate, be willing to explore and work hard, but also enhance the ability to collect and process information, acquire new knowledge, analyze and solve problems.

References