Advances
2020; 1(1): 11-14
http://www.sciencepublishinggroup.com/j/advances
doi: 10.11648/j.advances.20200101.12

Analysis on School-enterprise Co-construction of "Semiconductor Device" Course

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To cite this article:
Jianting He, Shulian Yang, Qinqin Wei. Analysis on School-enterprise Co-construction of "Semiconductor Device" Course. *Advances*. Vol. 1, No. 1, 2020, pp. 11-14. doi: 10.11648/j.advances.20200101.12

Received: September 9, 2020; **Accepted**: October 12, 2020; **Published**: October 17, 2020

Abstract: Semiconductor device course is a professional basic course for students majoring in electronic information science and technology, and is also a required course for the school-enterprise cooperative class in our college. The enterprise requires the students to be able to combine theory with practice and have the ability to solve practical problems. Because this course has the characteristics of high basic theory requirement, strong comprehensiveness and abstract content, our college work together with an enterprise for the semiconductor device course. To construct the "Semiconductor Devices" course by school and enterprise jointly can strengthen the linkage between them, which is of great significance for deepening the reform of application-oriented personnel training mode, deepening the reform of teaching content and teaching methods, highlighting the cultivation of students' practical ability, innovative and entrepreneurial ability, and improving the quality of personnel training. Jointly, by building a teaching team, making a course standard, improving the teaching files, developing the teaching resources, compiling the textbooks and examining the students, We have built an excellent teaching team with theoretical knowledge and practical experience, standardized and enriched various teaching documents and resources, and finally improved students' interest and enthusiasm in learning. Students could master the theoretical knowledge, at the same time possess the operational skills. High-quality talents who can meet the market demand have been cultivated.

Keywords: Semiconductor Devices, Teaching Team, Teaching Resources

1. Introduction

Semiconductor devices have become an indispensable part of electronic industry, automatic control, computer technology and so on [1-3]. Semiconductor Device course is to study the working principle and characteristics of semiconductor devices by analyzing the motion law of carriers in semiconductors, which is the basis for the development and application of semiconductor devices.

Semiconductor device course is one of the compulsory courses for undergraduates majoring in electronic science and technology. It is a core professional course with equal emphasis on theory and practice. This course discusses the working principle of various electronic devices based on the micro-motion law of electrons, and mainly teaches the students the basic structure, working principle, electrical characteristics and factors affecting device parameters of various semiconductor devices. Its core content is the working principle and design method of silicon microelectronic devices. Before this course, students need to learn quantum mechanics, solid state physics, semiconductor physics, microelectronic technology and so on, so as to have a profound understanding of solid energy band theory and the physical properties of semiconductor materials (Si, Ge, GaAs, etc.). The goal of this course is to enable students to understand and master the relationship between device structural parameters, process parameters, material parameters and electrical parameters of devices, laying a foundation for students to learn semiconductor device design and verification, integrated circuit design, integrated circuit CAD, integrated circuit layout design, integrated circuit test and analysis and so on [4].

Semiconductor device course in our college is a professional basic course for Integrated Circuit Technology major which was offered in cooperation with Qingdao Software Park. The textbook used for this course is "Semiconductor Device Physics"[5] compiled by Meng

Qingju. We adopt the school-enterprise cooperative teaching mode based on employment-oriented, which has the characteristics of work-integrated learning, order training and integration of production-study-research.

Based on the training plan of this major and the characteristics of the course itself, this paper discusses how to jointly build the course of "semiconductor device" in view of the training of school-enterprise cooperation for students.

2. Objectives of Course Construction

To construct the "Semiconductor Devices" course by school and enterprise jointly can strengthen the linkage between them, which is of great significance to deepen the reform of application-oriented personnel training mode, deepen the reform of teaching content and teaching methods, highlight the cultivation of students' practical ability, innovation and entrepreneurship ability, and improve the quality of personnel training. Through the targeted optimization and integration of the course, the advanced technology and production concept in the enterprise are introduced into the course construction, so that the course teaching and the talent training can meet the development needs of the society, and the teaching quality of the course can be improved effectively [6].

2.1. Achieving Win-win Situation Between School and Enterprise

The school-enterprise co-construction of "semiconductor device" course enables an organic combination of enterprise technical backbones with rich practical experience and course teachers who have solid theoretical foundation and are familiar with teaching rules. Theory teaching is mainly conducted by school teachers in the school, while course design and other practical teaching are mainly carried out by enterprise teachers in enterprises with the cooperation of school teachers. Oriented to a practical project, the practical teaching content related to "semiconductor device" course was completed. Guided by the enterprise demands and employments, the school optimizes the curriculum system and enriches the teaching content according to job requirements in technical fields and vocational posts. The company provides places for students to experiment and practice, and for school to train teachers. The school not only improves the overall teaching level, but also enriches the teachers' practical experience, the company can get professionals for its development. Through the cooperation between the school and the enterprise and the efforts of the teaching team, we can ensure a win-win situation.

2.2. Co-building Teaching Team

To improve the overall quality of teaching team as the central task, echelon of teachers for school-enterprise cooperation was constructed. According to the improvement plan of practical ability for professional backbone teachers and the introduction policies of enterprise part-time teachers in our school, the teaching team would be gradually built up which is composed of full-time and part-time teachers being a complement of each other and combines theory teaching with practice teaching, with sufficient number, reasonable echelon, excellent quality.

2.3. Developing Course Standards Together

Through in-depth investigation in the enterprise, the professional competency requirements for this course were understood [7]. Focusing on the students' vocational ability formation, the school and the enterprise jointly determine the standards of setting course and teaching content for "semiconductor devices", confirm the course objective, choose the course content, develop course implementation plan, standard course teaching process and instruct the teachers to complete the teaching tasks.

2.4. Improving Teaching Documents Together

Constructing and perfecting all kinds of teaching documents is an important basis and handbook for organizing and implementing teaching [8]. The school and the enterprise jointly formulate and improve training plans, theoretical teaching outlines, practical teaching outlines, teaching plans, experimental teaching instructions, lesson plans, handouts and other teaching documents. On the basis of the completion of teaching documents, the effectiveness, progressiveness, pertinence and operability of the content of teaching documents were improved.

2.5. Co-building Teaching Resources

The construction of teaching resources is a supporting measure to implement teaching and ensure teaching quality [9]. The teaching resources were constructed and improved by mutually beneficial cooperation between the school and the enterprise. Multimedia teaching courseware was developed which can vividly demonstrate the operation of diffusion and drift for carriers such as electrons and holes by animation. Teaching video and manufacturing video were recorded, and the course website for school-enterprise cooperation was developed and constructed on comprehensive network teaching platform in our university.

Textbook construction is an important part of teaching resources development. Through the continuous deepening of school-enterprise cooperation and the sustaining construction of teaching content, we strive to compile the distinctive co-construction textbook for the course of school-enterprise cooperation applicable to this major.

2.6. Joint Examination

We explored a series of new mechanisms and ways of course examination jointly participated by the school and the enterprise. In addition to the evaluation on campus, student assessment in the enterprise and society should also be introduced to strengthen the effectiveness and practicability of the course examination.

3. Implementation Plan and Measures

3.1. Construction of Teaching Team

In the construction of the teaching team, we adopted a combination of "external introduction and internal cultivation". "External introduction" refers to the introduction of enterprise technical backbone, technical experts as part-time teachers. "Internal training" is to promote the teachers' growth through studying in famous universities, studying abroad, communication and cooperation between teams, enterprise practice and other ways. The college has issued policies to allocate no less than 200,000 CNY each year for school-enterprise cooperation as teacher training expenses and performance appraisal reward. The cooperative enterprise provide school teachers with project practice and in-post training every year, so as to strengthen the cultivation and training of young teachers and improve the training plan for them. Set up a course teaching team with professional and part-time teachers which combining theory teaching with practice teaching [10-11]. By improving the modern mentoring relationship, and holding weekly teaching seminars and other activities by the teachers and their teams, we will strive to build an excellent teaching team with reasonable professional title, education background and age structure and finally recognized by students within a few years.

3.2. Formulation of Course Standards

In terms of course standards, the character, orientation and objective of the course shall be determined according to the training program of the major [12]. Based on the professional analysis, to improve the vocational ability as the starting point, find out the core technical ability of the occupation post. For example, students are instructed to observe and understand the PN junction by typical illustrations, and further master the ability to analyze the motion rules of carriers in complex devices, parameter calculation and device application through the motion rules of carriers inside the PN junction. The content of this course should be determined through teaching analysis. Due to the lack of basic knowledge of semiconductor physics in the early stage of this major for school-enterprise cooperation, the knowledge of semiconductor physics should be systematically and comprehensively elaborated in the course standard, and then the structure, working principle and working characteristics of typical semiconductor devices should be introduced. With reference to the relevant vocational qualification standards, set up the teaching content, construct the course standards that highlight vocational ability, and standardize the basic teaching requirements [13].

3.3. Improvement of Teaching Documents

Improve timely the relevant teaching documents according to the practical needs in all aspects. After the course, according to the teachers' own experience, students' opinions and the needs of enterprises, we will improve the course standard, adjust the teaching and the experimental plan, and improve the experimental instruction before the next class. Only in this way can the teaching documents have distinct timeliness and timely guidance. To improve teaching documents, it is necessary to start from the specific situation of this major. In combination with the reality of this major, the teaching document has the pertinence, the maneuverability, and can be put into practice and realized. In the case that the experimental hours is determined, anatomic analysis of transistor device in the experiment will be replaced by the measurement of transistor characteristic frequency which is more practical [14]. Timely adjust the corresponding course standard, experimental plan, experimental instruction and the content of the online course.

3.4. Construction of Online Courses

Using the campus network system, establish the course website for school-enterprise cooperation. The following sections are set on the website: (1) information zone, displaying the information of the teachers and the course; (2) learning zone, showing the course content, the learning objectives and the learning guidance; (3) resources zone, displaying multimedia teaching courseware, lesson plans, item bank, teaching video and enterprise production video; (4) interactive zone, discussion and exchange through a variety of network channels for teachers and students or students and students [15]. School teachers and enterprise teachers work together to complete and constantly enrich and improve the content of online course.

3.5. Compilation of the Textbook

Summarizing and refining the teaching content, absorbing and digesting the fruits in high level textbook home and abroad, we compiled the textbook according to the characteristics of school-enterprise cooperation. Teachers with rich teaching reformation experience are selected as the chief editor of the textbook. At the same time, set up a high-level textbook compilation team, which combined the old, the middle- aged and the young teachers. While maintaining the integrity of the original basic conception and foundation system, new theories and new knowledge developed in recent decades had been appropriately added in the textbook. The textbook lays equal stress on the foundation, the perspectiveness and the practicality, which meet the actual needs of enterprises, and enable students can have a clear understanding of the development process and development trend of semiconductor while mastering basic knowledge [16]. For example, the textbook includes some devices based on second-generation and third-generation semiconductor materials, as well as devices made from the latest graphene materials.

3.6. Assessment Methods and Standards

The university and the enterprise agree on the assessment methods and standards, which are conducted from the aspects of class attendance, in-class discussion, homework, experiment and examination. Among them, in-class discussion was conducted in groups, and the discussion

contents were mainly given by the enterprise about practical problems. After the discussion, each group recommends one student to give a report, and then the score are given among the groups. The score given by the students accounts for 40%, and the score given by the teacher accounts for 60%, the sum of the two is the result discussed in class. In the exam, in addition to the basic theoretical knowledge, the written test also includes some project-based questions, most of which are design-based and comprehensive, with multiple solutions to one question. The emphasis on engineering background is intended to test students' ability to apply the knowledge they have learned comprehensively to solve problems and innovative thinking [17]. Reduce the number of fill-the-blank and single choice questions and the proportion of written test scores, increase the proportion of analysis and discussion questions. In this way, the main body of assessment is changed from the teachers to the joint participation of teachers and students, and the content of assessment is also changed from the simple knowledge assessment to the comprehensive assessment of quality and ability.

4. Conclusion

In the practice of school-enterprise co-construction of "semiconductor devices" course, we feasibly reformed and innovated the course construction according to its actual needs and problems. We have built an excellent teaching team with theoretical knowledge and practical experience, standardized and enriched various teaching documents and resources, and finally improved students' interest and enthusiasm in learning. Students master the theoretical knowledge while their practical ability is enhanced. Graduates are recognized by employers, about 38 percent of students can find a job independently and about 30 percent of students were admitted by cooperative enterprises or recommended to other enterprises. Some students were admitted to graduate students, the total employment rate reached more than 96 percent. Our students are well adapted to the market demand.

Acknowledgements

This study was supported by Education Reform Fund Project of Shandong University of Technology (113167).

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