Exploration on Teaching Practice for the Principle and System of Numerical Control

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Abstract. With the large scale application of network technology in manufacturing industry, the higher requirements for talents has been put forward in the process of economic development. The principle and system of numerical control is an important specialized course for college students engaged in manufacturing industry. The object of study in the course is to realize the automation of a machine tool, which is one of main units in an intelligent manufacturing system. The delivery content has covered a lot of subject areas (machinery, control, electronics, computer, communication, etc.), that is, it is interdisciplinary. This creates great difficulties on the way to learning for compound applied talents. Therefore, it is imperative to explore the new pedagogical practice. In this paper, some suggestions are given on the organization of teaching contents, teaching mode, incentive method.

Introduction

With the advent of the intelligent manufacturing era, the manufacturing industry opens a new world. Less manual intervention, multi-equipment interconnection, uninterrupted running for 24 hours, highly automated operation, remote debugging, remote and real-time monitoring have become new features of manufacturing industry. As the key manufacturing equipment in this system, the numerical control machine tool, which needs a lot of theory and technology, undoubtedly plays an important pole. The principle and system of numerical control is an extremely essential course for undergraduate majoring in manufacturing automation. The depth of understanding for the work principle of NC machine tool control systems affects the ability of students to solve practical problems and design a system with better performance. Now under the background of rapid development of the industry, some ideas of teaching practice are introduced combined with the status of our college.

The Introduction of Numerical Control System and Principle

The principle and system of numerical control is such a course that introduces the theory and design of control systems used for machine tools. All delivery contents focus on the automation of machine tool. The kernel elements of NC system embrace NC code transfer and storage, NC code translation and diagnosis, tool compensation and real-time interpolation, generation and transmission of control commands, driving of the motors (for example: actuator motor, sled motor, alternating current motor), accurate positioning of the worktable, velocity control based on the technical conditions, the principle of electrical wiring, the software and hardware structure of NC system, parameter setting of the control system, and brief introduction of advanced numerical systems for machine tool around the world.

The feature of this course is massive in contents and involves many domains[1]. The difficulty in learning for the students lies in multi-discipline crossed. Moreover, whether foundation of Pre-course
is strong or not, is the key factor. Likewise, interdisciplinary teaching is a tremendous challenge to lecturers. It not only requires that the teacher has broad knowledge and profound theory on mechanics, electronics, control, hydraulic, sensors, motors, computer, communication, but also possess additional capacity, for example, the MCU and computer high-level language programming, hardware circuit design and analyzer, PLC control programming. Especially the teacher’s ability must be improved with the advances in technologies. Better yet, the teachers can lead the way, not following it.

**The Existing Problems in the Principle and System of Numerical Control Course**

**Lack of Learning Motivation**

The effect of teaching is affected by the periodic fluctuation of the market and the manufacturing industry. It is observed that intrinsic motivation to learn the course is not stable to students. In the past ten years or so, manufacturing industry has still remained low development trend. Many small and medium-sized manufacturing enterprises have a tough time. This caused decline in the number of workers employed by enterprises. Even if the students of this major took up an occupation, the salary is small compared with other industries. Since the delivery time of this specialized course paralleled to the job hunting time, the change of market demand for talents directly hurt the enthusiasm of students in learning. This indirectly leaded to poor teaching effect.

**Excessive Contents and Extensive Scope**

These two features increase the difficulties to learn for students. Now we take the decoding function of CNC system for example. The principle of decoding in the CNC system is relatively simple. When the algorithm of decoding is put into practice, the hardware used in the system needs to be considered. If the hardware is different, then the programs of decoding differ for numerical control manufacturing code. In addition, not only these generic G instructions but also macro program instructions can both be utilized in the process of programming NC codes. In order to decode properly, the rules for the generic G instructions and NC macro instructors must be familiar to the students. G code compilation is the easy part of decoding programs, but there are many algorithm operators, logic operators and looping statements, many macro variables in the macro instructors. So you will see that the mission is nearly the equivalent of designing a C-language compiler when a series of decoding procedures for macro programs are accomplished[2]. At the same time, the storage and addressing of MCU must also be mastered. The method of numbering system conversion in computer should be implemented by programming. From the above it can be seen that the development of just one decoding function needs software programming ability and the basic knowledge of computer and MCU.

**Poor Operability**

The machine tool control system, which is a large-scale one and a complicated structure, has many specific customized functions. The principle of every functional module is still developing. More than one type of operating principles for every function module can coexist widely in the machine tool industry. From the perspective of personal training, it is necessary that these diverse systematic functions and structures are to be passed on, which are the focal points and difficulties of teaching contents. And analysis of working principles is also a key point as well as difficult one for students and lectures. The teaching contents have the properties of abstract and complexity. Teachers are difficult to teach and students are laborious to learn. For instance, NC code will be communicated through the field bus between the machine tool and the host computer. Communication is not a touched process. Therefore, the visualization of operation results and the transparency of the realization process become one of the keys for students to master the content of principle. Obviously, the lack of practical links is not conducive to the understanding and application of principles. Besides that, there are many kinds of development tools involved. Students majored in this course is unskilled
in the usage of application development tools. This will lead to the difficulties in the designing procedure of function module.

**Limitations of the Course Examination**

At the end of this course, the teacher will do an overall assessment in theory for every student. According to the requirements of professional certification, all knowledge points will be listed in the scope of examination. In practice, however, due to the limitations of this evaluation mode, the incentive function to cultivate the application ability of students is not obvious. The motivation of the students is the pursuit of high scores of the course. There is a general lack of awareness of capacity building among teachers and students. For instance, after a series of course-related projects are distributed to students, a small number of students do like to finish the project from their own initiative. This implies that a great number of students have not given enough attention to the technicalization of principles.

**Exploration and Suggestion of the Teaching Practice in the Principle and System of Numerical Control Course**

Combined with the realities of our institute and undergraduate matriculate quality, some suggestion and reform methods will be put forward by drawing lessons from the teaching experience of similar courses in other colleges and universities. By implementing the teaching practice methods, these undergraduates can understand the working principles of all the core function modules and linkages among these modules. The students can improve themselves in theory level and form a complete curriculum core knowledge system. At the same time, the undergraduates’ abilities and qualities should be trained through the practice links in which the theory of the principle and system of numerical control course will be applied, and then the main force of teaching services effectively enhances their competitiveness in the human resources markets.

**Promotion of Learning Initiative**

From the perspective of the social environment, the machinery manufacturing industry has begun to be given full attention in our national level. It was found that the prosperity index of the manufacturing industry had its jump. Industry, small and medium-sized enterprises are a large majority of all manufacturing ones, which are the main target unit of our students' employment. The inclination of the state policy towards small and medium-sized enterprises is very good for students to improve their employment prospects and learning initiative.

In the campus learning environment, students usually need to learn more than one course during one semester. In fact, it is not practical to try to make our students concentrate on one course and spend a lot of time and energy to complete the design of course projects. Implementation of the teaching methods often depends on the cultivation of interest in learning and the love of course content. Students are such a group that are very willing to accept new things. When delivering course knowledge, teachers can introduce the connection between the content of courses and inventions winned Nobel Prize, that brings great honor and respect in the mind of common people, such as graphene and OLED screen. The process from theoretical research to application of technology can stimulate students' interest in learning.

**Well-designed Delivery Contents**

Education is not only to teach students what to learn, but also to instruct them how to learn. If the students actively can practise, explore and discover by education, this is a successful education, there is no doubt. Based on cognitive law and migration rule of adults, Only by satisfying the following conditions does it probably become a successful teaching process. These conditions include:

(1) Students have a sense of achievement in learning.
(2) Students have a visual sense about abstract things.
(3) Students have the experience sense of theoretical contents.
According to the above requirements, lectures should carefully design the teaching content of each class. In particular, teachers need to consider skillfully how to insert knowledge points of different subjects into the teaching content. It is quite evident that this puts forward a higher demand for teachers. The lecture has much experience in teaching and a wide range of knowledge, while teachers’ knowledge needs to be constantly updated. It’s worth pointing out that it takes time to improve teaching ability, and the accumulation of teaching experience is not a one-day success. It is necessary to set aside enough time for teachers to improve their professional quality and comprehensive ability. Hence the emphasis on teachers' cultivation should focus on the cultivation of interdisciplinary teachers.

For many students, the curriculum is comprehensive and involves a wide range of subjects. In addition, the teaching time span is long between the pre-course and the course. The phenomenon, that the students can forget what he or she had learned before, often occurs. One can imagine that it directly affects the teaching effect.

Now the MOOC market has exploded. Not only are there a proliferation of courses, there are now a proliferation of MOOC platform providers and tools[3]. Suppose that one student spends a lot of time taking offline classes or watching online course videos for free, there will be some problems. For example, firstly, it is difficult to keep watching the video tutorial day by day; secondly, it is difficult to guarantee adequate time to watch the videos. This will lead to the uncertainty of teaching effect.

However, the students can learn in such way. Aimed at the knowledge points from different disciplines mentioned by the lectures, students can use MOOC and online learning videos to break through the above mentioned knowledge points or technology separately after the teacher explains emphatically. In this process the students increase their knowledge.

To ensure the smooth implementation of this process, the teacher's teaching experience is very critical. The teachers had better be able to find the key points and difficulties of technology and analyze the origin and development of knowledge points in extremely limited teaching time according to the students’ learning characteristics and actual situation. It is feasible that online learning can only be used as an effective assistant means.

Guarantee of Practice Linkage

If there is no chance to practice the principle contents, the students will have a superficial impression on theory knowledge and have a weak ability. For this reason, the teachers should design the organizational structure of all teaching contents around the main research target—machine tool. Knowledge modules are built based on system functions. Then digs its technical details deeply and finely to realize module function. Practice linkage is from modularization to systematization, that is, the serial connection of practice links is from unit practice to system practice. The teachers implement goal-based strategies based on the function realization as carrier and promote from thorough understanding of principle to development of practical ability, so as to deepen the understanding of system work procedure. In practice, it brings a sense of achievement for students, and then produces a positive incentive.

Implementation of Assessment Link

The principle and system of numerical control course is a course requiring more practice. It is reasonable that evaluation has a less dependence on the form of closed-book examination. The knowledge from other disciplines is integrated from easy to difficult by the way of the improvement of teaching mode. After explaining the basic principles of work, we can provide students with completely developed practical projects for reference, and encourage them to design a new project by themselves in their spare time. Evaluate the results of project development and score them as part of the overall evaluation results.
Summary
This paper gives a detailed introduction on the teaching practice of the principle and system of numerical control course. It is a representative of comprehensive courses. With the development of science and technology, the teaching contents are also updated constantly. Under new era, in order to satisfy local and regional economic construction needs, higher requirements are put forward for the training of talents. The aim of the current teaching reform is to cultivate high-quality applied talents. The students’ ability and knowledge will be improved by the change of teaching mode.

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References