

Teaching reform of "production planning and control" for modern manufacturing industry

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Keywords: Production planning and control, Teaching reform, Modern manufacturing industry.

Abstract. "Production Planning and Control" is one of the major courses in Industrial Engineering, and its cross-cutting, adaptable, and practical characteristics require that the course should well integrate technology and management to meet the evolution of modern manufacturing industry. Through the study of the traditional teaching effectiveness of "Production Planning and Control", this paper pointed out the issues, including insufficient interaction, unappealing content, and lack of systematization of the knowledge. By introducing teaching reform approaches for the course, it proposes to combine various teaching methods, rearrange the teaching material, systematically plan the practical teaching links, and assess the learning effect through a diversified evaluation system, in order to promote students' motivation and learning enthusiasm, meanwhile improve the teaching effect of the course to meet the requirement of modern manufacturing industry for talents.

1 Introduction

Industrial Engineering is a new cross-cutting discipline covering engineering and management. It aims at optimizing the performance, economic efficiency and productivity of industrial systems and engineering projects through scientific and rational organization and coordination of relevant production factors, taking human resources, materials, information, energy and production organization as the elements in the system.[1] Throughout the teaching practice of industrial engineering at home and abroad, it can be divided into two major categories: those established in management disciplines, which are oriented to management methods, and those established in mechanical engineering disciplines, which are oriented to engineering.

"Production Planning and Control" course is one of the core professional courses in Industrial Engineering. By learning the course, students will be familiar with the theoretical framework of the operation of the production planning system, master the planning and

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control of the supply of materials and other resources [2], the main indicators of production planning, production capacity balance and production planning steps and methods. The students will have better understanding of the content and role of production operations planning, the principles and methods of production operations planning as well as inventory control, equipment maintenance planning and the corresponding control work.

However, with the rapid development of China's modern manufacturing industry, there is an obvious lag in the course content, such as the outdated cases with focus only on the traditional manufacturing fields, meanwhile the teaching methods are relatively monotonous, which ignore the practical problems, consequently making the teaching effectiveness of the course difficult to achieve expectation [3]. Therefore, it shows great significance to analyse the characteristics of the course, put forward the reform countermeasures, and sum up suggestions on teaching theory and practice for improving the teaching and learning efficiency.

2 Characteristics of "production planning and control" course

"Production Planning and Control" is a comprehensive intersection of engineering and management science, manufacturing technology and production planning science, the objectives of this course are, to familiarize students with modern enterprise production operation system, and ensure that the students can master the basic ideas and principles of production planning, while utilize or apply methods in the operation and management of production systems. This course exhibits unique characteristics, mainly in the following three areas.

2.1 Interdisciplinary

The cross-disciplinary character of the course is obvious. The objects of study, lie in the production process, operations planning, production line balance, inventory control and other technical learning based on the penetration of management concepts with an assist of time management, human resources management, and financial management.

2.2 Application-oriented

This course shows close connection between theory and practice, throughout the production operation process, facilities layout, enterprise resource planning and other aspects of a systematic and comprehensive understanding. It is focusing on the enterprise production process of integrated production planning, material requirements planning, assembly and production operations plan development methods and inventory control strategies.

2.3 Contemporary

The modern manufacturing industry and economic transformation show a significant impact on this course. As the traditional manufacturing industry is facing transformation and industrial upgrading, which requires enterprises to change from a production management system aimed at cost minimization to a production management system that places equal emphasis on cost, quality, and customer experience, therefore, the "production planning and control" course must also keep pace with the times.

3 Issues of "production planning and control" curriculum

Although this course shows significant importance in Industrial Engineering, the learning effectiveness is not as good as expected in many colleges where the course is offered.

3.1 Insufficient interaction

The traditional teaching method of "a chalk, three feet podium" still occupies a place in classroom lectures, and teachers instill a lot of knowledge into students through detailed explanations, while students just listen [4]. The learning is boring even annoying and may lead to lack of learning enthusiasm from the students.

First of all, in many situations, it is the teacher alone on the podium, while students may not have the chance to ask any questions, which resulted in the great creative ability loss and creative ability is mercilessly stifled. The classroom becomes boring, as students can only passively accept the knowledge. Some teachers prefer to read from books, also do not know how to activate or expand the students' thinking, making the classroom dead and weird.

In some cases, students are afraid of the teacher and do not dare to ask questions, especially for Chinese students. Hence. The teacher is unaware of the students understanding level, and the classroom has become a one-man show for the teacher only.

3.2 Unappealing content

The modern manufacturing industry and economic transformation development have a significant impact on this course. Due to the rapid development of China's economy, traditional manufacturing industries and service industries are facing transformation and industrial upgrading, and products are changing from the traditional single-variety, high-volume, stock-ready production method to multi-variety, small-volume, customized order-based production method.

In addition, some of the textbooks have been published earlier, and the case descriptions are slightly outdated compared with the current economic development. At present, the textbooks on the market are generally based on traditional manufacturing industries, which cannot reflect the ever-changing modern enterprise management methods and innovations in processes, methods, and tools.

When students graduate and enter the plants, they may feel a big difference between what they have learned in school and the actual application in the enterprise, which makes it impossible for them to use their existing knowledge to deal with production management-related work in a short period of time.

3.3 Lack of systematization

Most of the experiments of "production planning and control" are simple process simulations of a certain object of a production system, while the actual production site process changes are extremely complex. The traditional experimental means and methods are single and lack of systematization, and most of the course experiments are validation experiments, with few hours of practical teaching. Due to lack of practical system comprehensive use of analysis process, the knowledge points are independent of each other, lacking the necessary connection.

In this case, students can't establish a professional system-level concept in their mind after doing the experiments. Many professional knowledge is poorly understood. And most

experiments only meet the requirements of verifying the theory of classroom teaching. It is difficult to connect with the actual production site of enterprises.

The problems of disconnection of theory and practice are especially prominent, for example: theoretical teaching is separated from the real application; the experimental time is too little; the experimental projects are scattered; the content and form are single; instruments and equipment are in shortage; the experimental funds are insufficient, and etc. To get rid of this serious situation, a scientific and systematic practical teaching mode of "Production Planning and Control" needs to be resolved.

4 Innovations in curriculum reform

In view of the unique characteristics of the course, the main problems faced by the current teaching, and the author's practical teaching experience, this paper aimed at optimizing and adjusting, to make the teaching and learning in line with the current requirements of enterprise production operations, with focus in below four approaches.

4.1 Diverse the teaching methods with integrated approaches

The teaching method of multi-method integration is adopted in teaching nowadays, which is also be suitable in the teaching of "Production Planning and Control".

First of all, an inspiring and guiding way should be used, as the course involves a wide range of professional knowledge. Most of the chapters are with intrinsic connection, so it is difficult to talk about all the knowledge in a short time. Therefore, teachers should devote themselves to transforming the "injection" teaching mode into "inspiration", mainly guiding students, and changing the long-formed passive learning state of students. The most important knowledge should be pointed out in class by teacher, while it is better to guide students to study by themselves, solve problems after class by assigning relevant topics and consult relevant information next time.

Afterwards, discussions can be held in class, and students' understanding can be further expanded through mutual expressions and interactions. This could be a good solution to the problem when facing complex contents with limited class time nowadays. It can also stimulate students' learning enthusiasm and initiative, and improve their comprehensive ability of searching information, finding, analysing solving problems, and summarizing into conclusions. The teaching system is summarized in the following figure.

The teaching system can be disassembled and analysed in the lesson preparation, and made into a courseware animation, which can be shown and unfolded step by step in the classroom. In this way, students can understand the lecture content intuitively, with the teacher's explanation, and a better learning effect can be achieved. The courseware can add with animation, pictures, and other factors, which is conducive to the activity of classroom atmosphere and bring students' interest in learning.

Moreover, the concepts related to production management and advanced production technology (such as JIT production, flexible manufacturing system, enterprise production planning, etc.) should be covered in the course through relevant videos.

4.2 Rearrange the contents

The course materials should be rearranged or self-edited to make them better match the production characteristics of modern enterprises. As an important carrier, the course textbook is the main tool and reference for students to pre-study before class and review after class. Teachers need to deliver the course systematically through a combination of

textbooks and cases, to achieve the teaching objectives. Therefore, the selection of teaching materials should be consistent with the development objectives of the course. The content of the current textbook is mainly organized according to the three decision-making levels of strategic decision, operational decision, and control decision in the production operation of enterprises. The content is relatively small, which to a certain extent limits the space for students' independent learning and the depth of the course lectures. Therefore, the content and teaching methods of "Production Planning and Control" need to be adjusted with the progress of economy and society, to meet the changing needs of today's enterprise operation process and production planning.

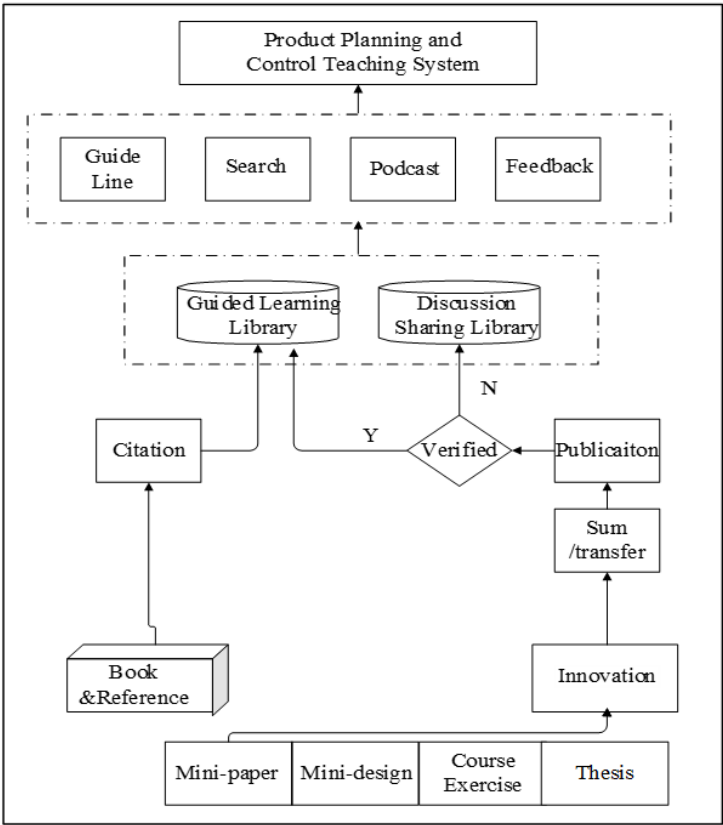


Fig. 1. "Production planning and control" teaching system.

Secondly, the curriculum reform focuses on the combination of theory and practice, highlighting the practical problem-solving skills training. Considering the content of the course "production planning and control", the combination of theory and practice is essential. The content of the textbook is highly condensed, and usually may not be easy for the college students, who are the lack of practical production experience. Therefore, it is especially important to combine theoretical learning with practical operations in certain actual production processes to broaden students' horizons and strengthen their theoretical basis.

At last, many actual production cases are collected from enterprises and a case library was prepared with supporting courseware, which is in line with the employment objectives of industrial engineering students. During the course, students are guided to apply the basic principles and methods of production planning and control to solve practical problems by combining rich case studies to improve their cognitive ability of practical production

problems. In addition, in order to enhance students' sensory understanding of the actual production, the course is interspersed with short videos of the production process, such as a short video of the production process of an automobile factory, which visually describes the whole process of stamping, welding, painting and final assembly, so that students have a deeper impression of the overall or local production process of the automobile, which helps to link the subsequent theoretical learning with the actual production.

4.3 Strengthen "industry-academia-research" trinity

Suitable manufacturing enterprises (such as Dongfeng, the biggest commercial vehicle manufacturer in China) are selected, in order to establish teaching system and management system of industry-university-research cooperation, with relocating experimental projects to enterprises, with the targets of "finding problems, proposing solutions, collecting and analysing data, testing and optimizing new solutions, and solving problems".

To strengthen students' ability to solve practical engineering problems with relevant theoretical knowledge, excellent graduates were created with innovative spirit, consciousness, and ability. As the opportunities of real internship in a factory are limited, a teaching software can also be used to simulate and demonstrate the functions of basic data, inventory management, production planning, operation management, equipment management, etc. Systematic reform and innovation were carried out through in-depth internship arrangement with enterprises, and virtual software system at the same time, by rearranging contents, innovating teaching methods, which help build up the undergraduate major of Industrial Engineering with higher level and continuous improvement.

4.4 Optimize the course assessment system

Although the learning contents of each subject and practice in Industrial Engineering are different, the assessment method basically adopts the examination plus course design. Under the requirement of curriculum reform, this course focuses on the "sequencing" of explicit knowledge and "manifestation" of tacit knowledge.

Table 1. Curriculum assessment and evaluation system.

Appraisal Items	Appraisal requirements	Ratio
Final Exam	Assessment of the mastery of basic knowledge and concepts, calculation ability, comprehensive analysis and application ability, independent learning ability, etc.	60%
Classroom Seminars	Assessment of understanding of complex engineering problems, mastery of research methods, data processing and analysis ability, etc. Study reports to be completed after lectures	20%
Course mini-paper / mini-design	The ability to calculate and analyse, the ability to think independently, and the ability to synthesize and design will be assessed. (Multiple assignments, can be combined to take the average score)	20%

In addition to the traditional assessment methods, this course adds the following:

- (1) Through the course mini-paper/design, course design, graduation design, let students "summarize" their achievements and feelings, and "convert" into a standardized model and "publish" into "Discussion and Sharing Library". So, the database becomes bigger and richer after several rounds running. The computer knowledge base is added to the "backstage" so as to realize the "manifestation" of tacit knowledge.
- (2) For the innovative designs, cases or short papers written by the students, the excellent cases are selected and transferred into the library, with multiple experimental

projects and micro-factory projects in the "Guided Learning Library", in order to provide continuous updating and progress of the curriculum. Fig.1 shows the teaching system logic.

Total evaluation score of 100 points = closed-book examination score of 60% + process assessment score of 40%.

(1) Closed-book examination 60%: According to the teaching objectives of the course, which are focusing on assessing students' understanding and application of basic knowledge and knowledge of important and difficult points. It can reflect students' ability to analyse problems and apply what they have learned; the content and type of assessment should be able to support the achievement of the course objectives.

(2) Process assessment 40%: including classroom seminar 20%, course mini-paper / mini-design 20%

The classroom seminar mainly assesses the students' attitude, the operability of the conclusions, and integration ability of data processing and team management, and etc. The assessment process should also emphasize the importance of completing assignments independently and cultivating students' ability to apply knowledge to solve problems.

5 Summary

In this paper, constructive approaches were proposed of course teaching reform to fit for the characteristics of "Production Planning and Control", and the current teaching situation. Various teaching methods were explored, and a talent training mode with close cooperation between industry, academia and research were established. This paper emphasizes the combination of theoretical teaching and engineering practice, supplemented by an efficient course assessment system, in order to adapt to the development of modern manufacturing industry. The approaches improve students' learning efficiency and practical problem-solving ability, and finally make necessary paving for students when they are transferring to the workplace. The curriculum reform ideas listed in this paper, may not only be used for Industrial Engineering but other related professional courses as a reference.

Supported by HUAT Doctoral Scientific Research Fund - BK202223

References

1. Zonghong Huang, Long Wu. *Contemporary Education Theory and Practice*, **2**, 105-107(2012)
2. Wei Wang, Jing Wang, Yujie Zhu, et al. *Forest Engineering*, **6**, 184-186, (2013)
3. Jingcai Li, Wenli Xu, Jiafu Yang. *Popular Science and Technology*, **1**, 94-96(2020)
4. Jingli Fan, Yunbing Hou, Zhang Hao. *Curriculum Education Research*, **1**, 253, (2020)
5. Wenlong Gui, Zhenhua Wu. *Popular Science and Technology*, **8**, 124-126, (2020)