Study on Teaching Methods for Engineering Project Management Based on Professional Accreditation of Engineering Programs

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Abstract

This article is focused on the teaching methodology for Engineering Project Management course. The course is an elementary and core course for automotive engineering major based on the requirement of professional accreditation of engineering programs. The course can be described as a course with big scale and more emphasized on industry. Three teaching methodologies have been used to coordinating with the course features: case-study learning, mission-driven learning, project-driven learning and flipped-classroom learning. The article addressed how the three methods have been applied in teaching. Meanwhile, the article also mentioned that a multi-methods evaluation should be more precise for evaluating students' abilities.

Keywords: engineering project management; professional accreditation of engineering programs; case-study learning; mission-driven learning; project-driven learning; flipped-classroom learning; multi-method evaluation

1 Introduction

Engineering project management is a subject which integrates science in management and engineering together. It is characterized by methods of restructuring management and adapting special management techniques, with the purpose of obtaining better control and use of existing resources. It has evolved from a management philosophy restricted to a few functional areas and regarded as essential to have to an enterprise project management system affecting every functional unit of the company. More and more companies are now regarding project management as being mandatory for the survival of the firm. Colleges and universities are now offering graduate degrees in project management. Project management is also a popular profession and career choice for many job searchers internationally. However, in academic areas, when searching the term 'project management' or similar terms, the come-out results always associate with construction projects or the so-called industrial management, and rarely find them on other field such as engineering fields especially in automotive research area while the project management approaches are everywhere around the automotive industry. In recent years, trends are changing. With more and more universities and colleges which have engineering majors are accreditation oriented, which raised managerial skills and abilities as one of the students' basic graduating requirements, project management related coursed are set up for engineering majors, such as 'Engineering project management' course is one of the core course for automotive engineering major in Shanghai University of Engineering Science.

The paper is aimed to provide some generally and innovative ideas about how to share knowledges with students and increase their understanding and practical skills based on the experiences on teaching for the 'Engineering Project Management 'course. The paper raises some teaching methods useful in teaching Engineering Project Management course, also proposes the examination method different from traditional examination methods.

2 Teaching Methods

In our country, traditional teaching methods, such as lecture method, discussion method, experimental teaching method, self-study method, etc. are more likely to be used for undergraduates. The newer methods at home and abroad include case-study teaching, task-driven teaching, project-driven teaching, flipped class teaching and bilingual teaching. The selection of methods should be carried out in accordance with the characteristics of the course itself and the requirements of the teaching objectives.

Engineering project management course are special for young Chinese engineering students for their majors' engineering priority are mainly based on basic courses such as mathematics, physics, engineering graphics, mechanics, mechanical design, mechanical principles, engineering materials, etc. They are rarely having economical and managerial courses such as economics, accounting, financial management and etc. As a so-called interdisciplinary course, engineering project management is totally different from the traditional engineering courses from teaching methodologies to examination methodologies. In traditional engineering courses, lecturer leading teaching methods are more common, while in managerial courses, or the so-called liberal arts courses or business courses, the student-oriented immersive teaching are more popular. As an engineering college lecturer, the first challenge is to change the passive teaching to more active ones. The most useful or successful ways used in the engineering project management course are case-based learning, mission-driven learning, project-driven learning and flipped-classroom learning.

2.1 Case-based Learning Method

Case-based Learning also means case-based teaching from different role-players' perspectives. From lecturers' perspective, the method could be called case-based teaching, which means the teachers use the cases as a medium to guide students to learn according to the teaching objectives, originated from Harvard University in the United States, and used for business management. The application of case teaching method in China appeared in the 1980s with the earliest traceable article Jingzhong Xie 's 'Case Teaching Method in Staff Education Application Series' published on the *Beijing Adult Education journal* in March 1984. In this paper, the characteristics of the case teaching method, the feasibility of applying the education of staff in China, the preparation of teaching cases and case teaching and examples are studied and discussed. In the following decade, the discussion and application of the case teaching method in China's academic circles is not too high until the change of the undergraduate education model in the 21st century, the case teaching method has returned to the mainstream.

The main advantage of the case teaching method is that the visual and vivid case can stimulate students' interest in learning, improve learning initiative, help to transform theoretical knowledge into practical skills, cultivate teamwork awareness, and train students to discover problems, analyze problems and solve problems.

Therefore, for the engineering project management course, choosing the right case is one of the keys to using the case teaching method.

In the teaching practice, the cases suitable for the engineering project management course mainly include Dongfeng Automobile Logistics Management Solution, which mainly introduce Dongfeng Motor Corporation's information system development, Shanghai General Motors Logistics Cost Management Case, which introduced Shanghai GM's lean production and recycling mode to save costs and Toyota Motor Corporation's Logistics Cost Management Case which provided Toyota's lean production model. The case selection criteria are whether it is closely integrated with automobile projects, the case representativeness and time effectiveness. After selecting the cases, the lecturer would brief on the key points and difficulties of the case, group the students, then organize the students to conduct group discussions, and then form a group presentation after each group form a formal opinion. Comments and scores are given by the lecturer when all groups finished their presentation and report. Through the exercise of this process, students can actively find problems, analyze problems and solve problems within limited information, which is conducive to a deeper understanding and application of the theory, and strengthen their team-cooperating abilities through group discussions and reports. In the teaching process, the main performance of the results is the improvement of the attendance rate of the case discussion class and the improvement of the concentration of students. According to the attendance rate statistics, the attendance rate and the speaking rate of the students in the case discussion class are 15% and 30% higher than the average lectures respectively.

In addition, the case teaching method can choose the graduates' practice content in the corresponding automobile enterprises to explain the PMBOK practice to the students in a targeted manner, to match the actual situation of the undergraduates more closely, and to mobilize their enthusiasm much better. In the meanwhile, the engineering project management course is set at the 7^{th} semester for the automotive engineering major, which means the students' graduating projects are perfect example for them in understanding the theories of project management such as time management, scope description, control theories, etc. it also can help students to formulate their graduating project process and priorities.

This teaching method is more suitable for the introduction of some theories or for the explanations and understanding of theories. However, because the students' thinking in the case teaching is easy to disperse, teachers need to be properly guided at the point. At the same time, because they occupy a long teaching time, the average case needs to take 1.5 class hours. In the case of limited class time, the teacher needs to carefully select the content and rationalize the time distribution.

2.2 Mission-driven Method

Task-driven learning method is a teaching method based on constructivist learning theory. It designs the teaching content into one or more specific tasks. Under the guidance of teachers, students are task-driven, and through the completion of tasks, they can cultivate the ability to discover, analyze and solve problems, as well as the ability to explore independently and the spirit of teamwork. It originated in the United States, and is represented by American psychologist Wittlock. The basic idea is that learning is the process in which learners actively construct their internal psychological structure, including structural knowledge and non-structural knowledge. On this basis, students can actively learn under the guidance of teachers.

The application of task-driven learning method in China's academic field can be traced back to the 'Application of Data Fusion Theory in Robot System Design' by Hai Zhao and Guangxing Wang of Journal of Northeast University in June 1995. Later, until April 2001, Xun Zhang and Zhengli Jin published the 'Advantage and Implementation of Task-Driven in the Teaching of Improving the Subject Status of College Students' in Journal of Hangzhou Institute of Electronic Technology which means the task-driven learning began to develop in the field of undergraduate education. Zhang and Jin's article mainly introduced the advantages of task-driven teaching in the teaching activities of practical courses in improving students' principal status, and gives a case study. From the research of scholars, it is known that task-driven teaching method conforms to the circular cognitive law of 'balance-imbalance-new balance' of human beings, and can give full play to the main role of students through the setting and completion of flexible tasks, which is conducive to the improvement of students' comprehensive ability.

The practice of using task-driven teaching method in the engineering project management course mainly lies in the big assignment (group project) that runs through the whole teaching process - completing the whole project process of students' own virtual enterprise. The whole assignment began at the end of the first lesson. The students are grouped into 4-6 groups. Each group is responsible for formulating a virtual enterprise or project started from stage 0, the idea generation to implementing of the whole process of project. After finishing a stage of project management course, the formulated teams should turn in an updated company file including project description, stakeholders and target customers reorganization, personnel assignment, project charter establishment, time and schedule management plan, cost management plan, quality management plan and etc. Each plan was corresponding to specific project management skills. The whole process is in a state of clear objectives, and can be closely related to the content of teaching, and the existence of grouping for students can promote their own expertise for division of labor and cooperation, but also because of the combination with practice, it also raised students' interests. In the process of teaching, teachers need give students guidance, feedbacks and evaluations of their achievements to help students summarize and expand their knowledge points.

In the process of teaching implementation, the difficulty lies in the collection and collation of relevant information. Some students' analysis is too formal, which violates the original intention of homework setting.

2.3 Project-driven Learning

In addition to case teaching and task-driven teaching methods, project-driven teaching is also an important part of the teaching mode reform in the new century. Project-driven teaching is a teaching method that designs the teaching content as a complete project. Under the guidance of teachers, students make plans in a group collaboration way and complete the whole project in a group collaboration manner, so as to achieve the goal of school knowledge, cultivate the ability of analysis and problem solving, and cultivate the spirit of team cooperation. Compared with the task-driven teaching method mentioned above, the project-driven teaching method is more open, comprehensive and practical. In the process of students completing the project, students are not restricted to play, but free to explore various ways and methods to complete the project. And because of the need to complete the project, students need to understand multi-disciplinary and professional knowledge, which is helpful to cultivate their learning ability, problem solving ability and team building ability. In addition,

the project pays more attention to social needs than the task, so that the practicability of teaching is strengthened.

The big assignment (group project) mentioned above is a perfect example for the project-driven learning. From the teaching practice, this kind of teaching method has strong practicality. Teachers only play a guiding role. It is suitable for the situation with clear purpose and certain practical project design as support. Similarly, because project-driven teaching method is the further development of task-driven teaching method, there is a free-rider behavior of students, which should be paid attention by the teacher for the examination purpose.

2.4 Flipped-classroom Learning

Flipped-classroom teaching is popular when online training are getting more and more common. In the flipped-classroom learning, the traditional learning process (teacher's speaking and student's listening) is reversed to enable learners to complete independent learning of knowledges and concepts in extra-curricular time. The classroom becomes a place for interaction between teachers and students, mainly for answering questions and reporting discussions, so as to achieve better teaching effect. This is a kind of reversal of teaching structure and mode, which not only innovates the teaching mode, but also reverses the traditional teaching structure, teaching mode and teaching mode, and establishes a more thorough 'student-centered' teaching mode. Under this mode, students become the main body of learning, while teachers are the organizers, helpers and instructors of students' learning. The application of this method can give full play to students' subjective initiative and cultivate students' exploratory and innovative abilities. In the process of classroom discussion and questions answering, the students' ability to ask questions and summarize questions is also trained. At the same time, the students' ability of communication and teambuilding is also been enhanced. In the meanwhile, a teacher's interaction with students in a flipped classroom can be more personalized and less didactic, and students are actively involved in knowledge acquisition and construction as they participate in and evaluate their learning.

Due to the limitation of curriculum characteristics, the use of flipped-classroom teaching method is just a part of the whole class, mainly concentrated in the need to strengthen the application of theory. However, almost two third of the students are going to prepare for the graduating college exam, the outcoming of turn-over class method was not as obvious as other methods, which means it need further implementation in the future teaching.

3 Examination Methodology

In the teaching practice, it also explores the assessment methods of the curriculum. Traditional undergraduate course assessment methods are examination centered with various ways include closed-book exam, open-book exam, semi-open-book exam and papers. According to the characteristics of this course, the examination method of paper form has certain requirements for time and energy, and it is less likely that the course will be used alone. Closed-book examination, open-book examination and semi-open-book examination can be used as a form of final examination.

In teaching practice, the assessment of students' performance is no longer limited to the students' usual performance and final examination or paper results, but with a valid combination of four parts: case analysis

results, task follow-up results, final close-book examination results and attendance status at ordinary times, in which case analysis results are set according to the teaching content of the semester. The number of cases accounted for 15-30% of the total score, while the scores of cases were scored scientifically and differently according to the discussion within and outside the group and the final group speech, combined with each student's mutual evaluation in the group. The task completion degree was similar to the case assessment, which was scored by the group's final report and the group members' 'mutual evaluation, accounting for 20-30%. Final exam scores accounted for 45-50% of the total score, while the rest were graded according to the usual attendance performance. This comprehensive form of assessment integrates all aspects of consideration, changing the original assessment method only through attendance and final examination results to measure the state of students' learning, diversified assessment methods help to measure students' comprehensive level.

In the process of practice, this comprehensive evaluation method is highly praised by students, and the average score of students is 73.5 points in the percentage system. There are relatively few students above 85 points and below 63 points. The whole performance curve is relatively smooth, and conforms to the standard normal distribution, which has a certain degree of scientific nature. However, there are high demands on teachers to determine the role of students in case teaching and task-driven teaching reasonably and correctly, and to use the appropriate question-setting methods on the fairness and impartiality of performance determination.

4 Conclusion

Under the new situation, the training of talents in universities should be closer to the needs of enterprises and society. Therefore, the continuous exploration and improvement of teaching methods and assessment methods will contribute to the realization of the training objectives of talents in universities, and the summary of their experiences and lessons can be extended to other similar disciplines with strong practicality and wide scope, which has certain practical significance.

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