Study on Application of Bloom’s Taxonomy in Engineering Project Management Course

YanTao Zhang¹*, ChenDan Yuan¹b, HaiLong Yu²c

¹School of Architecture and Mechanical Engineering, Chifeng University, Chifeng, Inner Mongolia, China 024000
²Logistics and capital construction department, Chifeng University, Chifeng, Inner Mongolia, China 024000

*Corresponding author e-mail: 155083499@qq.com
b869234636@qq.com, c1170780980@qq.com

Abstract: In recent years, educational reformers have focused on teaching philosophy of Bloom’s Taxonomy, studying theory and practice of relevant teaching philosophy at home and abroad in terms of cognition, application of engineering project management teaching models in classroom-based lamination teaching, classroom teaching models, assessment and evaluation.

1. Introduction

In the 1980s, Bloom’s Taxonomy was introduced to China, involving cognition, affection and motor skills. Benjamin Bloom (1956), an educational psychologist in the United States, divided the educational goals in cognition into 6 layers: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation[1].

On this basis, Lorin Anderson and David Krathwohl (2001) revised Bloom's Taxonomy of educational goals, dividing cognitive skills into Remembering, Understanding, Applying, Analyzing, Evaluating and Creating, offering specific definitions[2].

2. Teaching models against Bloom’s Taxonomy

2.1 Classroom-based lamination teaching

Classroom-based lamination teaching consists of the 2 layers of teaching objects and teaching contents.

2.1.1 Layer of teaching objects

Stevenson divides learning into the 3 low-high layers of knowledge mastery, intensification and creation, with memory and comprehension belonging to mastery, application and analysis belonging to knowledge intensification and evaluation and creation belonging to knowledge creation. Students are divided into different study groups according to their basics and acceptance, teaching accordance with their aptitude.
2.1.2 Layer of learning tasks

Teaching designs focus on the syllabus, developing different learning tasks based on cognition to adapt to different learning basics and acceptance. *Engineering Project Management* focuses on case teaching, taking question-based teaching methods to design learning tasks. The following shows a learning task layer example of construction schedule of an engineering foundation slab [3]. The learning tasks and their corresponding learning contents are shown in Table 1.

| Cognition          | Learning content                                                                 | Keyword definition                                                                 | Learning method                      |
|--------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------|
| Layer 1: Remembering | 1. Describing engineering project schedule, schedule indicators and schedule management; 2. Summarizing engineering project schedule management system | Cognition and memory                                                             | Mechanical repeated memory and reading |
| Layer 2: Understanding | 1. Understanding characteristics of engineering project schedule management; 2. Summarizing schedule goal verification methods and steps; 3. Differentiating schedule system classifications | Analysis, proof, classification, generalization, inference, induction, comparison, interpretation, summary | Cooperative learning Taking notes and narration |
| Layer 3: Applying   | 1. Finding the logical relationship between schedules 2. Taking activity time estimation methods, calculating project duration. | Utilization                                                                      | Collaborative learning, practical learning |
| Layer 4: Analyzing  | 1. Applying schedules, analyzing engineering project schedules, calculating construction process 2. Analyzing Gantt chart, developing arrow diagram 3. Identifying key work and critical lines | Identification, organization, analysis, decomposition, contrast, comparison, discrimination, explanation | Debate, group discussion, cooperative learning |
| Layer 5: Evaluating | 1. Checking schedules and key lines, evaluating Gantt chart rationality          | Evaluation, inspection, criticism, conclusion, identification, evaluation, description | Review, investigation, communication, test, self-assessment, peer review |
| Layer 6: Creating   | 1. Redesigning the case, adjusting and optimizing engineering project schedules | Reorganization, generation, creation, design, manufacturing, production, synthesis | Creating models, writing articles, designing cases |

2.2 Classroom teaching model application

2.2.1 Flipped classroom

According to Version 2001 Bloom’s Cognitive Goal, classroom essence is student knowledge gaining process. As an important place for students to learn, the classroom should focus on students,
with them as the classroom subject and teachers playing a guiding role. In terms of the teaching model of the flipped classroom, the teacher needs to arrange the first and second layers of memory and comprehension through video and reading before class, the third and fourth layers of analysis and application in class, the fifth and sixth layers in class or after class according to the tasks\cite{4}. Taking the case of Table 1 as an example, it is proper to have students prepare the basic materials such as the engineering project schedule basic concept and basic knowledge in advance in the previous class, and discuss the logical relationship between schedules and the calculation method in groups, draw the Gantt chart to identify key work and key lines through group cooperation. Finally, the teacher interacts with the students for the project and key lines, evaluating rationality of the Gantt chart, guiding students to adjust and optimize engineering project schedules, arranging other off-class tasks (the sixth layer) for creative learning.

2.2.2 Group cooperation

The teaching model of group cooperation needs to exert dominant positions of teachers and students, promoting student active learning through the guidance of teachers. Through problems or cases, the group applies concepts learned to discuss and analyze the cases, further understanding and applying the cases, participating in curriculum application activities. The engineering foundation slab and construction schedules in Table 1 are exchanged in the second to fourth layers with the group cooperation method, conducive to exchanges and communication between students, encouraging them to make statements, transferring from passive learning as active learning\cite{5}.

3. Assessment methods

According to student different cognitive abilities, the assessment methods and layer requirements are also different.

3.1 Assessment method layers

It is proper to enhance appraisal and create high cognition for students with fast acceptance and innovative ideas. For students with sound basics and acceptance, it is proper to improve applicability and analytical ability, and approximately increase the proportion of appraisal and creation tasks. For average students, it is proper to focus on memory and comprehension, assessing their application and analysis, making different students meet different cognitive needs and assessment requirements.

3.2 Learning evaluation methods

Learning evaluation centers on learning methods and standards, classroom performance, attendance, after class assignments, staged examinations, ensuring objective and effective evaluation. In evaluation, different standards are set for different layers of students\cite{6}.

3.3 Course performance analysis

Two classes of *Engineering Project Management* in civil engineering major were applied for comparative analysis as research objects. One group (the study group) adopted Bloom’s Taxonomy and the other (the control group) adopted the traditional indoctrination. Analysis of the results of the study group is shown in Figure 1.
Fig. 1. Distribution of results of the study group

Figure 1 shows that the number of failures is 2, accounting for 4.55% of the total. The number with 60 or more points is 42, accounting for 95.45% of the total and the number with 70 or more points is 40, accounting for 90.9% of the total.

Fig. 2. Distribution of results of the control group

Figure 2 shows that the number of failures is 5, accounting for 13.51% of the total. The number with 60 or more points is 32, accounting for 86.49% of the total and the number with 70 or more points is 15, accounting for 40.54% of the total.

Fig. 3. Comparison of Grades and Standard Deviation Data

Figures 1, 2, and 3 present the distribution of results for both the study and control groups.
Figure 3 shows comparison between the performance and standard deviation of the study group and the control group [7]. The study group has its average score increased by 7.73 points, pass rate increased by 9.01%, with the standard deviation of 4.53. In terms of usual results, the control group has higher points in basic concepts and theories, and the study group has higher points in case analysis. Against the characteristics of the actual case analysis in Engineering Project Management course, Bloom’s Taxonomy is suitable.

Based on comparison between Fig. 3 and Fig. 4, the class adopting Bloom’s Taxonomy has its failure rate decreased by 8.96%, with the results greatly improved. The ratio of 70 points or more was increased by 50.36%, with obvious effect. Through contrast and comparison of the 3 groups of data in Figure 3, the study group has its average points, pass rate, and standard deviation outweigh those of the control group, with significant results, significantly related to the introduction of Bloom’s Taxonomy and improvement of student initiative in independent learning.

4. Conclusion

Based on Bloom’s Taxonomy educational philosophy, group teaching in class, flipped classroom and group cooperation driving methods enhance student interest in learning. Students complete studies of teaching materials such as teaching video before class, focusing on students, group cooperation in class, interactive communication [8], counseling and question answering, achieving cognitive internalization, inspiring student learning interest and creating potentials, achieving sound learning effect, subverting traditional cramming teaching effect, of great significance to improvement of student cognitive ability and cultivation of their overall quality.

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