ISSN 2616-5902 Vol. 6, Issue 5: 281-287, DOI: 10.25236/AJBM.2024.060538

Project-Based Management Model for Surveying and Mapping Engineering Experimental Teaching in Colleges

Xia Kang, Meihua Zhang

College of Water Conservancy and Hydropower Engineering, Gansu Agricultural University, Lanzhou, 730070, China

Abstract: *This paper aims to explore the project-based management model for surveying and mapping engineering experimental teaching in colleges. By analyzing the application of project-based management in teaching, a project-based management framework suitable for college surveying and mapping engineering experiments is proposed. Through field research, case analysis, and a review of professional literature, the paper delves into the advantages of project-based management in improving experimental teaching outcomes and cultivating students' practical abilities. Finally, the proposed project-based management model is evaluated, and directions for future research are suggested.*

Keywords: *College Surveying and Mapping Engineering Experimental Teaching, Project-Based Management, Practical Abilities, Teaching Effectiveness, Research and Analysis*

1. Introduction

With the continuous development of China's surveying and mapping engineering industry, higher demands are placed on the practical abilities of students majoring in surveying and mapping engineering in colleges. Traditional experimental teaching methods can no longer meet these requirements, necessitating the introduction of more flexible, innovative, and effective management models to improve the quality of talent training. Project-based management, as a management method widely applied in the engineering field, has great potential in enhancing the effectiveness of college surveying and mapping engineering experimental teaching. This paper aims to explore the feasibility of applying project-based management in college surveying and mapping engineering experimental teaching through in-depth research on its application in teaching, and proposes a corresponding management framework and model.

2. Overview of Project-Based Management

2.1 Basic Concept of Project-Based Management

Project-based management is a systematic management approach designed to organize tasks into independent projects, achieving successful completion through clearly defined objectives, phased plans, and collaborative teamwork. Core concepts include project objectives, specifying the expected outcomes of tasks; project planning, ensuring orderly progression of tasks through phased plans; project teams, leveraging the professional strengths of multidisciplinary team members; and project evaluation, conducting comprehensive assessments of the process and results to enhance management effectiveness. [1] These concepts form the basic framework of project-based management, providing a flexible and efficient organization method for experimental teaching, facilitating orderly task progression, and comprehensively enhancing students' practical abilities.

2.2 Current Application of Project-Based Management in Teaching

With the continuous evolution of higher education philosophies, the application of project-based management in teaching is gradually becoming a widely recognized experimental teaching method. Across various disciplines, such as engineering, management, and computer science, project-based management is widely adopted to enhance students' practical abilities and problem-solving skills. In

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higher education, project-based management creates a learning environment and practice method closer to reality by forming multidisciplinary teams and defining practical project tasks for students. [2]

Through project-based management, students participate in real projects, facing actual challenges, thereby cultivating innovation and teamwork skills. Students can apply classroom knowledge to solve real problems and experience different phases of the project cycle, enhancing their comprehensive problem-solving abilities. This teaching method emphasizes the organic integration of practice and theory, providing students with a more comprehensive and in-depth learning experience, enabling them to better adapt to the complex environments of future work. [3] Therefore, the application of project-based management in higher education will become an effective method for cultivating students' comprehensive qualities and practical abilities.

2.3 Problems in College Surveying and Mapping Engineering Experimental Teaching

Currently, college surveying and mapping engineering experimental teaching faces several issues, including a shortage of experimental equipment, insufficient management personnel, and limited experimental sites. Traditional teaching often focuses on classroom lectures and experimental demonstrations, failing to effectively integrate experimental measurements with actual engineering projects, leaving students underprepared for real-world problems. This disconnect from practical engineering applications hinders students' ability to apply theoretical knowledge flexibly in practice, affecting their adaptability in real work environments. [4]

Additionally, the disconnection between disciplinary knowledge and practical operations in experimental teaching is a widespread issue. Students acquire theoretical knowledge but lack practical experience, unable to effectively apply what they have learned to real surveying and mapping projects. This disconnection restricts the improvement of students' overall qualities, making it difficult for them to handle complex tasks in engineering practice.

Therefore, addressing the issues in college surveying and mapping engineering experimental teaching, project-based management is considered a potentially powerful experimental teaching management method. By integrating theoretical knowledge with practical operations through project-based management, students can participate in real projects, enhancing their adaptability and practical experience, thereby improving the quality and effectiveness of experimental teaching. This method is expected to break the constraints of traditional teaching and cultivate surveying and mapping engineering technicians with practical application value. [5]

3. Feasibility Analysis of Project-Based Management in College Surveying and Mapping Engineering Experimental Teaching

3.1 Relationship between Project-Based Management and Cultivation of Practical Abilities

3.1.1 Student Team Collaboration and Role Awareness

In project-based management, emphasizing students' role awareness and collaboration skills within team cooperation is crucial for cultivating practical abilities. By forming multidisciplinary teams with each member responsible for independent tasks, students can develop a spirit of teamwork through collaborative work. This collaborative environment not only simulates the team collaboration model in actual engineering projects but also helps students better adapt to future work environments. Students involved in projects are not just acquiring professional knowledge but are also practicing the ability to play different roles within a team, providing strong support for their future career development.

3.1.2 Task Division and Collaboration Ability Training

Project-based management focuses on task division and collaboration, requiring students to cooperate based on their professional backgrounds and skills to complete different stages of the project. This not only deepens students' understanding of various aspects of surveying and mapping engineering but also cultivates their ability to cooperate in actual work. By collaborating to complete tasks, students not only deepen their understanding of surveying and mapping engineering knowledge but also improve their ability to collaborate in actual engineering projects. [6] This ability training provides students with a practical ability foundation for better adapting to complex engineering projects in the future.

ISSN 2616-5902 Vol. 6, Issue 5: 281-287, DOI: 10.25236/AJBM.2024.060538

3.1.3 Feedback Mechanisms Within the Project Cycle and Ability Enhancement

Feedback mechanisms within the project cycle are key elements of project-based management. Regular feedback allows students to understand their performance in the project, adjust learning strategies timely, and continually enhance practical abilities. This feedback mechanism simulates the timely adjustment and improvement process in actual projects, gradually cultivating students' habit of continuously learning and optimizing surveying solutions in practice. Through such feedback mechanisms, students can better understand their task completion status and shortcomings in the project, prompting them to improve relevant skills targetedly, better adapting to future work demands. Feedback mechanisms serve not only as tools for problem identification and resolution but also as catalysts for student ability enhancement, driving their continuous progress in projects. [7]

3.2 Advantages of Project-Based Management in Enhancing Teaching Effectiveness

3.2.1 Clear Goals and Task Division Guide In-depth Professional Learning

Project-based management guides students into deeper disciplinary knowledge through clear project goals and task division. Firstly, clearly defined project objectives help students understand the purpose and expected outcomes of experiments more clearly, improving their in-depth understanding of surveying and mapping engineering knowledge and better applying theoretical knowledge in actual engineering. Secondly, task division allows students to focus on areas of expertise within the project, utilizing their professional strengths. This professional division not only promotes students' deeper understanding of various aspects of surveying and mapping engineering but also provides them with strong technical support for their future professional development.

3.2.2 Phased Management Facilitates Organic Connection in Experimental Teaching

Phased management within the project cycle aids in the organic connection of experimental teaching. Firstly, dividing experimental teaching into different phases allows students to gain practical experience and feedback at each stage, preventing isolated knowledge and gradually enhancing practical abilities throughout the experimental teaching process. Secondly, phased management aids in timely identifying and resolving issues within experimental projects, ensuring the overall progress of experimental teaching. Through this management style, students can undertake learning activities with goals at each stage, making experimental teaching more orderly and efficient.

3.2.3 Team Collaboration Cultivates Students' Team Spirit and Communication Skills

Project-based management emphasizes team collaboration, cultivating students' team spirit and communication skills. Firstly, in projects, students need to work closely with team members to complete tasks together. This not only enhances students' teamwork ability but also teaches them effective communication and coordination. These teamwork skills are essential for future involvement in surveying and mapping engineering projects, laying a foundation for students' comprehensive quality enhancement. Team collaboration is not just about completing tasks but also a process of growing and learning together, providing students with practical experience for cooperation in actual engineering projects. [8]

3.3 Characteristics and Needs of College Surveying and Mapping Engineering Experimental Teaching

3.3.1 Defining Project Goals and Tasks to Promote Knowledge Learning and Application

College surveying and mapping engineering experimental teaching requires students to possess solid theoretical knowledge and proficient practical operation skills. Under the project-based management model, clear project goals and tasks help students concentrate on learning and applying relevant knowledge. Clearly defined project objectives give students a clearer understanding of the experiment's purpose, while task division allows them to focus on learning subject knowledge related to their professional fields within the project. This clear goal and task setting enhance students' knowledge learning and application levels in surveying and mapping engineering experiments, laying a foundation for their future career development. [9]

3.3.2 Spatial Data Processing and Practical Ability Training

Surveying and mapping engineering experiments involve the collection and processing of spatial data, requiring students to possess spatial data processing abilities. Project-based management, through

ISSN 2616-5902 Vol. 6, Issue 5: 281-287, DOI: 10.25236/AJBM.2024.060538

actual project operation experiments, allows students to cultivate spatial data processing abilities in practice. Students can better understand and apply spatial data processing methods through teamwork, enhancing their spatial data processing skills through actual operations. [10] This practice-integrated experimental approach allows students to combine theory with reality, aligning more closely with the actual needs of surveying and mapping engineering, providing practical skills for their future work.

3.3.3 Team Collaboration and Task Division Adapt to Actual Project Needs

College surveying and mapping engineering experimental teaching needs to adapt to the requirements of actual surveying projects, where team collaboration and task division mechanisms play key roles in project-based management. Team collaboration requires students to fully cooperate with team members during experiments, completing experimental project tasks together. This collaboration model simulates the cooperative environment in actual surveying projects, offering students practical cooperation experience. Meanwhile, the task division mechanism allows students to complete project tasks based on their professional backgrounds and skills, better adapting to the division of labor needs in actual surveying projects. This learning environment benefits the improvement of students' actual surveying engineering abilities and provides valuable experience for team collaboration and task division in their future professional development.

4. Constructing an Efficient Project-Based Management Model for College Surveying and Mapping Engineering Experiments

4.1 Clarifying Project Objectives and Designing Reasonable Tasks

In college surveying and mapping engineering experimental teaching, establishing specific and practical project objectives is crucial. These objectives should be closely integrated with the core content of the course, enabling students to comprehensively master key knowledge in surveying and mapping engineering through practical application. Task design needs to balance challenge and feasibility, aiming to stimulate students' enthusiasm for learning and promote their active participation in the experimental process.

4.2 Optimizing Team Formation and Achieving Efficient Division of Labor

The success of experimental projects depends on the effective formation of multidisciplinary teams and a clear division of roles. When building teams, the diverse needs of surveying and mapping engineering should be considered to ensure coverage of professional knowledge from all relevant disciplines. Rational role allocation not only facilitates members to leverage their strengths but also promotes team cooperation and smooth project implementation.

4.3 Implementing Phased Management to Ensure Teaching Quality

Adopting a phased management approach helps to effectively organize and guide students' experimental learning processes. Phased experimental design allows students to gain specific practical experience and timely feedback at each stage, facilitating the gradual improvement of their skills. Moreover, phased progress monitoring and problem-solving ensure the continuity and efficiency of the entire experimental teaching process.

4.4 Establishing Comprehensive Evaluation and Feedback Mechanisms

Implementing comprehensive evaluation and establishing effective feedback mechanisms are crucial for fully understanding students' experimental performance and promoting skill enhancement. By combining individual and team performance assessments, students are motivated to achieve a balance between personal professional development and team collaboration. Regular feedback not only guides students to adjust their learning strategies timely but also helps them learn from practice and continually improve.

4.5 Continuous Optimization and Innovation of Experimental Projects

To ensure the long-term effectiveness of the project-based management model in college surveying and mapping engineering experimental teaching, continuous optimization and innovation are necessary.

ISSN 2616-5902 Vol. 6, Issue 5: 281-287, DOI: 10.25236/AJBM.2024.060538

This includes regularly reviewing and updating the content of experimental projects to keep pace with the latest developments in the surveying and mapping engineering field. Encouraging students and teachers to propose innovative experimental methods and teaching strategies is essential to adapt to changing educational needs and technological advancements. Systematic evaluation of completed projects not only helps to identify potential improvements but also provides valuable experience for the design of future experiments. The key is to establish a flexible and open learning environment that inspires the innovative spirit of students and teachers, thereby continuously enhancing teaching quality and learning outcomes.

5. Case Analysis and Field Research

5.1 Case Study: Key Factors for Successful Implementation

In this section, we delve into the key factors behind the success of a college in implementing project-based management in surveying and mapping engineering experiments. The school's success is primarily reflected in the following aspects:

5.1.1 Effectiveness of Goal Setting

In setting project goals, the school demonstrated a high degree of specificity and practical orientation. By closely aligning with industry standards and the latest technological trends, they ensured that project goals were not only challenging but also realistically achievable. For example, they established objectives that align with current developments in surveying technology, including drone mapping and 3D reconstruction. Such goals attracted students and also met the demands of the future job market.

5.1.2 Construction of Multidisciplinary Teams

In team building, the school adopted a cross-disciplinary strategy, involving multiple fields such as surveying and mapping engineering, computer science, and geographic information systems. Through multidisciplinary integration, students were able to understand the complexity of surveying and mapping engineering from different perspectives and learned how to collaborate across various professional fields. This team-building approach not only enhanced students' collaborative skills but also expanded their understanding of the diversity within surveying and mapping engineering.

5.1.3 Efficiency of Role Division

In role allocation, the school excelled by cleverly distributing roles based on students' interests and strengths, such as data analysts, field surveyors, project coordinators, etc. Such division ensured that each member found their appropriate place in the project, effectively utilized their personal strengths, and learned how to contribute fully to the team.

5.1.4 Implementation of Phased Management

The school utilized a phased approach, ensuring that each phase had clear objectives and plans. The initial phase focused on theoretical learning and skill training, the middle phase shifted towards practical surveying operations, and the final phase concentrated on data analysis and project reporting. This phased management helped students gradually build their knowledge system, ensuring they progressively improved in practice.

5.1.5 Establishment of Feedback Mechanisms

The school established regular and real-time feedback mechanisms, where students received evaluations from teachers and peers at the end of each project phase. This feedback helped students understand their strengths and areas for improvement, promoting self-enhancement.

5.2 Field Study: Challenges and Countermeasures

During a field study at another university, we identified and analyzed the main challenges in implementing project-based management and proposed detailed countermeasures.

5.2.1 Insufficient Interdisciplinary Collaboration

In multidisciplinary teams, students from different professional backgrounds may face difficulties in communication and collaboration, potentially leading to misunderstandings and inefficiency. To

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address this issue, we recommend organizing interdisciplinary seminars and team-building activities, designed as interactive workshops, to promote mutual understanding and collaboration within the team.

5.2.2 Rationality of Team Division

Some teams did not fully consider members' expertise and interests when dividing tasks, possibly leading to lack of engagement and motivation. The suggestion to solve this issue is to implement personalized role assignments, encouraging students to choose roles based on strengths and career interests, and providing training and guidance to help students better adapt to their roles.

5.2.3 Time Management and Practical Experience

Students face problems with poor time management and lack of practical experience in project-based management. We suggest introducing time management tools and training to help students plan and utilize their time more effectively. At the same time, offering more practical opportunities, such as simulated projects and internships, to enhance students' practical abilities and experience.

5.3 Comparative Analysis and Practical Guidance

The comparative analysis of cases from two universities revealed several key factors in the implementation of project-based management.

5.3.1 Flexibility of Goals

Goal flexibility is a key factor for project success, ensuring that objectives are not only challenging but also adaptable to different students' needs and market changes. When setting goals, it is essential to deeply consider students' professional backgrounds and individual interests, aligning them with industry development trends and future employment demands. This flexibility makes the project more attractive and provides students with broader development opportunities.

5.3.2 Balanced Team Formation

When achieving balanced team formation, careful consideration must be given to each member's professional knowledge and skills to ensure coordination and balance among each other. By effectively integrating professional strengths from different fields, team members will complement each other better, promoting interdisciplinary learning and collaborative cooperation. This collaborative effort will inject more innovation and diversity into the project, improving the overall team's performance.

5.3.3 Flexible Phased Management

Adjust project phases and content flexibly based on project progress and student feedback, ensuring the smooth running of the project. This flexibility allows teachers to make necessary adjustments based on students' learning progress, such as changing the focus of the project or adjusting the timetable.

5.3.4 Timely Evaluation and Feedback

Establish an inclusive and open feedback environment, encouraging interaction and communication between students and teachers. Timely feedback helps students understand their progress and areas for improvement, while also providing teachers with an opportunity to adjust teaching methods. This bidirectional communication mechanism contributes to building a supportive and growing learning community.

6. Conclusion

Through the study of project-based management in college surveying and mapping engineering experimental teaching, this paper proposes a referenceable project-based management model. This model can not only improve the effectiveness of experimental teaching but also better cultivate students' practical abilities. However, it is also necessary to pay attention to some problems that may be encountered during the implementation process, requiring continuous summarization of experience and optimization of the management model. Future research directions could focus on the application of project-based management in different colleges and different experimental projects, as well as more in-depth assessments of teaching effectiveness and the improvement of students' comprehensive qualities.

ISSN 2616-5902 Vol. 6, Issue 5: 281-287, DOI: 10.25236/AJBM.2024.060538

Acknowledgements

Fund project: Gansu Provincial Education Science Planning 2022 School Ideological and Political Work Special Project—Research on the construction of "Three Complete Education" system under the Training goal of Outstanding Agricultural and forestry talents (GS [2022] GHBZX013).

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