

Teaching capacity and quality improvement in engineering education based on scientific research projects

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Abstract: *In the context of cultivating outstanding engineers in higher education, the introduction of scientific research work content for teaching practice can promote the improvement of teaching ability. It can give full play to the academic strengths of scientific researchers, incorporate innovative theories and methods, and improve the teaching capacity through the enhancement of the breadth and depth of knowledge; it can also mobilize students to learn actively, stimulate students' interest and enthusiasm, and promote the quality of course education through the strengthening of related knowledge theory and practice. Combining the current research stage in teaching improvement, this paper put forward a set of methods for promoting teaching capacity and quality based on scientific research projects, leading the development of university education.*

Keywords: *Teaching Capacity; Teaching Quality; Engineering Education; Scientific Research Projects*

1. Introduction

Economic globalization and science and technology advancement have brought about great changes in higher education ^[1]. In the context of the new education system and model, it is necessary to establish a close link between industry, education, and scientific research, to improve the teaching capacity and quality. Especially for engineering technology courses, the dual promotion of scientific research projects and teaching can improve the quality of education and talent cultivation, so it is necessary to integrate scientific research practice into daily teaching and promote the positive interaction between scientific research and teaching.

Integrating transversal competencies in engineering education curricula is important for engineering education, and the students' mastery of competencies in communication, lifelong learning, innovation/creativity and teamwork play a key role ^[2]. Teachers are the main body of teaching, and their quality and ability directly impact the quality of teaching, so it is necessary to strengthen the training and development of teachers in conjunction with scientific research topics. Universities and colleges improve teachers' teaching levels and research ability by organizing teacher training, conducting teaching seminars, and international academic conferences, and setting up research funds for teachers.

Cultivating advanced specialized talents and promoting scientific and technological development are important functions of higher education ^[3]. Teaching ability and teaching quality improvement methods based on research projects have been widely researched and practiced both at home and abroad. However, Challenges exist for identifying clear learning goals and assessments for interdisciplinary education in engineering ^[4]. Therefore, it is important to draw on advanced scientific research results and development concepts to promote the development of educational reform. This paper will aim at improving the teaching capacity and quality of engineering education, and explore the dual promotion mechanism of scientific research and teaching. The article will focus on developing teachers' abilities and improving students' cultivation quality, exploring the professional collaborative education training mode under the background of research and teaching integration. The framework is shown in Figure 1, and the effectiveness of teaching capacity and quality improvement is presented.

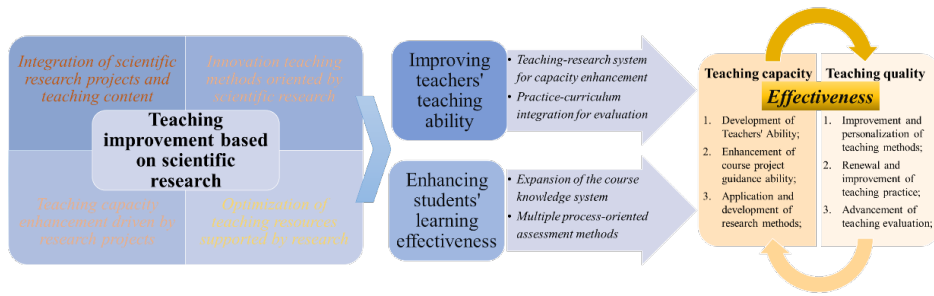


Figure 1: The framework of the study

2. Teaching improvement based on scientific research

Teaching performance relates to the number of students, degrees awarded, and the quality of the education provided, while research performance in academia typically refers to scientific advancements, predominantly published in academic journals [5]. Some research results have been achieved in the improvement of teaching ability based on scientific research projects, especially from the aspects of integration of scientific research projects and teaching content, innovation teaching methods oriented by scientific research, teaching capacity enhancement driven by research projects, and optimization of teaching resources supported by scientific research projects, which can realize the method of improving teaching ability and teaching quality based on scientific research projects to a certain extent.

2.1. Integration of scientific research projects and teaching content

Based on the iterative characteristics of technological updating, the content is updated based on the existing course materials, and the cutting-edge knowledge and technology of scientific research projects are introduced into the course to ensure that the course content is up-to-date and reflects the latest developments of the industry. At the same time combined with the actual cases in the scientific research projects, analyze the application of technology and problems, so that students can learn and master the theoretical knowledge in a real situation. It also encourages interdisciplinary cooperation in scientific research projects, integrating knowledge and technology from other fields to broaden students' horizons and knowledge.

2.2. Innovation teaching methods oriented by scientific research

Introducing project-based teaching in the teaching of specialized courses, especially guided by scientific research projects, allows students to learn the knowledge of processing technology while completing the project, and cultivates students' practical ability and innovative spirit. In teaching, students are encouraged to work together in groups to carry out research projects and improve their communication and teamwork skills through teamwork to solve problems. By utilizing the flipped classroom mode, students are allowed to pre-study the relevant information of the research project before class, and then conduct in-depth discussion and practical operations in class, to enhance students' learning initiative and participation.

2.3. Teaching capacity enhancement driven by research projects

Highlight the important roles of both *teaching* and research. Taking scientific research penetration in teaching as a basis, teachers' scientific research and teaching levels are enhanced through case lectures and practical exercises. The school establishes an incentive mechanism for scientific research courses, recognizes and rewards teachers who participate in scientific research project courses, stimulates teachers' enthusiasm for scientific research and teaching motivation, encourages teachers to participate in relevant training and seminars, strengthens exchanges and cooperation among teachers, and shares teaching experiences and insights from scientific research projects, to promote the common growth among teachers.

2.4. Optimization of teaching resources supported by research

Scientific research and teaching practice involve many resources, including theoretical knowledge,

modeling data, experimental equipment, etc. It is conducted by integrating scientific research resources and teaching, updating and improving the school's experimental equipment and facilities, enabling students to practice in an advanced experimental environment. At the same time, schools can further cooperate with enterprises to establish practice bases, provide students with more practice opportunities in the company, and enhance students' competitiveness in employment. Through strengthening school-enterprise cooperation and jointly carrying out scientific research projects and technological research and development, teaching capacity and quality improvement can be achieved.

3. New Methods improving teachers' teaching ability based on scientific research

As an essential way to develop the teaching ability of teachers, training has been emphasized by many colleges and universities [6]. Based on this, and combined with the problems encountered in teaching and research, this paper put forward new methods of improving teachers' professional practice ability with the dual promotion of scientific research and teaching.

3.1. Model of teacher capacity enhancement under the teaching-research system

The in-depth integration of scientific research and teaching includes course teaching, scientific research, and engineering application, in which the professional knowledge of the school is the foundation, scientific research is the enhancement of technological development, and the practical application of the enterprise unit is the goal. Therefore, the construction of the teaching-research system needs the collaboration of schools and enterprises.

The new model requires teachers to improve their academic level with the help of basic scientific research projects, and to fully integrate the development projects of enterprises to improve their practical experience; then, the new model can be integrated with enterprise training and engineers' seminars to enhance the dimension of university research. On the one hand, with the help of the Industry-University-Research program and off-campus practice bases, teachers "go out" and integrate into enterprises to enhance their capabilities; On the other hand, relying on scientific research projects and platforms, to introduce enterprise tutors "go into" and in-depth exchanges with colleges, to excavate and organize various engineering cases, forming a regular mechanism of teaching-scientific system development.

3.2. Evaluation of the integration of research practice and curriculum teaching

Evaluation should pay attention to the inextricable relationship between scientific research transformation and practical teaching, involving the development of research projects and implementing curriculum teaching. The foundation of scientific research and practical application are important parts of course teaching and should be fully integrated to achieve the purpose of education and teaching ability improvement.

In the evaluation of education and teaching ability, the practical guidance ability of scientific research projects is emphasized, and it plays an active role in the teaching of theoretical courses, practical course cases, and graduation design. Based on the requirements of the engineering major requirements, research is carried out in the aspects of "integrating engineering cases in theoretical courses" and "reinforcing theoretical foundations in practical courses", to explore the mutual promotion mechanism of engineering topics, cutting-edge research, and course teaching, and to provide support for the ultimate enhancement of education and teaching level. This will provide support for the ultimate improvement of teachers' education and teaching levels.

4. New methods enhancing students' learning effectiveness based on scientific research

Considering the requirements of technical university graduates (communicative readiness, creativity, positive relation to the profession, methods of technical and economic analysis, etc.) [7], and combined with the problems encountered by students in course learning, project research, hands-on practice, etc., this paper put forward new methods enhancing students' learning effectiveness with the improvement of modern teaching methods and process-oriented assessment mode.

4.1. Expansion of the course knowledge system incorporating research projects

Contemporary students are curious about new things, so flexible teaching methods can be applied in

the class to realize the expansion of the course knowledge system. Enhancement of the course can be realized through different ways, including interpretation of social news, breakthroughs in application technologies, and innovations in scientific research projects.

Increase students' participation in the course by combining discussion topics and research subjects, enrich classroom teaching sessions and teaching methods, and mobilize students' enthusiasm to participate in the class. In particular, it is necessary to deeply explore the new educational resources contained in scientific research projects, combine the teaching content with the technological development of the new era, strengthen the cutting-edge core content of the courses by exploring the integration of the teaching content with the scientific cases, and form a new syllabus and electronic courseware.

4.2. Process-oriented assessment methods based on scientific inquiry skills

The technological development needs the students and the engineers to have scientific inquiry skills, the course assessment system should consider the synthesis of various forms, note the penetration of the spirit of scientific exploration, and consider the process of classroom learning and the integration of research topics.

Process-oriented assessment methods can be used with classroom presentations and interactive reviews, to achieve a new process-oriented assessment mode based on research projects, so that the teaching connotation can focus on students' learning effectiveness. At the same time, students are encouraged to combine the course assessment papers, and course examination answers with research projects, reflecting the students' learning achievements from multiple perspectives, stimulating the students' interest in self-learning and self-improvement, and comprehensively improving the students' innovation ability and comprehensive quality.

5. Conclusions

The modern methods of engineering education involve contemporary teaching and learning practices using project and program-based learning, work-integrated learning, and multi-integrative learning approaches^[8]. This paper explores the ways to improve teaching capacity and quality in engineering education based on scientific research projects, the effect can be summarized as follows:

5.1. Effectiveness of teaching capacity improvement

1) Development of Teachers' Ability: By organizing various forms of scientific research lectures and teacher-student scientific research exchanges, teachers are allowed to make good pre-talks and lesson plans, and teachers' classroom infectiousness is strengthened based on the case studies of scientific research projects, so the students have a more in-depth understanding of knowledge and scientific research.

2) Enhancement of course project guidance ability: B By guiding the students to carry out the course design, experimental program, and graduation design projects, the teachers gave effective guidance to the students in terms of topic selection, literature research, research conduct, and report writing. Based on the experience of scientific research projects, it promotes the cultivation of students' independent learning ability.

3) Application and development of research methods: By strengthening the cross-fertilization of research methods, teachers can conduct teaching practice and research based on scientific research, expanding the breadth and depth of teaching. Incorporating the innovative and cutting-edge nature of the research project, the student's learning ability, research ability, and innovation abilities are effectively strengthened.

5.2. Effectiveness of teaching quality improvement

1) Improvement and personalization of teaching methods: Through the research on the subject, teachers were able to explore teaching methods suitable for different students, which not only stimulated students' interest and initiative in learning but also improved the effectiveness of teaching quality. At the same time, through the development of personalized learning plans, teachers help students improve in a targeted way and give full play to their strengths.

2) Renewal and improvement of teaching practice: The support and promotion of educational research have enabled teachers to better understand their students and the teaching environment, to adjust the curriculum of teaching practice. Incorporating elements of cross-disciplinary thinking, innovative and creative design, and artificial intelligence in scientific research provides strong support for updating and improving teaching practices.

3) Advancement of teaching evaluation: By establishing a teaching evaluation system based on the research project methodology, teachers can analyze relevant teaching data through classroom observation, student testing, and field research. Teachers better understand the nature of the problem, continue to promote problem-solving methods and strategies, and improve the quality of teaching in a progressive teaching process.

To summarize, the method of improving teaching ability and teaching quality based on research projects has achieved remarkable results. This is reflected in the improvement of teachers' teaching ability and the continuous improvement of teaching quality. In the future, the combination of scientific research and teaching should continue to be strengthened to promote the innovation and development of education.

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