

# Research on the Innovation of "Advanced Mathematics" Blended Teaching Based on Knowledge Graph in the Context of New Engineering



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**Abstract:** Based on the analysis of the relation between the knowledge of higher mathematics and the characteristics of the mixed teaching mode, this paper discusses the innovation of the mixed teaching mode of "higher mathematics" under the background of new engineering, and puts forward the innovation strategy of the mixed teaching mode of "higher mathematics" under the background of new engineering, including optimizing teaching resources, reforming teaching methods, innovating course modules and promoting interdisciplinary cooperation. The research finds that the innovation of "higher mathematics" mixed teaching mode based on knowledge graph is helpful to improve the teaching effect, stimulate students' thinking on mathematical problems, cultivate students' innovative thinking and mathematical modeling ability, and lay a solid foundation for the cultivation of new engineering talents.

**Keywords:** blended teaching; knowledge graph; advanced mathematics; new engineering

## Introduction:

In recent years, the state has implemented innovation-driven industrial development, adopted major strategies such as "Made in China 2025" and "Internet Plus", and promoted the vigorous development of the new economy in the form of new technologies, new forms of business, new models and new industries. It has put higher requirements on engineering talents and decided to carry out research and practice on new engineering. With the deepening of educational reform under the background of new engineering, higher education needs to adapt to the development requirements of The Times and cultivate talents with practical ability and innovative spirit. The reform of "new engineering" boils down to training new talents to meet the needs of national strategic development under the new situation (Zhong, 2017). Compared with traditional engineering, the biggest difference of "new talents" is that it puts forward higher requirements for students'

innovation ability and practical ability. Ma Yuena put forward that the essence of the new training mode is to change the training mode of new engineering talents (Ma & Wang, 2024). In this process, "advanced mathematics", as a basic course for engineering majors, is crucial to improving students' logical thinking, scientific calculation ability and practical problem-solving ability. However, from the perspective of the past teaching practice, there are still some problems in the current course teaching, such as scattered and fragmented teaching content and rigid and simple teaching mode. These deficiencies lead to the disconnection between the theoretical knowledge reserve of undergraduates and the improvement of their ability and quality, so the teaching effect in cultivating students' innovative ability and practical ability is not obvious. In order to tap students' learning potential and enhance their innovative consciousness, it is urgent to reform the teaching of higher mathematics. As an innovative teaching method combining online and offline teaching resources and the integration of academic knowledge, the hybrid teaching mode can effectively

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promote the interaction between teachers and students, enhance the teaching effect and enhance the innovation ability. This paper aims to explore the application value of mixed teaching mode in "higher mathematics" teaching by using knowledge graph and put forward innovative strategies, so as to provide theoretical reference and practical reference for "higher mathematics" teaching reform under the background of new engineering.

## 1. Theoretical Basis

### 1.1 Characteristics of blended teaching

In recent years, the research content of blended teaching mode is rich and diverse, including the theoretical framework research on clarifying the basic concepts, principles and theoretical basis of blended teaching; There are studies to evaluate the effectiveness of blended teaching for educators and scholars on how to improve the quality of teaching, meet the needs of students, and develop the ability to learn independently; In order to provide more comprehensive and efficient educational solutions to the education community, it is concerned about the research on the promotion of interdisciplinary cooperation and disciplinary integration of hybrid teaching models. With a high degree of flexibility, students can arrange their own learning time and progress, which breaks the time and space restrictions of traditional classroom teaching, and can be adjusted according to the curriculum and students' needs, making teaching more personalized. The teaching resources of the mixed teaching mode are diversified and rich. Teachers can use multimedia teaching resources and online teaching platforms to provide students with diversified learning materials, so as to make students' learning interest and participation more active. The mixed teaching mode is deeply interactive, and the combination of online and face-to-face teaching makes the interaction between teachers and students, and students and students become more in-depth. The blended teaching model is practical in solving practical problems, and students can apply what they have learned to real situations, and improve their practical

ability and innovation ability through projects, case studies and other means. To sum up, the unique characteristics of the hybrid teaching model include high flexibility, diverse richness, deep interaction, and practical problem-solving. These characteristics make the mixed teaching mode have a wide application prospect in the field of education, and provide a strong support for educational innovation. It is necessary to analyze the application significance of the mixed teaching mode combined with the teaching content of higher mathematics.

### 1.2 Knowledge graph and teaching

Knowledge mapping is a technique for graphically representing knowledge and its interrelationships (You et al., 2019). It can organize teaching resources such as textbooks, documents and cases in a knowledge context, which is convenient for teachers and students to use. At the same time, it can also classify, label and organize teaching resources, improve the utilization rate of resources and teaching effect, and improve the integration efficiency of teaching resources. It can help teachers sort out the course knowledge context, form teaching ideas, and improve the quality of teaching design. Through it, teachers can sort out the teaching ideas, concretize the abstract knowledge points, and form a visual knowledge structure, so as to help students better understand the course content. Knowledge graph By analyzing students' learning history, interests and abilities, the system can recommend suitable learning resources and paths according to students' needs and characteristics, and support personalized learning path design. Teachers can use knowledge graph to explore new teaching modes such as project-based teaching, case teaching, problem-oriented learning, "5E" teaching mode, split class, "CDIO" teaching mode, etc., so as to improve the interaction and effectiveness of teaching (Singh, 2003). For example, teachers can design problem-oriented learning activities, allowing students to solve practical problems by exploring nodes and connections in the knowledge graph, improving students' participation and problem-solving ability, and promoting innovation in

teaching methods.

## **2. The Application Significance of the Hybrid Teaching Model of "Advanced Mathematics"**

### **2.1 Improving the quality of classroom teaching**

In the mixed teaching mode, make full use of Internet teaching resources to broaden students' horizons and learning content, stimulate students' learning interest and motivation; Make use of online teaching platform to understand students' learning progress and needs, and adjust teaching strategies in time; To stimulate students' learning enthusiasm through the combination of online interaction and face-to-face discussion; And emphasizing practicality through projects, case studies and problem solving to encourage students to apply what they have learned to practical situations and improve students' hands-on and problem-solving skills.

### **2.2 Meeting students' learning needs**

In the mixed teaching mode, rich learning resources can encourage students to choose appropriate learning materials according to their own interests and needs, and use these resources to deeply understand important concepts, principles and applications in higher mathematics, and improve their academic ability. The online teaching part enables students to arrange their learning progress and adjust their learning style according to their own learning plans, abilities and needs, which helps students better balance the needs of study, life and interests. The learning data collected on the online teaching platform can provide students with personalized tutoring and support, encourage students to actively participate in learning and develop communication skills both inside and outside the classroom.

### **2.3 Cultivate students' independent learning**

The blended teaching mode encourages students to actively participate in learning outside the classroom, arrange their own time and progress, and cultivate their ability to explore and solve problems independently, which helps to cultivate students' time management and self-regulation ability, and improve learning efficiency. Through independent learning,

students can exercise their ability of information retrieval, analysis and integration, and cultivate their ability to solve problems independently.

### **2.4 Optimize the classroom teaching environment**

By introducing a variety of teaching methods and tools, such as videos, charts, interactive question banks, etc., the mixed teaching mode enriches the classroom teaching content and makes the teaching more interesting and challenging. This diversified teaching environment helps to mobilize students' interest in learning, stimulate their enthusiasm and creativity.

## **3. Innovative Strategies of Mixed Teaching Mode of "Advanced Mathematics" in the New Engineering Background**

### **3.1 Optimize the knowledge system and consolidate the theoretical foundation**

Under the background of new engineering, from the perspective of optimizing students' knowledge structure and promoting the combination of basic knowledge and professional growth, optimizing the teaching content of the mixed teaching mode of "higher Mathematics" is an important link to improve the teaching quality. For example, in the "core curriculum" plan, American universities usually design diversified teaching methods to promote various learning methods, form a learning atmosphere dominated by independent inquiry and cooperation and communication, and promote the accumulation of multidisciplinary basic knowledge and the formation of students' innovative thinking (Lin, 2000). Many undergraduate colleges and universities pay attention to keeping pace with The Times in the curriculum, pay attention to the combination of teaching content and reality, and constantly update and develop the course content to ensure that students can have access to the latest knowledge, ideas and thoughts. From this we can see that solid basic knowledge is the key to the top innovative talents of engineering majors in an invincible position in the social demand market. Inspired by the design ideas of other undergraduate basic courses, the teaching reform of higher

mathematics under the background of new engineering should first start with the knowledge system of the course and work hard to consolidate the theoretical foundation. It is embodied in: the teaching content of higher mathematics is divided into two main bodies and three modules. Taking "unary function calculus" and "multivariate function calculus" as the two main bodies, the three modules include: function limit and continuity, vector algebra and space analytic geometry, infinite series and differential equations, in which unary function limit and continuity are the basis of the two main bodies, vector algebra and space analytic geometry are the bridge connecting the two main bodies. Differential equations and infinite series are the extension and application of the two main bodies. Secondly, according to the status and role of different knowledge points in the whole knowledge system and specialized courses under the background of new engineering, the course knowledge points are sorted and integrated, and summarized into two categories: basic knowledge points and applied knowledge points, so as to make the knowledge structure clearly layered and contextual Clear and definite. This work has laid a foundation for the reform of teaching mode and the innovation of teaching methods of basic theoretical courses. Among them, the most critical is to combine the development direction of engineering major, broaden the source of learning resources, ensure the richness, diversity and application of resources, so as to help students have a deeper understanding of abstract mathematical concepts and principles, so as to improve the learning effect.

### 3.2 Reform the teaching method

Reforming the teaching method of "higher Mathematics" is an important way to improve the effect of mixed teaching mode. Teachers can improve students' ability to solve practical problems by introducing problem-based learning methods and combining high mathematical knowledge points with practical engineering problems. In classroom teaching, teachers can organize interactive sessions such as discussion, case analysis and group cooperation to encourage students to think, explore

and solve problems and improve teaching results. Teachers should encourage students to actively participate in discipline competitions or extracurricular practice activities, and apply the advanced mathematical knowledge they have learned to practical problems, so as to improve students' practical operation ability and innovation ability (Wan, 2019). Based on the special role of higher mathematics curriculum in the training of new engineering talents, this paper firstly combs and integrates the existing knowledge system of higher mathematics curriculum based on the characteristic law of talent growth, and explores teaching methods and means in line with the cognitive law of engineering students on this basis, so as to stimulate students' thirst for knowledge. Such as "5E" teaching mode (i.e., Engagement, Exploration, Explanation, Elaboration, Evaluation, short for 5E), "CDIO" teaching and learning mode (i.e. Construction Conceive, Design, Implement, Operate, referred to as CDIO), sub-class, discussion-type teaching, experiment-driven teaching, industry-university-research cooperative teaching and other new teaching models. According to many years of teaching practice experience, under the framework of the above knowledge system, a teaching method that meets the needs of students' ability development, with high flexibility and strong operability is designed. In the teaching process of basic knowledge points, the "node-connection" teaching method is designed for the knowledge points with strong abstract concept and nature. For the knowledge points with strong logic such as lemma and theorem, the "reproducibility" teaching method is designed; In the teaching process of applied knowledge points, the discussion-based teaching method and case teaching method are introduced into the classroom, and students are guided to complete the teaching content according to the implementation steps of "design-practice-feedback-perfection". At the same time, the above teaching methods are combined with the traditional heuristic, induction, discussion and problem-oriented teaching methods, so as to make

the whole teaching more effective.

### 3.3 Innovative curriculum module design

From the perspective of the integration of theoretical teaching and practical teaching, in order to better implement the mixed teaching mode of "higher mathematics" under the background of new engineering and better play the role of this course in the cultivation of students' ability, it is necessary to strengthen the training of practical ability while implanting theoretical knowledge (Zhang et al., 2016). The specific design is as follows. First, the teaching hours of theoretical teaching and practical teaching in the course are reasonably allocated. Moreover, in the design of practical teaching content, starting from the characteristics of knowledge points and combining the characteristics of different disciplines, the professional needs are oriented to build a supporting professional application case base. The second is to select the teaching application cases matching the subject specialty from the case database in the teaching unit, so that the mixed teaching mode can be used to complete the teaching task. The design of the teaching content and teaching mode of this practical course can lay a good foundation for the subsequent study of professional courses, so as to realize the effective connection between basic theory courses and professional courses. Take Higher Mathematics course B as an example, which is a provincial-level excellent resource-sharing course with abundant digital supporting teaching resources. The current advanced mathematics course consists of two modules: basic theory course and practice course. The total class hours of the course are 120, of which 90% are set as theory course and 10% as practice course. In order to promote the teaching reform of practice course, according to the existing online and offline teaching resources, the teaching content of practice course is re-set and optimized according to the knowledge point structure of the course. Secondly, by revealing the background of frontier knowledge points and different characteristics of disciplines, in-depth research on the connection point between knowledge points and disciplines, and build a matching professional application case base. And

improve the supporting teaching resources on the basis of the existing teaching resources. Finally, by optimizing the teaching content and innovating the teaching mode, it can strengthen the students' awareness of independent learning according to the teaching implementation strategy of "collecting data and refining problems - centralized guidance to solve problems - communication and evaluation to expand problems" and provide a platform and guarantee for the students' professional development. In course evaluation, we should pay attention to students' learning attitude, participation degree and ability to solve time problems, and carry out process evaluation on students through group tasks, project assignments, mathematical contest in modeling and other forms. Although the practical class hours are less, this module is a bridge between students' theoretical knowledge reserve and application ability cultivation, and a starting point for students' practical ability and innovation consciousness cultivation. It not only plays an important role in realizing the overall teaching goal of higher mathematics curriculum, but also plays an indispensable role in the cultivation of innovation ability. Therefore, it is imperative to strengthen the construction of teaching resources of higher mathematics practice course, reform the teaching mode and explore the matching teaching methods.

### 3.4 Promote team building and interdisciplinary cooperation

In order to continuously promote the reform of higher mathematics teaching, teachers should not only keep pace with The Times, enrich the frontier knowledge reserve, but also update the teaching concept in time and broaden their horizons (Cao & Yin, 2016). However, at present, the teachers of higher mathematics are generally weak, with structural deviation and insufficient reserve of high-quality talents. In view of these problems, it is necessary to strengthen the education and guidance of young teachers, formulate feasible growth plans from the aspects of knowledge reserve, teaching experience, ability and quality, and encourage teachers to carry out interdisciplinary academic research. Actively participate in interdisciplinary research projects, improve their own theoretical application level and enrich practical teaching cases in the research; Accelerate the introduction of



high-end talents, optimize the structure of the teaching staff, and quickly reverse the phenomenon of weak ability and quality of young teachers through the training and reward mechanism. Through interdisciplinary cooperation, mathematics knowledge can be combined with engineering knowledge to forge a higher mathematics teaching team with reasonable structure, strong dedication, excellent professional quality and rich knowledge reserve. The teachers of the higher Mathematics curriculum Group promote teaching by competition, encourage teachers to actively participate in teaching competitions and win a number of provincial teaching competitions. During the teaching process, they maintain close communication with teachers of other disciplines, and jointly design teaching tasks and projects with practical application value. In the aspect of guiding the students' competition, the students' professional background is comprehensively considered to optimize the competitive team members, so that the engineering students can achieve excellent results in the mathematics competition. The members of the course team were awarded as excellent instructors in the National Mathematical Contest in Modeling for College students, and many of them were awarded as excellent instructors in the National Mathematical Contest for College Students.

### Conclusion

The teaching reform and practice of higher mathematics courses have promoted the accumulation of students' basic knowledge and the continuous improvement of mathematical literacy, and made students' innovative consciousness and application ability have been comprehensively exercised. Aiming at promoting the teaching reform of higher mathematics, this paper analyzes the problems in the middle school students' unclear knowledge system, inadequate use of curriculum resources, teachers' emphasis on theory rather than practice, and takes the reform of information-based teaching mode as a guide and the cultivation of innovative talents as a guide. By optimizing the curriculum knowledge system, this paper fully reflects the foundation, application and development of the curriculum. It is helpful to explore the new content and new ideas of higher mathematics teaching under the new situation, and stimulate students' interest and enthusiasm in learning mathematics. In the follow-up study, we will combine professional knowledge and software programming ability, and encourage students to actively participate in various high-level skill competitions such as the National Mathematical

Modeling Competition for College Students, Mathematical Competition for College Students, and Program Design Competition for College Students, so that students can apply what they have learned and constantly improve their innovation ability and engineering practice ability.

### Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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