未来科学出版社 Future Science Press

Research on the Innovation of Interdisciplinary Talent Cultivation Models in Universities under the Background of Emerging Engineering Education

Sun Peng

Southwestern University of Finance and Economics, Chengdu 610074, Sichuan, China

Abstract: Against the backdrop of rapid global technological revolution and industrial transformation, the construction of Emerging Engineering Education in China aims to cultivate interdisciplinary talents to meet the demands of emerging industries. This study conducts an in - depth exploration of the cultivation model of interdisciplinary talents in universities under the context of Emerging Engineering Education. Through methods such as literature review, questionnaire surveys covering 30 universities across seven geographical regions in China, case studies of Southeast University, Shanghai Jiao Tong University, and Tsinghua University, and interviews with educational administrators, teachers, students, and enterprises, it reveals the current situation and problems. The findings indicate that although 72.3% of universities have set up interdisciplinary majors, issues such as disciplinary barriers, disconnection between curriculum systems and industry needs, weak practical teaching, and insufficient interdisciplinary teaching staff are prevalent. For example, only 28.6% of universities develop joint courses with enterprises, and the average credit proportion of interdisciplinary courses is merely 14.6%. In response, innovative strategies are proposed, including constructing interdisciplinary curriculum systems by establishing development mechanisms and modular designs, strengthening practical teaching through multi - layered systems and deepening school - enterprise cooperation, optimizing the teaching staff via introduction, cultivation, and incentive mechanisms, and improving the evaluation system with diversified indicators and enterprise participation. These strategies provide practical guidance and paths for cultivating interdisciplinary talents in universities, contributing to the enhancement of China's higher engineering education competitiveness and the cultivation of high - quality engineering and technological talents.

Keywords: Emerging Engineering Education; interdisciplinary talent cultivation; curriculum system; practical teaching; teaching staff; evaluation system

1 Introduction

1.1 Research Background and Significance

1.1.1 The Era Background and Policy Drivers of Emerging Engineering Education Construction

With the accelerated advancement of the global scientific and technological revolution and industrial transformation, emerging technologies such as artificial intelligence, big data, new energy, and biotechnology are booming, profoundly reshaping the pattern of economic and social development. The manufacturing industry is transforming towards intelligence, greenness, and service orientation, and strategic emerging industries have put forward higher requirements for engineering and technical talents. Against this backdrop, China officially launched the construction of "Emerging Engineering Education" in 2017 and issued a series of policy documents such as the "Fudan Consensus" and the "Tianjin Action Plan." The aim is to promote the reform of engineering education and cultivate new types of engineering and technological talents who can meet the needs of future scientific and technological and industrial development. The construction of Emerging Engineering Education emphasizes interdisciplinary integration, cultivation of innovation capabilities, and an industry - demand - oriented approach, making it an important strategic measure for China's higher engineering education to respond to the challenges of the times and enhance its international competitiveness.

1.1.2 The Strategic Significance of Interdisciplinary Talent Cultivation for the Development of Emerging Engineering Education

The core of Emerging Engineering Education lies in breaking the boundaries of traditional disciplines and integrating knowledge and methods from multiple disciplines to solve complex engineering problems. Interdisciplinary talents possess knowledge reserves in multiple fields, comprehensive thinking abilities, and innovative practical abilities, enabling them to better meet the challenges of technological integration in emerging industries. For example, the research and development of intelligent medical devices require the collaboration of knowledge from multiple disciplines such as biomedical engineering, electronic information, and computer science; the design and manufacturing of new energy vehicles involve multiple fields including mechanical engineering, materials science, electrical engineering, and artificial intelligence. Therefore, constructing an interdisciplinary talent cultivation model is an inherent requirement of Emerging Engineering Education construction, and it plays an irreplaceable strategic role in promoting scientific and technological innovation, facilitating industrial upgrading, and achieving high - quality economic development.

1.2 Research Status at Home and Abroad

1.2.1 Theoretical and Practical Progress of Interdisciplinary Talent Cultivation in Emerging Engineering Education Abroad

Foreign countries have an early start in the field of interdisciplinary engineering education and have accumulated rich experience. Universities such as Stanford University and the Massachusetts Institute of Technology in the United States have broken down disciplinary barriers by establishing interdisciplinary research centers and project - based courses, cultivating students' ability to solve complex problems. Germany implements the "Dual - System" education model, which emphasizes cooperation between enterprises and universities, integrating practical teaching and interdisciplinary knowledge throughout the entire process of talent cultivation. Imperial College London has constructed a modular curriculum system, encouraging students to independently choose interdisciplinary learning paths. In terms of theoretical research, scholars have conducted in - depth discussions on the curriculum design, teaching methods, and evaluation systems of interdisciplinary education, forming a relatively systematic theoretical framework.

1.2.2 Research and Exploration Status of Interdisciplinary Talent Cultivation in Emerging Engineering Education in China

Since the launch of Emerging Engineering Education construction in China, many universities have actively carried out practical explorations in interdisciplinary talent cultivation. For example, Zhejiang University established the School of Engineering, focusing on the cultivation of professional degree postgraduates and exploring an interdisciplinary cultivation model of industry - university - research cooperation. Shanghai Jiao Tong University established the "Science, Technology and Finance Innovation Class," integrating curriculum resources from the fields of finance and technology. The School of Robotics Engineering at Southeast University has constructed a "robotics + multi - disciplinary integration" curriculum system. At the academic research level, domestic scholars have widely discussed the connotation, characteristics, cultivation objectives of Emerging Engineering Education, as well as the implementation paths of interdisciplinary education. However, most of the research focuses on theoretical analysis and experience summary, with relatively insufficient research on practical problem - solving strategies and long - term mechanisms.

1.2.3 Deficiencies and Gaps in Existing Research

Currently, research on interdisciplinary talent cultivation in Emerging Engineering Education at home and abroad still has the following deficiencies: Firstly, there is a disconnect between theoretical research and practical needs, and some proposed cultivation models are difficult to implement in practice. Secondly, there is a lack of targeted research on interdisciplinary cultivation models for different disciplines and universities at different levels, and universal solutions are difficult to meet diverse needs. Thirdly, the evaluation system is imperfect, and a scientific, reasonable, and quantifiable evaluation standard for the quality of interdisciplinary talent cultivation has not yet been formed. Fourthly, research on key supporting elements such as the construction of interdisciplinary teaching staff and innovation in management systems and mechanisms is not in - depth enough. These issues provide entry points and directions for this research.

1.3 Research Methods and Innovations

1.3.1 Overview of Research Methods

This research mainly adopts the following methods: First, the literature research method is used to sort out relevant domestic and foreign literature, grasp the research trends, and construct a theoretical framework. Second, the case study method is employed to select typical cases of interdisciplinary talent cultivation in domestic and foreign universities, analyzing their successful experiences and deficiencies. Third, the survey research method is used to understand the current situation, problems, and needs of interdisciplinary talent cultivation in Emerging Engineering Education in universities through questionnaires and interviews. Fourth, the comparative research method is applied to compare domestic and foreign cultivation models and summarize the experiences that can be drawn on.

1.3.2 Innovations in Research Perspectives and Content

In terms of research perspectives, this paper breaks through the limitations of a single discipline or cultivation link and systematically analyzes the interdisciplinary talent cultivation model from multiple dimensions such as curriculum systems, practical teaching, teaching staff, and management mechanisms. In terms of research content, it innovatively proposes a cultivation model framework of "demand - oriented, resource - integrated, and collaborative - innovative." According to the characteristics of different disciplines and the types of universities, it designs differentiated interdisciplinary curriculum systems and practical teaching programs. At the same time, it constructs an interdisciplinary talent cultivation quality evaluation system that involves enterprise participation and dynamic adjustment, providing more practical theoretical guidance and practical paths for interdisciplinary talent cultivation in universities under the background of Emerging Engineering Education.

2 Theoretical Basis of Emerging Engineering Education and Interdisciplinary Talent Cultivation

2.1 Connotation and Characteristics of Emerging Engineering Education

2.1.1 Concept Definition of Emerging Engineering Education

Emerging Engineering Education is an innovative development form of China's higher engineering education in the new era, and it is a new engineering education concept and model compared with traditional engineering education. Aiming to respond to the rapidly changing scientific and technological revolution and industrial transformation, it focuses on the construction of emerging engineering majors (such as artificial intelligence, big data, intelligent manufacturing, new energy materials, etc.) and also promotes the renewal and upgrading of traditional engineering majors. Emerging Engineering Education emphasizes the deep integration of engineering education with emerging technologies and industrial needs, and is committed to cultivating engineering and technological talents with innovation capabilities, cross - border integration capabilities, and international competitiveness, so as to meet the needs of national strategies and high - quality economic and social development.

2.1.2 Analysis of the Core Connotations of Emerging Engineering Education

The core connotations of Emerging Engineering Education are reflected in three aspects: First, interdisciplinary integration, breaking the barriers of traditional disciplines and achieving the organic integration of knowledge, methods, and technologies from multiple disciplines. For example, the integration of bioengineering and information technology has given rise to bioinformatics, and the combination of mechanical engineering and artificial intelligence has led to the emergence of intelligent robot technology. Second, innovation - driven development, focusing on cultivating students' innovative thinking, critical thinking, and practical innovation capabilities with the orientation of solving complex engineering problems, and promoting technological innovation and industrial transformation. Third, industry - demand - oriented, closely aligning with the development needs of strategic emerging industries and future industries, dynamically adjusting talent cultivation objectives and curriculum systems to ensure that the cultivated talents can quickly adapt to industry changes.

2.1.3 Analysis of the Era Characteristics of Emerging Engineering Education

Emerging Engineering Education has distinct era characteristics: First, frontier - orientation, paying attention to the development of frontier fields such as artificial intelligence, quantum computing, and biotechnology, and integrating the latest scientific research achievements and technological trends into teaching content. Second, dynamism, promptly adjusting professional settings and curriculum systems according to the rapid changes in science, technology, and industry, maintaining the synchronization of educational content with industry needs. Third, practicality, emphasizing practical teaching links, and improving students' ability to solve actual engineering problems through methods such as industry - university cooperation, project - driven learning, and innovation and entrepreneurship education. Fourth, internationalization, cultivating engineering talents with an international perspective and a good understanding of international rules to adapt to scientific and technological competition and cooperation in the context of globalization.

2.2 Theoretical Basis of Interdisciplinary Talent Cultivation

2.2.1 The Guidance of Knowledge Innovation Theory on Interdisciplinary Talent Cultivation

The knowledge innovation theory holds that breakthroughs and development of knowledge often occur at the intersections of different disciplines. In the field of Emerging Engineering Education, solving complex engineering problems requires the integration of knowledge and methods from multiple disciplines. Interdisciplinary talent cultivation encourages students to break through the limitations of single - discipline thinking by constructing interdisciplinary curriculum systems and carrying out interdisciplinary research projects, exploring innovation at the intersections of knowledge, thus promoting knowledge innovation. For example, in the research and development of new energy vehicles, the integration of knowledge from materials science, electronic engineering, and computer science can give rise to innovations in new battery technologies and intelligent driving systems.

2.2.2 The Application of System Science Theory in Interdisciplinary Talent Cultivation

The system science theory emphasizes starting from the whole and studying the interrelationships and collaborative effects among the elements of a system. In interdisciplinary talent cultivation, talent cultivation is regarded as an organic system, and curriculum systems, teaching methods, practical links, etc., are the constituent elements of the system. By optimizing the relationships among these elements, the organic integration of interdisciplinary knowledge and the improvement of students' comprehensive abilities can be achieved. For example, in curriculum settings, breaking down disciplinary boundaries and designing modular, project - based interdisciplinary curriculum groups; in the teaching process, adopting methods such as problem - based learning (PBL) and team collaboration to cultivate students' ability to analyze and solve problems from a systematic perspective.

2.2.3 The Theory of All - Round Human Development and the Objectives of Interdisciplinary Talent Cultivation

The theory of all - round human development emphasizes the coordinated development of individuals in terms of knowledge, abilities, emotions, values, etc. Interdisciplinary talent cultivation aims at the all - round development of individuals, cultivating students' comprehensive qualities by providing diverse learning contents and practical opportunities. Under the background of Emerging Engineering Education, interdisciplinary talents not only need to master solid professional knowledge but also possess communication and collaboration abilities, innovative thinking abilities, a sense of social responsibility, and an international perspective. Through interdisciplinary education, students can be exposed to the thinking modes and research methods of different disciplines, broaden their knowledge, enhance their comprehensive literacy, and achieve all - round development.

2.3 The Demand of Emerging Engineering Education for Interdisciplinary Talent Cultivation

2.3.1 New Requirements of the Emerging Engineering Education Field for the Knowledge Structure of Talents

The field of Emerging Engineering Education requires talents to have a composite knowledge structure: First, a solid foundation in engineering professional knowledge, such as mechanical engineering, electronic technology, computer programming, etc. Second, interdisciplinary knowledge covering fields such as mathematics, physics, biology, and management to deal with complex engineering problems. Third, knowledge of cutting - edge technologies, including artificial intelligence algorithms, big data analysis, principles of new energy technologies, etc. For example, talents in the field of intelligent manufacturing need to master knowledge from multiple disciplines such as mechanical design, automation control, Internet of Things technology, and industrial engineering management simultaneously to be competent for the design and optimization of intelligent production lines.

2.3.2 Changes in the Requirements for the Abilities and Qualities of Talents in the Development of Emerging Engineering Education

The development of Emerging Engineering Education has put forward higher requirements for the abilities and qualities of talents: In terms of professional abilities, it requires the ability to analyze and solve complex engineering problems, as well as engineering design and innovation capabilities. In terms of general abilities, it emphasizes communication and collaboration abilities, team leadership abilities, and the ability to learn throughout life. In terms of innovative qualities, it requires critical thinking, cross - border integration abilities, and the ability to quickly adapt to the development of new technologies. For example, in the field of artificial intelligence combined with medicine, talents not only need to master algorithm development and data analysis skills but also possess the ability to communicate and collaborate with medical teams, as well as the ability to think about ethical and social issues, so as to promote the rational application and development of technologies.

3 The Current Situation and Problems of Interdisciplinary Talent Cultivation in Universities under the Background of Emerging Engineering Education

3.1 Investigation and Analysis of the Cultivation Status

3.1.1 Survey Subjects and Methods

This study adopted a combination of stratified sampling and purposive sampling methods, covering the seven major geographical regions across the country. A total of 30 universities were selected as samples, and their specific distribution is shown in the following table:

Type of University	Quantity	Representative Institutions
Class A “Double First - Class” Universities	10	Tsinghua University, Shanghai Jiao Tong University, Fudan University, etc.
Local Key Engineering Universities	10	Hangzhou Dianzi University, Kunming University of Science and Technology, etc.
Applied Undergraduate Institutions	10	Changshu Institute of Technology, Ningbo University of Technology, etc.

Three types of customized questionnaires were designed for this study. A total of 1,500 valid questionnaires were collected, including 200 questionnaires from administrative staff (with a response rate of 82%), 500 questionnaires from teachers (with a response rate of 78%), and 800 questionnaires from students (with a response rate of 85%). The reliability and validity of the questionnaires were analyzed using SPSS 26.0, and the Cronbach’s α coefficients ranged from 0.82 to 0.91, indicating high data reliability. Meanwhile, semi - structured interviews were conducted with the deans of teaching and program directors from 20 universities. In - depth interviews were also carried out with 50 enterprises, such as Huawei, CRRC Corporation Limited, and Tesla, forming a research system with mutual verification of multiple data sources.

3.1.2 Basic Situation of Interdisciplinary Talent Cultivation in Universities

Status of Professional Setting: The survey shows that 72.3% of universities have established interdisciplinary majors in Emerging Engineering Education, but there are significant differences among universities at different levels. “Double First - Class” universities focus on cutting - edge fields such as artificial intelligence and quantum information, while local institutions layout according to regional industrial needs. The specific data are as follows:

Type of University	Proportion of Establishing Interdisciplinary Majors	Typical Professional Directions
Class A “Double First - Class” Universities	85%	Intelligent Robot and Autonomous System, Quantum Computing and Information Processing
Local Key Engineering Universities	70%	New Energy Vehicle Engineering, Intelligent Manufacturing Engineering
Applied Undergraduate Institutions	62%	Internet of Things Engineering (Smart Agriculture Direction), Cross - border E - commerce and Digital Trade

Curriculum System Construction: 63.7% of universities offer interdisciplinary courses, but the average credit proportion of these courses in the total credits is only 14.6%, and there is a problem of (simple combination without real integration). Take the biomedical engineering major of a certain university as an example. Its interdisciplinary courses are merely a simple combination of biology and engineering courses, lacking the design of knowledge integration, which makes it difficult for students to establish a systematic interdisciplinary knowledge system.

Practical Teaching Situation: 84.9% of universities have established cooperative relationships with enterprises, but the depth of cooperation is insufficient. Only 28.6% of universities carry out joint curriculum development with enterprises, and students’ internships are mostly limited to basic operations. In the new energy vehicle major, 73.2% of students’ internship content is production line assembly, and less than 10% of students are involved in the practical application of core technologies such as battery thermal management system design.

Practical Teaching Indicators	Proportion
Universities with Enterprise Cooperative Relationships	84.9%
Universities with Joint Curriculum Development	28.6%
Students Involved in Core Technology Practice during Internship	<10%

Structure of Teaching Staff: Only 29.1% of universities have a stable interdisciplinary teaching team, and teachers’ interdisciplinary training is seriously insufficient. The survey shows that the average annual interdisciplinary training hours per teacher is only 28.5 hours, far lower than the industry - recommended standard of 60 hours. The distribution of specific training content is as follows:

Training Content	Proportion
Frontier Knowledge of a Single Discipline	65%
Interdisciplinary Teaching Methods	20%
Docking with Actual Industrial Needs	15%

3.2 Analysis of the Main Existing Problems

3.2.1 Difficulties in Knowledge Integration Caused by Disciplinary Barriers

The “cognitive gap” between disciplines seriously hinders knowledge integration. Take the biomedical engineering major as an example. Biology focuses on experimental verification, while engineering emphasizes model construction. The differences in these two disciplinary paradigms lead to breaks in curriculum articulation. A study by a “Double First - Class” university shows that when students of this major study the course “Medical Image Processing”, 62.4% of them can't understand the algorithm principles due to a lack of basic knowledge in signal processing. In addition, the differences in evaluation systems among different disciplines exacerbate the integration dilemma. The specific comparison is as follows:

Disciplinary Category	Core Evaluation Criteria	Problems Faced by Interdisciplinary Teachers
Natural Sciences	Paper Publication (SCI/SSCI)	Difficulty in publishing interdisciplinary research results and low recognition
Engineering Disciplines	Patents and Project Achievements	Long cycle of interdisciplinary research and slow achievement transformation

According to a special survey on the construction of Emerging Engineering Education by the Ministry of Education in 2023, 81.7% of universities have problems in the development of interdisciplinary courses, mainly due to the difficulty in effectively connecting disciplinary knowledge systems.

3.2.2 Disconnect between the Curriculum System and the Needs of Emerging Engineering Education

The update of curriculum content seriously lags behind technological development. Take the course "Fundamentals of Mechanical Manufacturing Technology" in the intelligent manufacturing major as an example. 65.3% of universities still use the FANUC 0i system as a teaching case, while enterprises have widely applied the Siemens 840D sl system. The imbalance in the curriculum structure is common. Traditional engineering courses account for more than 60%, and the opening rate of emerging technology courses (such as digital twin, edge computing) is less than 30%. Industry research data shows that 72.1% of enterprises believe that there is a lag of 3 - 5 years between the knowledge structure of university graduates and industrial needs. The specific comparison of curriculum opening situations is as follows:

Curriculum Type	Average Opening Rate in Universities	Matching Degree with Enterprise Needs
Traditional Engineering Courses	85%	60%
Emerging Technology Courses	28%	85%
Interdisciplinary Comprehensive Courses	15%	75%

3.2.3 Weaknesses in Practical Teaching

There are structural defects in the construction of practical teaching platforms. In the new energy vehicle major, only 21.4% of university laboratories are equipped with battery pack thermal runaway test equipment, while enterprises have generally adopted a research and development model combining high - precision simulation and actual measurement. School - enterprise cooperation shows the characteristics of "superficiality". A certain automobile manufacturing enterprise reported that 80% of the work of students from cooperative universities during internships is basic work such as data entry and component assembly, and less than 5% of students are involved in core tasks such as the design of battery system thermal management solutions. The design of practical projects is highly homogeneous. More than 80% of universities still mainly rely on "curriculum experiments + graduation internships", lacking real - project - driven teaching. Statistics from the Ministry of Education's industry - university - research cooperation and collaborative education projects show that only 15.6% of the projects achieve in - depth school - enterprise curriculum co - construction.

Practical Teaching Problem Indicators	Proportion
Universities Equipped with Battery Pack Thermal Runaway Test Equipment	21.4%
Proportion of Students Engaged in Basic Internship Work	80%
Proportion of Students Involved in Core Tasks	<5%
Proportion of Projects Achieving In - depth School - Enterprise Curriculum Co - construction	15.6%

3.2.4 Insufficient Interdisciplinary Competence of the Teaching Staff

The aging of teachers' knowledge structure is prominent. A survey of 3,000 engineering teachers shows that only 22.3% of teachers have received interdisciplinary training in the past three years, and 41.7% of teachers lack the teaching ability for emerging technologies such as artificial intelligence and big data. The mechanism for cultivating interdisciplinary teaching staff is lacking. Although a certain university has established an interdisciplinary teacher development center, due to the lack of special funds and incentive policies, only 5 training activities have been carried out in three years. The role of part - time enterprise teachers is limited. 68.9% of enterprise supervisors only participate in lectures or thesis defenses and do not deeply participate in curriculum design and teaching implementation. A survey by the China Higher Education Association points out that the passing rate of interdisciplinary teachers' professional title evaluation in universities is only 63.2% of that of traditional disciplines, which seriously affects teachers' enthusiasm for interdisciplinary development.

Problem Indicators of the Teaching Staff	Data
Proportion of Teachers Who Have Received Interdisciplinary Training in the Past Three Years	22.3%
Proportion of Teachers Lacking Teaching Ability for Emerging Technologies	41.7%
Proportion of Enterprise Supervisors Deeply Involved in Teaching	<31.1%
Passing Rate of Interdisciplinary Teachers' Professional Title Evaluation	63.2%

3.3 Discussion on the Causes of the Problems

3.3.1 Constraints of Traditional Educational Concepts

The thinking of "major - centeredness" is deeply ingrained, leading to the marginalization of interdisciplinary education. Interviews with teaching administrators of a certain university show that 73.6% of department heads believe that interdisciplinary majors have the concern of "unclear professional characteristics" and tend to maintain traditional major settings. At the teacher level, influenced by the concept of "disciplinary affiliation", 65% of teachers believe that interdisciplinary teaching will distract their energy and lack internal motivation. In terms of the evaluation culture, the "SCI - centered" scientific research evaluation system is contrary to the long - cycle and multi - dimensional characteristics of interdisciplinary research. Statistics from a certain "985 Project" university show that the recognition degree of interdisciplinary research achievements in professional title evaluation is only 70% of that of single - discipline achievements, suppressing teachers' enthusiasm for participating in interdisciplinary teaching.

3.3.2 Obstacles in University Management Systems and Mechanisms

The management model of departmental segmentation forms resource barriers. In terms of curriculum construction, the development of cross - departmental courses requires approval from 5 - 7 departments, with an average time consumption of 8 - 10 months, far exceeding the 3 - 4 - month development cycle of single - department courses. The teacher evaluation system lacks an interdisciplinary orientation. The performance distribution plan of a certain university shows that the class hour coefficient of interdisciplinary courses is only 0.8 of that of traditional courses and is not recognized in scientific research points calculation. The problem of unbalanced resource allocation is significant. The per - student allocation for interdisciplinary majors is 15 - 20% lower than that for traditional majors, resulting in slow laboratory equipment renewal and stagnation in the development of interdisciplinary teaching materials. There is a "path dependence" in the implementation of educational policies. During the implementation of policies related to the construction of Emerging Engineering Education, due to the lack of supporting detailed rules, it is difficult to break through the existing management framework.

Problem Indicators of the Management System	Data/Situation Description
Average Time Consumption for Cross - Departmental Curriculum Development	8 - 10 months
Average Time Consumption for Single - Department Curriculum Development	3 - 4 months
Relative Value of Class Hour Coefficient of Interdisciplinary Courses	0.8 (compared with traditional courses)
Difference Proportion of Per - Student Allocation for Interdisciplinary Majors	15 - 20% lower

3.3.3 Unbalanced Investment in Educational Resources

There are structural biases in fund investment. According to statistics from the Ministry of Education, 68.3% of the special funds for the construction of Emerging Engineering Education are used for the transformation of traditional engineering majors, and only 12.7% are invested in the construction of interdisciplinary majors. In terms of hardware resources, there is a coexistence of redundant construction and shortages in the procurement of equipment for interdisciplinary laboratories. For example, in a certain university, the actual utilization rate of multiple high - end simulation equipment is less than 30% due to the lack of supporting software, while experimental equipment in emerging fields (such as brain - machine interfaces) is severely scarce. The construction of software resources lags behind. Interdisciplinary online courses in Emerging Engineering Education in national universities only account for 8.9% of the total, and high - quality courses (recognized as national excellent courses) account for less than 10%. The coordination of school - enterprise resources is insufficient. The funds invested by enterprises in the cultivation of Emerging Engineering Education talents only account for 2.3% of their R & D investment, which is far lower than the level in Germany (8 - 10%).

Problem Indicators of Educational Resources	Data
Proportion of Funds Invested in Interdisciplinary Majors	12.7%
Proportion of Interdisciplinary Online Courses in Emerging Engineering Education	8.9%
Proportion of High - quality Interdisciplinary Online Courses	<10%
Proportion of Enterprises' Investment in Talent Cultivation in R & D Investment	

4 Analysis of Successful Cases of Interdisciplinary Talent Cultivation in Universities under the Background of Emerging Engineering Education

4.1 Case 1: The Talent Cultivation Model of the School of Robotics Engineering, Southeast University

4.1.1 Positioning of the College's Talent Cultivation Objectives

The School of Robotics Engineering at Southeast University takes "serving the national intelligent manufacturing strategy and cultivating composite innovative talents who can lead the development of robotics technology" as its core objective. It clearly aims to cultivate high - level talents who possess interdisciplinary knowledge in mechanical engineering, electronic technology, control science, and artificial intelligence, and are capable of engaging in design, development, and management work in robotics research and development, intelligent manufacturing, and other fields. The college decomposes this objective into three dimensions of capabilities: technological innovation ability (mastery of core robotics algorithms and system development), engineering practice ability (competence in integrating and debugging complex robotics systems), and industry leadership (familiarity with industry development trends and proficiency in team collaboration and project management). Employment data of graduates in the past three years show that 85% of students have entered leading robotics enterprises (such as Estun, Siasun) or research institutions, confirming the high degree of alignment between the cultivation objectives and industry needs.

4.1.2 Design of the Characteristic Curriculum System

The college has constructed a three - level curriculum system of "foundation - intersection - frontier", with interdisciplinary courses accounting for 45% of the total 180 credits. It specifically includes:

Foundation - integrated Courses: Integrate traditional engineering courses such as Principles and Design of Machinery, Circuit and Electronic Technology, and Fundamentals of Programming, reconstructing knowledge modules by breaking disciplinary boundaries.

Interdisciplinary Core Courses: Offer core courses that integrate mechanical, electronic, and artificial intelligence knowledge, such as Kinematics and Dynamics of Robotics, Perception and Control of Robotics, and Intelligent Algorithms for Robotics.

Frontier Expansion Courses: Set up elective courses that reflect industry frontiers, such as Technology of Human - Robot Collaboration, Application of Medical Robotics, and Design of Bionic Robots. In addition, the college has independently developed 12 school - enterprise co - constructed courses, including Practice of Robotics System Integration, and updates the course content every two years to ensure synchronization with technological iterations.

4.1.3 Practical Teaching and Industry - University - Research Cooperation Model

The college has established a progressive practical system of "experiment - training - actual combat":

Experimental Platform: Relying on the national electromechanical comprehensive engineering training center, it has built 8 professional laboratories, such as the robotics innovation laboratory and intelligent control laboratory, equipped with more than 200 sets of training equipment for industrial robots, including ABB and Fanuc.

Training Programs: Collaborate with Estun and Harbin Institute of Technology Robotics Group to establish "robotics research and development training bases". Each year, 16 - week enterprise training programs are carried out, enabling students to participate in the development of real industrial robot products.

Actual Combat Competitions: Organize students to participate in competitions such as the China Robot Competition and the National College Student Robot Innovation Design Competition. In the past three years, students have won a total of 56 national awards, among which the project "Design of Exoskeleton Robots for Medical Rehabilitation" won the gold award in the China International "Internet +" College Students Innovation and Entrepreneurship Competition.

4.2 Case 2: The Talent Cultivation Model of the Science, Technology and Finance Innovation Class at Shanghai Jiao Tong University

4.2.1 Educational Philosophy and Characteristics of the Innovation Class

The innovation class adheres to the educational philosophy of "technology empowering finance and finance driving innovation", focusing on the intersection and integration of emerging technologies such as artificial intelligence and big data with the financial field. It aims to cultivate composite talents who understand both financial product design and risk management and possess technological research and development capabilities. The innovation class adopts a cultivation model of "small - class teaching (30 students per class), internationalization, and customization" and implements a dynamic assessment and elimination mechanism to ensure student quality. The employment of graduates shows "three highs" characteristics: more than 30% enter top international financial institutions (such as Goldman Sachs, Morgan Stanley), 40% pursue doctoral degrees at top domestic and foreign universities, and the success rate of entrepreneurship reaches 15%.

4.2.2 Construction of Interdisciplinary Curriculum Groups

The curriculum system is divided into four modules:

Module Name	Core Courses	Credit Proportion
Science and Technology Foundation Module	Python Programming and Data Science, Machine Learning, Blockchain Technology	30%
Financial Professional Module	Corporate Finance, Financial Engineering, Investment	35%
Interdisciplinary Integration Module	Artificial Intelligence and Financial Innovation, Big Data Risk Control, Practical Financing of Technology Enterprises	25%
Practical Innovation Module	Case Analysis of Fintech, Practical Quantitative Investment, Design of Science, Technology and Finance Projects	10%

The innovation class specially offers "Frontier Lectures on Fintech", inviting senior executives from enterprises such as Ant Group and the Shanghai Stock Exchange to teach, with an average of 20 lectures held each year.

4.2.3 Dual - Tutor System and Practical Teaching System

It implements a dual - track system of "in - school academic tutors + off - campus industry tutors". Each student is assigned a professor in computer science or finance and a senior expert from a financial institution or technology enterprise. Practical teaching includes:

Enterprise Internships: Establish internship bases with 20 enterprises, including Goldman Sachs Asia and Alipay. Students are required to complete at least six months of enterprise practice.

Project - Driven Learning: Carry out school - enterprise joint projects such as "Design of Supply Chain Finance Based on Blockchain" and "Development of Intelligent Investment Advisor Systems". In the past three years, students have completed a total of 42 actual projects and published 28 related papers.

International Exchanges: Carry out joint training programs with the Wharton School of the University of Pennsylvania and the London School of Economics and Political Science, with 100% of students participating in overseas exchanges.

4.3 Case 3: Interdisciplinary Talent Cultivation of Landscape Architecture at Tsinghua University

4.3.1 Interdisciplinary Curriculum Integration Plan for the Major

Taking the intersection and integration of "ecology, technology, and humanities" as the core, the Landscape Architecture major at Tsinghua University has constructed a "platform + module" curriculum system:

Basic Platform Courses: Integrate basic courses from disciplines such as ecology, geography, architecture, and art design, such as Landscape Ecology, Fundamentals of Architectural Design, and Environmental Behavior.

Professional Module Courses: Set three directions of "ecological restoration", "urban and rural planning", and "digital landscape", including courses such as Engineering Technology of Ecological Restoration, Urban and Rural Landscape Planning and Design, and Digital Landscape Modeling and Visualization.

International Joint Courses: Collaborate with the Graduate School of Design at Harvard University and the University of Pennsylvania to offer transnational workshops on "Sustainable Landscape Design", inviting more than 10 international experts to teach each year.

4.3.2 Measures for Interdisciplinary Construction of the Teaching Staff

Build an interdisciplinary teaching team through "internal cultivation and external introduction":

Internal Integration: Form a teaching team composed of teachers from multiple departments, including the Department of Landscape Architecture, School of Environment, and School of Architecture. Currently, there are 45 full - time teachers, with 72% of them having interdisciplinary backgrounds.

External Introduction: Hire 15 industry experts from institutions such as the China Academy of Urban Planning & Design and AECOM as part - time professors.

Teacher Development: Establish an interdisciplinary research fund for teachers, sponsoring 10 - 15 interdisciplinary teaching and research projects each year, and organizing teachers to participate in international academic conferences and industry practices to enhance their interdisciplinary teaching capabilities.

4.3.3 Practical Teaching and Project - Driven Model

Practical teaching takes real projects as carriers, forming a trinity model of "curriculum design - scientific research projects - social practice":

Curriculum Design Projects: Combine with courses such as Landscape Planning and Design to carry out practical project teaching, such as the landscape design of the Beijing Sub - center and the ecological planning of Xiong'an New Area.

Scientific Research Practice Projects: Rely on platforms such as the National Park Research Institute of Tsinghua University and the Ecological Restoration Research Center, enabling students to participate in national key research and development projects.

Social Practice Projects: Establish "rural revitalization" practice bases in Yunnan, Guizhou, and other places, carrying out interdisciplinary practices of "landscape design + cultural heritage protection + community development". Relevant achievements have won 3 excellent design awards from the Ministry of Housing and Urban - Rural Development.

4.4 Enlightenments and References from the Cases

4.4.1 Experience References for Curriculum System Construction

All three universities have broken traditional disciplinary boundaries and achieved knowledge integration through modular design. The enlightenments include: First, establish a dynamic curriculum update mechanism to ensure that courses are synchronized with industry needs; second, increase the proportion of interdisciplinary core courses to avoid the "patchwork" phenomenon; third, develop school - enterprise co - constructed courses and introduce real industry cases and cutting - edge technological content.

4.4.2 Enlightenments from Practical Teaching Reform

The successful experiences are reflected in three aspects: constructing a progressive practical teaching system to gradually improve students' abilities from experimental simulation to enterprise actual combat; deepening industry - university - research cooperation and establishing stable enterprise internship bases and joint project mechanisms; using competitions and international exchanges as breakthroughs to broaden students' horizons and strengthen the cultivation of innovative abilities.

4.4.3 Innovative Ideas for the Construction of the Teaching Staff

Universities need to build interdisciplinary teaching teams through internal integration, external introduction, and special cultivation. Specific measures include: establishing interdisciplinary teacher development centers to provide training and research support; setting up special funds to encourage teachers to carry out interdisciplinary teaching research; improving the evaluation mechanism and incorporating interdisciplinary teaching achievements into the teacher assessment system.

5 Innovative Strategies for the Cultivation Model of Interdisciplinary Talents in Universities under the Background of Emerging Engineering Education

5.1 Breaking Disciplinary Barriers and Constructing an Interdisciplinary Curriculum System

5.1.1 Establishing a Curriculum Development Mechanism for Interdisciplinary Integration

Universities should establish a special working group for interdisciplinary curriculum development, led by the academic affairs department and jointly participated in by multiple faculties and industry experts. A closed - loop development process of "needs research - curriculum design - dynamic evaluation" should be established: First, accurately grasp industry needs through means such as enterprise interviews and graduate follow - up surveys; second, organize teachers from different disciplines to form a curriculum development team and reconstruct curriculum content by breaking knowledge boundaries; finally, evaluate the effectiveness of courses every academic year and dynamically adjust curriculum content and teaching methods based on feedback. For example, drawing on the experience of the Science, Technology and Finance Innovation Class at Shanghai Jiao Tong University, inviting enterprises like Ant Group to participate in the formulation of curriculum outlines and integrating cutting - edge content such as blockchain finance and quantitative investment into the curriculum system.

5.1.2 Designing Modular Interdisciplinary Curriculum Clusters

Construct a curriculum cluster structure of "basic module + core interdisciplinary module + frontier expansion module". The basic module integrates basic knowledge from multiple disciplines such as mathematics, physics, and computer science; the core interdisciplinary module designs core courses that integrate knowledge from multiple disciplines around specific fields of Emerging Engineering Education, such as intelligent manufacturing and new energy; the frontier expansion module sets up elective courses that reflect technological development trends, such as the ethics of artificial intelligence and the frontiers of biomedical engineering. Clear progressive relationships are set among the modules, allowing students to freely combine courses according to their interests and career plans. For example, the three - level curriculum system of "foundation - intersection - frontier" at the School of Robotics Engineering of Southeast University realizes the systematic integration of knowledge and the ladder - type cultivation of abilities through modular design.

5.1.3 Promoting the Construction of Online - Offline Hybrid Interdisciplinary Courses

Leverage digital resources such as MOOC platforms and virtual simulation experiments to develop online - offline hybrid interdisciplinary courses. Online resources provide theoretical knowledge learning, case analysis videos, etc., while offline teaching conducts interactive activities such as group discussions and project practices. For example, building an online experimental platform for "virtual intelligent factories" where students can complete operations such as factory layout design and equipment debugging online, and then conduct actual project drills offline, achieving the deep integration of theory and practice. At the same time, universities are encouraged to share courses across institutions, breaking geographical limitations and integrating high - quality educational resources.

5.2 Strengthening Practical Teaching to Enhance Students' Practical and Innovative Abilities

5.2.1 Constructing a Multilayered Practical Teaching System

Create a progressive practical teaching system of "experimental courses - training projects - enterprise internships - innovation and entrepreneurship". Experimental courses focus on basic skills training; training projects are combined with specific engineering problems, such as setting up "Industrial Robot System Integration Training" for the robotics major; enterprise internships arrange for students to participate in actual projects of leading enterprises in the industry; the innovation and entrepreneurship link encourages students to participate in various competitions and incubate innovative projects. For example, the Landscape Architecture major at Tsinghua University allows students to enhance their practical abilities through the trinity model of curriculum design projects, scientific research practice projects, and social practice projects in real - world projects.

5.2.2 Deepening School - Enterprise Cooperation and Collaborative Education Mechanisms

Universities should establish long - term and stable cooperative relationships with enterprises and jointly build platforms such as industrial colleges and joint laboratories. Enterprises should deeply participate in the entire process of talent cultivation, including curriculum development, practical teaching guidance, and graduation project evaluation. For example, the School of Robotics Engineering at Southeast University has jointly built research and training bases with enterprises like Estun, where enterprise engineers and university teachers jointly guide students to complete the development projects of industrial robots. Meanwhile, school - enterprise joint cultivation funds should be set up to support the implementation of cooperation projects and the transformation of achievements.

5.2.3 Improving the Innovation and Entrepreneurship Education System

Integrate innovation and entrepreneurship education into the entire process of talent cultivation, offer basic innovation and entrepreneurship courses, and organize lectures and training camps on innovation and entrepreneurship. Establish innovation and entrepreneurship incubation bases to provide students with venues, equipment, and financial support. For example, encourage students to form interdisciplinary teams and participate in the China International "Internet +" College Students Innovation and Entrepreneurship Competition, cultivating innovative thinking and entrepreneurial abilities through project - driven approaches. In addition, invite successful alumni entrepreneurs and business leaders as mentors to share practical experience.

5.3 Optimizing the Teaching Staff and Building Interdisciplinary Teaching Teams

5.3.1 Mechanisms for the Introduction and Cultivation of Interdisciplinary Teachers

In terms of talent introduction, prioritize the recruitment of teachers with multidisciplinary backgrounds or interdisciplinary research experience, and at the same time, introduce engineers with rich practical experience from enterprises as part - time teachers. In terms of teacher cultivation, set up special funds for interdisciplinary teacher training to support teachers in participating in domestic and international interdisciplinary training courses and academic conferences; encourage teachers to engage in enterprise practice to enhance their engineering application capabilities. For example, the Landscape Architecture major at Tsinghua University has built a high - level interdisciplinary teaching team through internal integration of teachers from multiple faculties and external introduction of industry experts.

5.3.2 Interdisciplinary Teaching and Research Activities and Training Systems for Teachers

Regularly organize interdisciplinary teaching and research activities, such as interdisciplinary curriculum design workshops and teaching case sharing sessions, to promote knowledge exchange and experience sharing among teachers. Establish an interdisciplinary teacher training system, covering content such as interdisciplinary teaching methods and knowledge of emerging technologies. For example, carry out a series of training programs on "Improving Interdisciplinary Teaching Abilities in Emerging Engineering Education" every semester, inviting teaching experts and industry elites to teach, helping teachers update their knowledge structures and improve their interdisciplinary teaching abilities.

5.3.3 Establishing Incentive Mechanisms for Interdisciplinary Teaching Teams

Improve the teacher assessment and evaluation system by including interdisciplinary curriculum development, school - enterprise cooperation projects, and guidance for students' innovation and entrepreneurship in the assessment indicators. Set up awards for interdisciplinary teaching achievements to reward teams and individuals who have made outstanding achievements in interdisciplinary teaching reform. For example, give preferential treatment in professional title evaluation and performance distribution to teachers who participate in interdisciplinary curriculum development and achieve good teaching results, stimulating teachers' enthusiasm for participating in interdisciplinary teaching.

5.4 Improving the Evaluation System to Ensure the Quality of Talent Cultivation

5.4.1 Constructing a Diversified Evaluation Index System

Change the single - dimensional knowledge assessment method and establish a multi - dimensional evaluation index system covering knowledge acquisition, practical abilities, innovative thinking, and teamwork. For example, in the evaluation of the robotics major, comprehensively assess students' abilities, including not only their theoretical knowledge but also their robot system design capabilities, project team communication skills, and the ability to propose innovative solutions.

5.4.2 Establishing an Evaluation Method Combining Formative and Summative Assessments

Strengthen formative evaluation by tracking and assessing students' learning processes through classroom performance, group assignments, and project phased results; summative evaluation mainly takes the form of final exams, graduation projects, and project defenses. For example, in the assessment of interdisciplinary courses, formative evaluation accounts for 40%, including classroom participation, group discussion performance, and the quality of experimental reports; summative evaluation accounts for 60%, covering final exams and the presentation of final project results.

5.4.3 Introducing Industry and Enterprises to Participate in Talent Cultivation Evaluation

Invite enterprise experts to participate in students' course assessment, internship evaluation, and graduation project review, integrating enterprise standards into the talent cultivation evaluation system. For example, in the graduation project defense of the Science, Technology and Finance Innovation Class, form a review committee jointly composed of enterprise experts from Goldman Sachs, Alipay, etc., and in - school teachers to evaluate students' achievements from the perspective of actual industry needs, ensuring a seamless connection between talent cultivation and industry requirements.

6 Conclusions and Prospects

6.1 Summary of Research Results

This study deeply explores the innovation of the cultivation model of interdisciplinary talents in universities under the background of Emerging Engineering Education. Through theoretical analysis, current situation research, and case studies, it clarifies the urgent need for interdisciplinary talents in the construction of Emerging Engineering Education, and analyzes the existing problems in the current cultivation model, such as disciplinary barriers, disconnection of curricula, weak practical teaching, and insufficient teaching staff. The research finds that the constraints of traditional educational concepts, obstacles in management systems and mechanisms, and unbalanced investment in educational resources are the key factors leading to these problems.

In response to these issues, combined with the successful practices of universities such as Southeast University, Shanghai Jiao Tong University, and Tsinghua University, a systematic set of innovative strategies has been proposed: In terms of curriculum system construction, establish a curriculum development mechanism for interdisciplinary integration, design modular curriculum clusters, and promote online - offline hybrid teaching; practical teaching reform emphasizes constructing a multi - layered practical system, deepening school - enterprise collaborative education, and improving innovation and entrepreneurship education; the construction of the teaching staff focuses on the introduction and cultivation of interdisciplinary talents, optimizing teaching and research activities and incentive mechanisms; the evaluation system ensures cultivation quality by introducing enterprise participation through diversified indicators and a combination of formative and summative evaluations. These strategies provide operable theoretical guidance and practical paths for the cultivation of interdisciplinary talents in universities under the background of Emerging Engineering Education.

6.2 Prospects for Future Research Directions

6.2.1 Deepening Research on Interdisciplinary Talent Cultivation Mechanisms

Although this study has proposed a series of innovative strategies, the mechanisms for cultivating interdisciplinary talents still need further deepening. Future research can focus on how to construct more scientific and efficient interdisciplinary coordination mechanisms, including exploring the normal operation models of interdisciplinary major setting, curriculum development, and teacher resource sharing; studying how to use technological means such as artificial intelligence and big data to achieve dynamic monitoring and precise regulation of the talent cultivation process; and deeply analyzing the growth laws of interdisciplinary talents to establish personalized cultivation programs that match them, improving the pertinence and effectiveness of talent cultivation.

6.2.2 International Exploration of Interdisciplinary Talent Cultivation in Emerging Engineering Education

Under the background of globalization, the cultivation of interdisciplinary talents in Emerging Engineering Education needs to strengthen international exploration. Subsequent research can pay attention to international frontier interdisciplinary education concepts and models, such as the CDIO model of engineering education in the United States and the dual - system education in Germany, and analyze the paths for their localized application in Chinese universities; study how to strengthen international cooperation and exchanges, broaden students' international perspectives, and enhance their global competitiveness through means such as joint cultivation, credit recognition, and international project cooperation; at the same time, explore the establishment of talent cultivation standards and evaluation systems that are in line with international norms, promoting the internationalization process of interdisciplinary talent cultivation in Emerging Engineering Education in China.

References

[1] Lin, J. (2017). The construction of emerging engineering education: Strong promotion and active response. Research in Higher Engineering Education, (1), 1-9.

[2] Gu, P. H., Hu, W. L., Lin, P., Bao, N. S., Lu, X. H., Xiong, G. J., & Chen, Y. (2014). The OBE-based engineering education model: Practices and explorations at Shantou University. Research in Higher Engineering Education, (1), 27-37+72.

[3] Wu, A. H., Hou, Y. F., Yang, Q. B., & Wang, Y. J. (2017). The connotation and actions of emerging engineering education construction. Research in Higher Engineering Education, (3), 1-6.

[4] School of Robotics Engineering, Southeast University. (2023, March 15). Talent training program of School of Robotics Engineering, Southeast University.

[5] Shanghai Jiao Tong University. (2022, September 20). Enrollment brochure of the Science, Technology and Finance Innovation Class, Shanghai Jiao Tong University.

[6] Tsinghua University. (2021, August 10). Training program for landscape architecture professionals at Tsinghua University.