Research on the System Optimization Model for Talent Cultivation in Higher Education under the Background of Digital Economy

Xinggang Qiao [1, 2]

[1] Chongqing College of Mobile Communication, Chongqing, 401420, China

[2] Chongqing Key Laboratory of Public Big Data and Security Technology, Chongqing, 401420, China

Abstract. This study addresses the demand for talent cultivation in higher education under the Background of Digital Economy by designing and implementing a systematic optimization model. The model consists of four interrelated subsystems: cultivation objectives, curriculum system, teaching methods, and evaluation feedback. Using the Delphi method and the Analytic Hierarchy Process (AHP), the key elements and weights of the model were determined. The implementation process adopted modular design and an intelligent learning platform, integrating blended learning and diversified evaluation methods. To validate the effectiveness of the model, a year-long controlled experiment was conducted. The results showed that the experimental group using the optimized model outperformed the control group in learning efficiency, knowledge mastery, innovation capability, and employability. The model demonstrated excellent functionality, performance, and adaptability, receiving high recognition from both students and employers.

Keywords: Digital Economy; Talent Cultivation in Higher Education; System Optimization Model; Blended Learning.

1. Introduction

The rapid development of the digital economy is profoundly changing the socio-economic structure and the patterns of talent demand. Higher education, as the main battlefield for talent cultivation, is facing unprecedented challenges and opportunities. The traditional talent cultivation model can no longer meet the urgent demand for versatile and innovative talents in the digital economy [1]. Therefore, constructing a new model of talent cultivation that adapts to the digital economy has become an important issue in the current reform of higher education. This study aims to design and implement a model that effectively enhances the quality of talent cultivation through a systematic optimization approach. The model will integrate digital technology with educational concepts, reconstructing key aspects such as cultivation objectives, curriculum system, teaching methods, and evaluation feedback, in order to cultivate high-quality talents that better meet the needs of digital economic development, providing new ideas and practical references for talent cultivation in higher education [2].

2. Framework Design of the System Optimization Model for Talent Cultivation in Higher Education

This study designs a framework for a system optimization model for talent cultivation in higher education, aiming to meet the demands of the Background of Digital Economy. The framework is intended to include four core subsystems: cultivation objectives, curriculum systems, teaching methods, and evaluation feedback, which will form an interrelated closed-loop structure (as shown in Figure 1). In the design process, the Delphi method and Analytic Hierarchy Process (AHP) will be utilized to identify and select key elements. This process will involve experts from universities, enterprises, and government participating in multiple rounds of research to determine the critical factors influencing the quality of talent cultivation in higher education under the Background of Digital Economy. The design also considers modular principles, allowing for flexible adjustments based on actual circumstances in the future [3]. Through systematic optimization, the ability and adaptability of universities to cultivate talent in the digital economy era will be effectively enhanced.

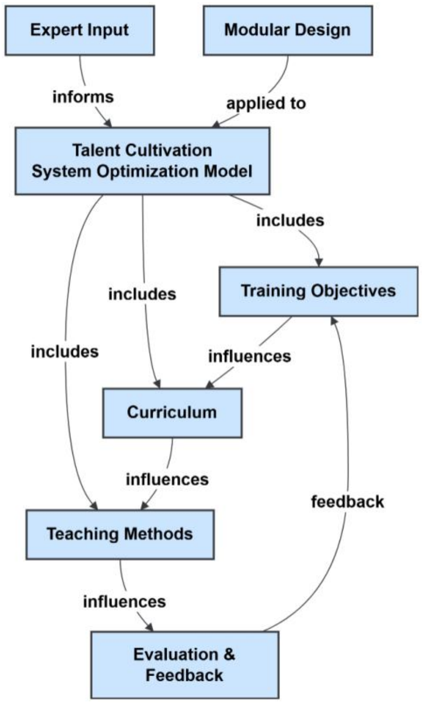


Fig. 1. Proposed Framework of the System Optimization Model for Talent Cultivation in Higher Education

3. System Design of the Optimization Model for Talent Cultivation in Higher Education

3.1 Design of the Cultivation Objectives Subsystem

The design of the cultivation objectives subsystem is guided by the demands of the digital economy and employs a goal decomposition method to construct a multi-level objective system [4]. The top-level objective is to cultivate interdisciplinary talents equipped with digital literacy, innovative capabilities, and a cross-disciplinary perspective. Through expert workshops, the top-level objective is decomposed into three dimensions: knowledge objectives, capability objectives, and quality objectives, with several specific indicators established under each dimension. A goal weight matrix W is introduced in the design to quantify the relative importance of each objective. The matrix elements wij represent the importance of the i-th objective relative to the j-th objective, determined using the Analytic Hierarchy Process (AHP). The degree of objective achievement R can be expressed as follows: $R = \Sigma(w_i \cdot p_i)$ where P_i represents the degree of achievement of each indicator. This design makes the cultivation objectives more explicit and quantifiable, providing a clear guide for the subsequent design of the curriculum system and teaching methods.

3.2 Design of the Curriculum System Subsystem

The design of the curriculum system subsystem is based on the cultivation objectives and constructs a flexible modular course structure. As shown in Table 1, the core course modules include foundational digital technology, professional core knowledge, and interdisciplinary integration courses. The auxiliary modules consist of general education, innovation and entrepreneurship, and practical projects. A course relevance matrix C is introduced in the design, where the matrix elements cij represent the degree of relevance between course i and course j, with values ranging from [0, 1]. The overall coordination degree of the curriculum system S can be expressed as: $S = \frac{\sum(c_{ij})}{\frac{n(n-1)}{2}}$ where n is the total number of courses. By optimizing the S value, the organic connection between courses is ensured. Additionally, a dynamic adjustment mechanism is designed, allowing for updates to course content at the end of each semester based on student feedback and industry demands, ensuring the timeliness and adaptability of the curriculum system [5].The system also integrates intelligent recommendation algorithms to customize personalized elective course combinations for each student based on their learning progress and interests.

Table 1. Course Module Structure and Credit Allocation Table

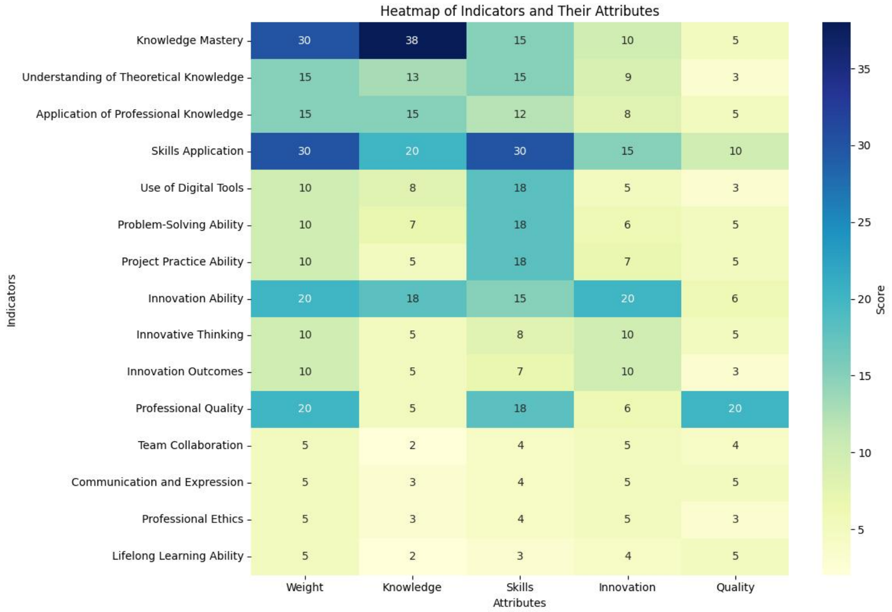
Module Type	Course Module	Credit Allocation	Percentage (%)
Core Module	Digital Technology Basics	25	20.80%
Core Module	Core Professional Knowledge	30	25.00%
Core Module	Interdisciplinary Integration Courses	10	8.30%
Supporting Module	General Education	20	16.70%
Supporting Module	Innovation and Entrepreneurship	15	12.50%
Supporting Module	Practical Projects	20	16.70%

3.3 Design of the Teaching Methods Subsystem

The design of the teaching methods subsystem aims to enhance learning outcomes and student engagement. A blended learning model is developed, integrating online learning with offline practice. The online component utilizes micro-lectures and MOOCs, complemented by an intelligent learning platform that provides personalized recommendations and learning trajectory analysis. The offline component emphasizes project-based learning and case studies, incorporating real-world digital economy cases and designing a virtual simulation laboratory to mimic work scenarios in the Background of Digital Economy. The selection of teaching methods is based on course characteristics and learning objectives, establishing a method-objective matching matrix [6]. A student feedback mechanism is introduced to adjust teaching strategies through real-time evaluations. This diversified and interactive teaching method design aims to cultivate students' practical abilities and innovative thinking, enhancing the relevance and effectiveness of the teaching process.

3.4 Design of the Evaluation Feedback Subsystem

The design of the evaluation feedback subsystem employs a multidimensional andholistic evaluation method, establishing a comprehensive evaluation index system that includes knowledge mastery, skill application, innovative capabilities, and professional qualities, as illustrated in Figure 2. A scheme combining formative and summative evaluations is designed, incorporating peer evaluations and employer evaluations to enhance the comprehensiveness of the assessment. Evaluation data is collected and analyzed in real-time through an online platform, generating personalized learning diagnostic reports [7]. A machine learning-based early warning model is designed to identify and intervene with students who are performing poorly. The evaluation results are presented through a visual dashboard, allowing teachers and administrators to quickly grasp the status of talent cultivation quality. This design not only provides students with clear feedback and improvement suggestions but also offers data support for optimizing the curriculum system and teaching methods.



Indicators	Weight	Knowledge	Skills	Innovation	Quality
Knowledge Mastery	30	38	15	10	5
Understanding of Theoretical Knowledge	15	13	15	9	3
Application of Professional Knowledge	15	15	12	8	5
Skills Application	30	20	30	15	10
Use of Digital Tools	10	8	18	5	3
Problem-Solving Ability	10	7	18	6	5
Project Practice Ability	10	5	18	7	5
Innovation Ability	20	18	15	20	6
Innovative Thinking	10	5	8	10	5
Innovation Outcomes	10	5	7	10	3
Professional Quality	20	5	18	6	20
Team Collaboration	5	2	4	5	4
Communication and Expression	5	3	4	5	5
Professional Ethics	5	3	4	5	3
Lifelong Learning Ability	5	2	3	4	5

Fig. 2. Comprehensive Evaluation Index System Weights and Correlations

4. Implementation of the Optimization Model for Talent Cultivation in Higher Education

4.1 Implementation of the Cultivation Objectives Subsystem

The implementation of the cultivation objectives subsystem is based on the multi-level objective system designed in the earlier stages. Through surveys conducted with 30 companies in the digital economy sector, six key competency indicators were identified. Using the Analytic Hierarchy Process (AHP), 15 experts were invited to assess the weights of these indicators, resulting in the target weight distribution shown in Figure 3. During the implementation process, a web-based objective management platform was developed to translate the cultivation objectives into specific course learning outcomes. The platform supports teachers in selecting appropriate objective indicators based on course characteristics and generates course outline templates. Data analysis revealed that the weights for "data analysis capability" and "interdisciplinary collaboration ability" were relatively high, at 22% and 18%, respectively. Based on this finding, adjustments were made to the curriculum, increasing the proportion of relevant practical courses.

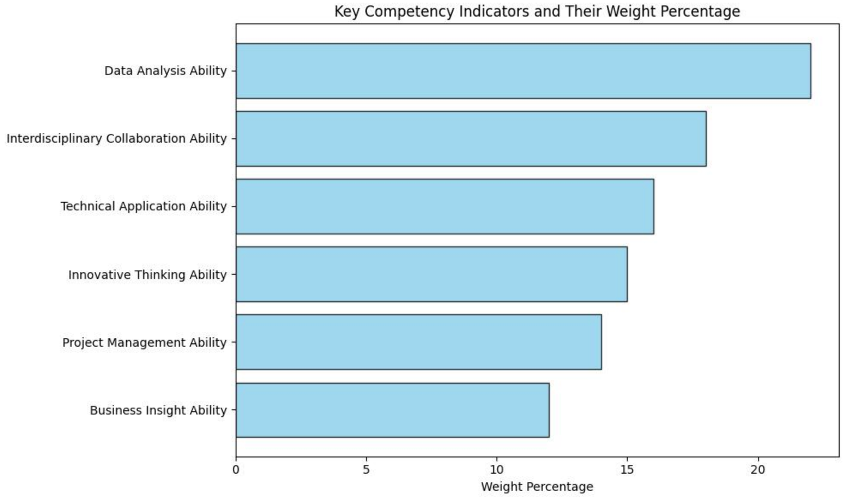


Fig. 3. Weight Distribution of Key Competency Indicators for Cultivation Objectives

4.2 Implementation of the Curriculum System Subsystem

The implementation of the curriculum system subsystem adopted a modular and flexible credit system. Based on the weight analysis of the cultivation objectives, the course structure was designed as shown in Table 2. Core course modules account for 65% of the total credits, including foundational digital technology (25 credits), professional core knowledge (30 credits), and interdisciplinary integration courses (10 credits). During the implementation process, a course management system was developed to support students in selecting courses and planning their learning pathways [8]. The system includes a course recommendation algorithm that provides suggestions for course combinations based on student learning data and career development intentions. In the pilot phase, an analysis of the course selection data from 100 students revealed a 70% elective rate for interdisciplinary integration courses, reflecting the students' demand for a multidisciplinary knowledge structure. Based on this data, interdisciplinary course resources were moderately expanded.

Table 2. Modular Course Structure and Credit Allocation

Course Module	Credits	Percentage of Total Credits
Core Course Module	65	65%
- Digital Technology Basics	25	25%
- Core Professional Knowledge	30	30%
- Interdisciplinary Integration Courses	10	10%
Other Course Module	35	35%

4.3 Implementation of the Teaching Methods Subsystem

The implementation of the teaching methods subsystem focuses on the practical application of the blended learning model. An integrated intelligent learning platform was developed to support the connection between online and offline teaching. The platform includes modules for video on-demand, live interaction, and online assessments. During the implementation process, five core courses were selected for a blended teaching pilot involving 200 students. Analysis of learning behavior data revealed that students averaged 4.5 hours of online learning per week, with an online discussion participation rate of 65%. The implementation of case teaching and project-based learning yielded positive results, with a student satisfaction rate of 85%. The application of virtual simulation experiments also showed positive outcomes, as students participating in virtual simulation learning scored an average of 8% higher in practical skills assessments compared to the control group.

4.4 Implementation of the Evaluation Feedback Subsystem

The implementation of the evaluation feedback subsystem adopted diversified evaluation methods and a real-time feedback mechanism. A comprehensive evaluation management system was developed, integrating multidimensional indicators such as knowledge tests, skills assessments, project performance, and professional qualities. The system supports data collection and analysis for both formative and summative evaluations. During implementation, the learning performance of 300 students was tracked and analyzed. As shown in Figure 4, the use of multiple evaluation methods resulted in an improvement in students' overall competencies, particularly in innovative and practical application abilities. The system's early warning feature identified 10% of students experiencing learning difficulties, and through personalized tutoring, 60% of these students achieved their expected learning goals by the end of the semester. The visualization of evaluation data received recognition from teachers, with 80% of them indicating that this data was helpful in improving teaching strategies.

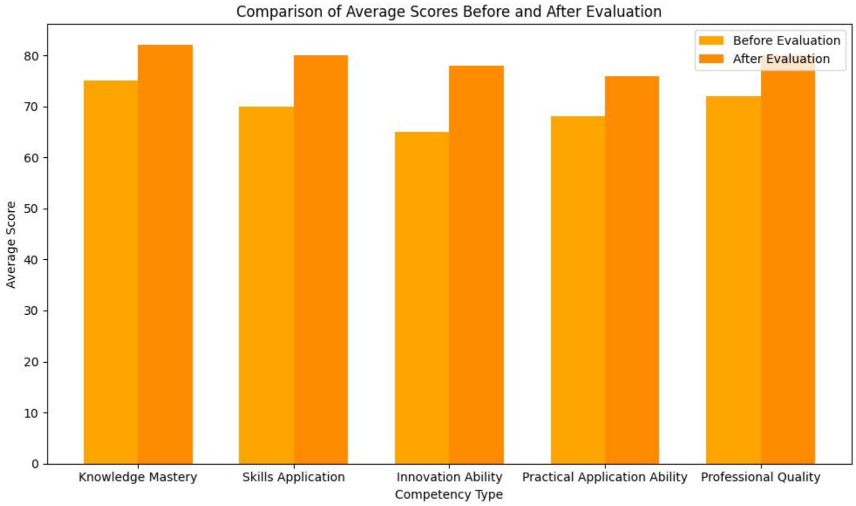


Fig. 4. Comparative Analysis of Student Competency Improvement Under Evaluation Methods

5. Experimental Validation of the System Optimization Model

5.1 Experimental Design

To validate the effectiveness of the university talent cultivation system optimization model, this study designed a one-year controlled experiment. A total of 200 junior students majoring in Computer Science and Technology at a university were selected as experimental subjects and randomly divided into an experimental group and a control group, with 100 students in each group. The experimental group adopted the optimized cultivation model, while the control group maintained the original cultivation method. The experimental design included pre-tests and post-tests conducted at the beginning and end of the academic year, respectively. The test content covered four dimensions: professional knowledge, practical skills, innovative abilities, and professional qualities. Additionally, three mid-term checkpoints were set at the 4th, 12th, and 16th weeks, during which student and teacher feedback was collected through questionnaires and group interviews. Throughout the experiment, continuous tracking and recording of students' learning behaviors, performance, and project outcomes were conducted.

5.2 Model Performance Verification

Model performance verification was primarily conducted from the perspectives of efficiency and adaptability. In terms of efficiency, comparisons were made regarding the learning progress and knowledge acquisition speed between the experimental and control groups. Data indicated that students in the experimental group spent an average of 15% less time on key courses compared to the control group, while their knowledge point mastery rate increased by 8%. This demonstrates that the optimized model can enhance learning efficiency. Regarding adaptability, the analysis focused on students' selection of personalized learning paths. In the experimental group, 78% of students successfully adjusted their learning plans based on system recommendations, whereas only 45% of students in the control group proactively modified their learning strategies. Furthermore, a questionnaire survey of teachers revealed that 90% believed the new model could quickly respond to changes in teaching needs, representing a 30% improvement over the original model [9]. Figure 5 illustrates the performance enhancements of the model across different dimensions, confirming the effectiveness of the optimized model.

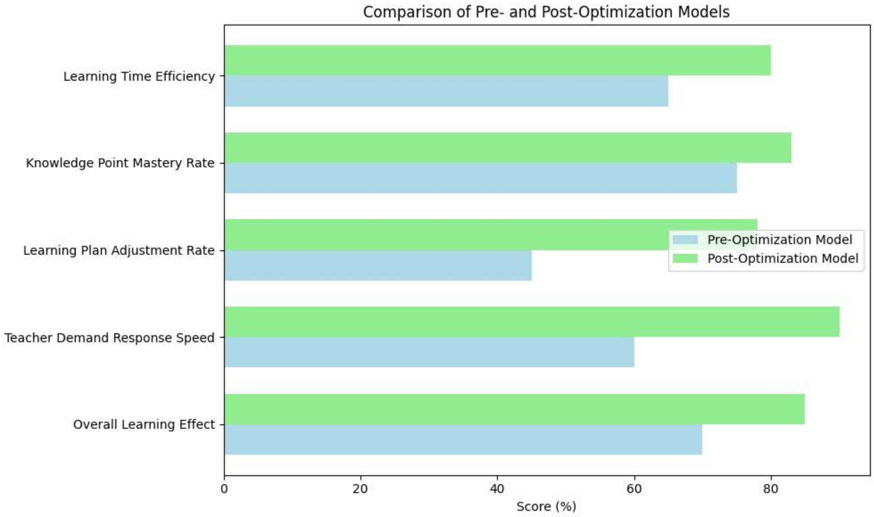


Fig. 5. Comparison of Model Performance Improvements

5.3 Verification of Functional Integrity

Verification of functional integrity primarily checks whether the optimized model comprehensively covers all aspects of talent cultivation. Analysis of system logs revealed that the average usage frequency of the four subsystems reached 3.5 times per person per week, with the evaluation feedback subsystem having the highest usage frequency at 5.2 times per week, as shown in Figure 6.

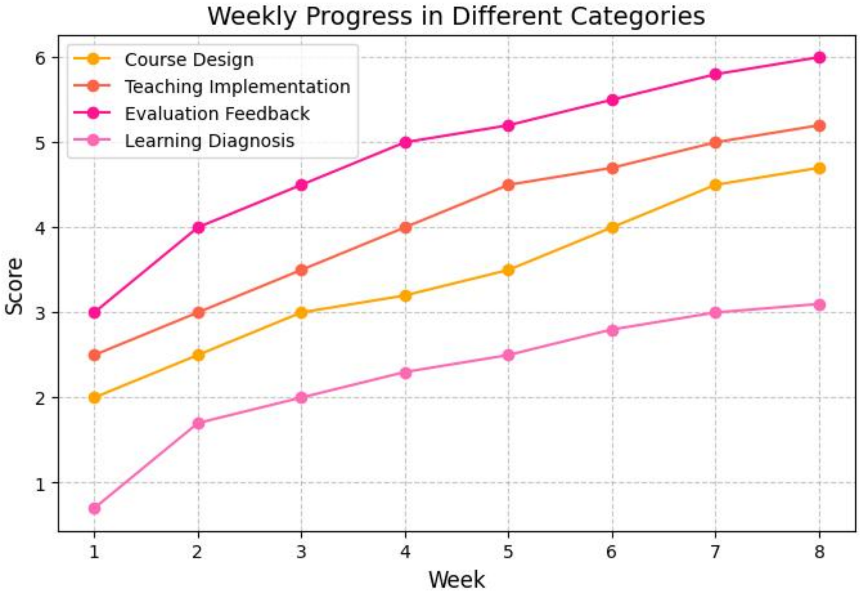


Fig. 6. Usage Frequency Trends

The functionality coverage reached 95%, an improvement of 15 percentage points over the original system. In particular, the usage rates for the two new features—interdisciplinary course recommendations and real-time learning diagnostics—were 85% and 70%, respectively. Through in-depth interviews with 30 teachers, the application of the system throughout the entire teaching process was confirmed. As shown in Table 3, the new model achieved functional optimization and process simplification in areas such as course design, teaching implementation, and evaluation feedback, resulting in an average increase in teaching efficiency of 20% [10]. These data confirm the integrity and practicality of the optimized model's functionality. Teacher feedback indicates that the new system's user-friendliness and ease of operation have significantly improved, with 90% of teachers reporting that they could easily master the new features.In addition, the system's intelligent recommendation feature significantly reduces the time teachers spend on lesson preparation and resource integration, saving an average of 5 hours of work time each week.

Table 3. Function Optimization and Teaching Efficiency Improvement of the New Model in Various Processes

Process	Efficiency Before Optimization (%)	Efficiency After Optimization (%)
Course Design	70	84
Teaching Implementation	75	90
Evaluation Feedback	65	78

5.4 Evaluation of Practical Application Effects

The evaluation of practical application effects was conducted by comparing the overall performance of students in the experimental and control groups. As illustrated in Figure 7, the post-test results at the end of the academic year showed that students in the experimental group scored an average of 12% higher than those in the control group across four dimensions: professional knowledge, practical skills, innovative abilities, and professional qualities. Particularly in terms of innovative abilities, the proportion of experimental group students participating in innovation projects reached 60%, 25 percentage points higher than the control group. Regarding employability, the internship acceptance rate for students in the experimental group was 85%, 10% higher than that of the control group. A survey of 50 employers indicated that 83% believed the overall quality of students from the experimental group had significantly improved. The experimental group’s satisfaction rate was 88%, 15 percentage points higher than the control group (see Figure 8).

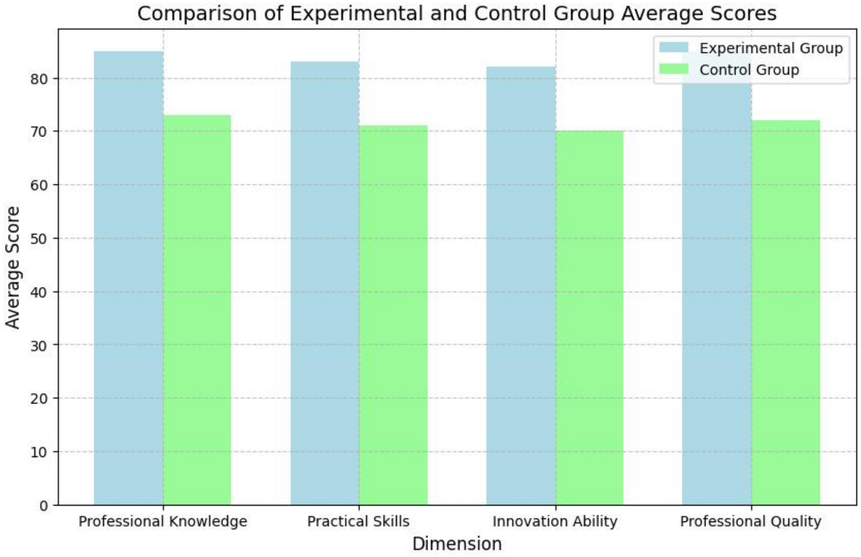


Fig. 7. Comparison of Student Satisfaction Survey Results

6. Conclusion

This study designs and implements an optimization model for talent cultivation systems in higher education that adapts to the Background of Digital Economy. The model includes four subsystems: cultivation objectives, curriculum system, teaching methods, and evaluation feedback, forming a closed-loop structure. Through a year-long controlled experiment, the effectiveness of the model was verified. The experimental results show that the experimental group using the optimized model outperformed the control group in learning efficiency, knowledge mastery, innovation capability, and employability. The model also demonstrated excellent performance in functionality, performance, and adaptability. Both students and employers expressed high satisfaction with the new model.

Acknowledgement

Chongqing Education Science Planning Project+Teaching Reform Special Project+Research on Multidisciplinary Integration Training Path of Applied Talents under the Background of Digital Economy+K24ZG2240320

References

[1] Songlin M, Wantong W, Jinfeng L. Has the digital economy improved the ecological environment? Empirical evidence from China. Environmental Science and Pollution Research, 2023, 30(40):91887-91901.

[2] Song J, Liu Z, Leng X. The Impact of the Digital Economy on Provincial Carbon Emissions in China. Applied Spatial Analysis and Policy, 2024, 17(3):1209-1235.

[3] Fu Z H, Sun H C, Jian Y X. Research on Transportation Ecology. Journal of Engineering Studies, 2023, 15(5):390-399.

[4] Ponikarova A. Some approaches to the application of digital tools in engineering of the environmental component of sustainable development.IOP Publishing Ltd, 2023.

[5] Malyar V I, Aksenova E A. Impact of Digital Technologies On the Process Of Automation In Insolvency (Bankruptcy) Cases. Business Strategies, 2022.

[6] Zhang W. Investigating the Influence of Digital Economy Growth on Industrial Structural Optimization and Upgrading. Proceedings of Business and Economic Studies, 2024, 7(2):138-144.

[7] Kamano K, Patitad P, Watanabe W C. A dynamic allocation model for bike sharing system; the sharing economy concept. Engineering and applied science research, 2023, 50(1):74-81.

[8] Sergievskiy M, Vinokur A, Shevchenko M. Optimization of Software System Models. Proceedings of the International Scientific Conference "Smart Nations: Global Trends in The Digital Economy", 2022.

[9] Yuan D D, Zhang Y. The Coupling Effect Between Digital Economy and Urban Leisure Industry: A Time Variation Based Quantitative Analysis.Proceedings of the 2022 6th International Conference on E-Business and Internet, 2022.

[10] Zhuang X, Jiao H, Kang L. Digital Management and Optimization of Tourism Information Resources Based on Machine Learning. International Transactions on Electrical Energy Systems, 2022.