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Research on Diagnosis and Enhancement Pathways of University Students' Innovation and Entrepreneurship Ability Driven by Big Data

Yuwan He, Yueqiao Shang, Shanshan Hu*

Business School, Lingnan Normal University, Zhanjiang, Guangdong, China

**Corresponding Author*

Abstract: Against the backdrop of the country's vigorous promotion of "double innovation" education, this study explores a precise solution driven by big data to address the problems of static, homogeneous, and disconnected from the promotion process in the current evaluation of college students' innovation and entrepreneurship abilities. By constructing an evaluation index system that includes six dimensions: innovative thinking, opportunity identification, resource integration, risk-taking, educational innovation, and practical execution, and relying on the independently developed "Lingnan Maker Pass" system, this study has achieved multidimensional diagnosis and dynamic profiling of college students' innovation and entrepreneurship abilities. Based on the diagnostic results, the study proposed the design principle of "concentrated supplementation of common shortcomings and precise assistance for individual differences", and constructed differentiated improvement strategies and intelligent intervention mechanisms for different ability groups. The pilot application shows that this path can effectively enhance students' comprehensive abilities and project practice results, providing a feasible theoretical and practical paradigm for the transformation of university entrepreneurship education from "extensive supply" to "precise empowerment".

Keywords: Innovation and Entrepreneurship Ability; Big Data Driven; Diagnostic Model; Upgrade Path

1. Introduction

Driven by the national innovation driven development strategy and the wave of "mass entrepreneurship and innovation", deepening innovation and entrepreneurship education in universities and comprehensively enhancing the innovation and entrepreneurship abilities of college students have become the core tasks of cultivating high-quality innovative talents in the new era [1]. However, current universities still face significant challenges in evaluating their entrepreneurial abilities: the commonly used questionnaires or scales are mostly static one-time assessments, making it difficult to track the dynamic development of students' abilities; The evaluation tools tend to be homogenized and fail to fully consider the characteristics of universities and individual differences among students; More importantly, the evaluation results are often disconnected from subsequent teaching, training, and practice, and cannot form an effective closed loop of "evaluation feedback improvement", resulting in a significant reduction in the accuracy and effectiveness of entrepreneurship education.

The flourishing development of new generation information technologies such as big data and artificial intelligence provides a new paradigm for solving the above-mentioned difficulties[2]. By collecting and analyzing multidimensional and procedural data, it is possible to achieve continuous characterization and accurate diagnosis of individual abilities, and provide scientific basis for personalized intervention. In this context, this study aims to explore two key questions: firstly, how to systematically utilize big data technology to conduct multidimensional and dynamic accurate diagnosis of college students' innovation and entrepreneurship abilities? Secondly, how to construct a personalized improvement path that matches individual abilities, weaknesses, and traits based on diagnostic results? The exploration of these issues has important theoretical and practical significance for promoting innovation and entrepreneurship education from "extensive supply" to "precise empowerment".

2. Literature Review

2.1 Research on Competency Models

The research on innovation and entrepreneurship capability models has formed a relatively systematic theoretical system. The EntreComp framework launched by the European Union constructs fifteen core competency indicators from three major areas: ideas and opportunities, resources and specific actions, providing a universal reference for competency assessment[3]. The model of the National Entrepreneurship Education Alliance in the United States focuses more on the application of knowledge and skill development in entrepreneurial practice. Scholars has developed a three-dimensional model for vocational college students, which includes innovative consciousness, practical ability, and entrepreneurial literacy, reflecting the efforts of localization exploration[4]. However, existing models are mostly based on commercial entrepreneurship scenarios, with insufficient attention paid to the unique educational innovation ability, curriculum design ability, and social service orientation of normal university students, making it difficult to accurately reflect the innovation and entrepreneurship potential of this group[5].

2.2 Development of Assessment Methods

At the level of evaluation methods, research shows a trend towards developing from static evaluation to dynamic diagnosis. Early research mainly relied on one-time questionnaire surveys to measure abilities through scale tools. With the development of technology, foreign scholars have begun to try to integrate big data analysis into the evaluation process, such as the entrepreneurial ability diagnosis system developed by Morris et al., which can achieve personalized feedback[6]. Domestic scholars have attempted to introduce the OBE concept into the design of assessment tools and explored the optimization of assessments under blended learning models[7]. However, overall, the existing evaluations still rely mainly on static data, and the dynamic monitoring and real-time feedback mechanisms are not yet perfect, making it difficult to support continuous tracking of capability development.

2.3 Application of Big Data

The application research of educational big data demonstrates the prospects of data-driven educational innovation[8]. In the field of learning analytics, researchers have achieved innovative applications such as academic warning and personalized resource recommendation by collecting and analyzing students' learning behavior data[9]. These practices have validated the value of data insights in enhancing educational precision[10]. However, in the field of innovation and entrepreneurship education, the depth of application of big data is still insufficient. Existing research is mostly limited to the analysis of traditional data sources, and has not fully explored the value of process data and behavioral data. The integration of technology and educational scenarios still needs to be deepened.

Looking at the existing research, three obvious limitations can be found: insufficient adaptability between the general ability model and the characteristics of normal students, the need to improve the dynamism and sustainability of assessment methods, and the lack of a closed loop in the application of big data technology in entrepreneurship and innovation education. These limitations make it difficult for the existing system to achieve effective integration from diagnosis to intervention. This study proposes the construction of a complete closed-loop framework for data diagnosis, portrait generation, path recommendation, and effectiveness verification. Through empirical research on the Lingnan Maker System, we explore the innovative path of entrepreneurship education from standardization to precision.

3. Construction of the Diagnostic Model and Data-Driven Analysis

3.1 System Architecture and Assessment Indicator System

The Lingnan Maker System adopts a front-end and back-end separation architecture. The front-end is based on WeChat mini programs for convenient access, while the back-end relies on Python and Django frameworks to handle core business. Data storage uses MySQL database. The core functions of the system include three modules: dynamic capability evaluation, intelligent analysis, and resource recommendation.

This study constructed an innovation and entrepreneurship capability evaluation index system consisting of six dimensions, as shown in Table 1. The dimension of innovative thinking examines students' ability to identify problems and propose original solutions; The dimension of opportunity recognition evaluates its sensitivity to market demand and trends; The dimension of resource integration measures the ability of internal and external resources to solve problems within an organization; The dimension of risk-taking reflects its attitude and decision-making courage towards uncertainty; The dimension of educational innovation focuses on creative practical abilities in teaching scenarios; The dimension of practical execution focuses on the effect of transforming ideas into actions. The weights of each dimension are determined through the Analytic Hierarchy Process, and experts in innovation and entrepreneurship education from both inside and outside the school are invited to make pairwise comparisons and judgments, ultimately forming a scientific allocation of weights.

Table 1. Innovation and Entrepreneurship Competency Assessment Indicator System

	Weight %	Dimension Description
Innovative Thinking	22	Identifying problems and proposing solutions
Opportunity Recognition	18	Discerning needs and recognizing opportunities
Resource Integration	20	Organizing and utilizing various resources
Risk-Taking	15	Decision-making in the face of uncertainty
Educational Innovation	15	Innovation within teaching scenarios
Practical Execution	10	Translating ideas into action

3.2 Data Collection and Preprocessing Process

The research data comes from multiple rounds of assessment data recorded by the system for over 500 students from Lingnan Normal University, while integrating students' learning behavior data with some academic data. Learning behavior data includes resource browsing duration, course completion rate, etc; Academic data covers information such as professional background and academic performance.

In the data preprocessing stage, data cleaning is first performed, including removing invalid records and handling outliers. Then standardize the multi-source data to eliminate dimensional differences. Finally, the input features of the model are constructed through feature engineering, including basic features such as dimension scores, as well as derived features such as ability development balance indicators, laying the foundation for subsequent modeling analysis.

3.3 Data Analysis Methods and Diagnostic Results

Based on the cleaned data, descriptive statistical analysis is first conducted. The results show that the overall ability of students is at a medium to high level, but there are significant differences in different dimensions. Through radar visualization analysis, it was found that the scores of resource integration and risk-taking dimensions were generally low, becoming a key weakness that restricts students' development.

The use of random forest algorithm for feature importance ranking further validates the core position of resource integration capability in the entire indicator system. This dimension not only has a low score on its own, but also shows strong correlation with multiple other dimensions, confirming that it is a bottleneck factor affecting the development of students' innovation and entrepreneurship abilities.

Using K-means clustering algorithm to divide students into four typical groups. Comprehensive students with balanced development of various abilities; Students with active thinking have outstanding innovative thinking but insufficient practical ability; Students with practical weaknesses exhibit rich ideas but lack execution ability; Students with untapped potential have significant room for improvement in all dimensions. These four types of portraits provide precise targets for subsequent personalized interventions.

3.4 System Application and Effect Verification

This study selected the School of Business, School of Computer and Artificial Intelligence, and School of Education Science at Lingnan Normal University as pilot units to conduct a six-month system application verification. These three colleges represent three different professional characteristics: business, engineering, and teacher education, which can

better reflect the universality and adaptability of the system. During the pilot period, more than 500 students completed the initial ability assessment and entered the personalized improvement path. The system generated more than 2000 personalized learning plans and pushed various learning resources more than 4000 times. By comparing and analyzing the quantitative data before and after system intervention, significant improvement in abilities can be observed. In terms of ability assessment scores, participating students scored significantly higher in the post test than in the pre-test in all six dimensions. Among them, the resource integration dimension showed the largest improvement, with an average increase of 18.6%, followed by the risk-taking dimension, with an increase of 15.3%. In terms of practical achievements, the number of awards won by students from pilot colleges in various innovation and entrepreneurship competitions increased by 45.2% compared to the previous cycle, and the number of entrepreneurial projects at or above the school level increased by 60.3%. Especially in the field of educational innovation, student teams trained based on assessment results have achieved excellent results in the provincial teacher training skills innovation competition, reflecting the system's precise empowerment of teacher training students' traits.

Through in-depth interviews with 28 representatives of teachers and students, the profound impact of the system on education and teaching was further revealed. Most students have reported that through the systematic ability radar chart and group positioning, they have established a clear understanding of their own innovation and entrepreneurship abilities for the first time. A business school student said that the resource integration training recommended by the system helped him successfully form a cross disciplinary entrepreneurial team. Teachers believe that the group ability analysis report provided by the system provides data support for curriculum optimization, making teaching reform more targeted. The teaching management personnel pointed out that the system has achieved a transformation from experience management to data management, providing a scientific basis for resource allocation and policy formulation.

4. Design of Personalized Enhancement Pathways Based on Diagnostic Results

4.1 Design Logic and Mapping Mechanism

The design of personalized improvement path is based on scientific educational diagnosis and accurate resource matching. This study proposes the core design principle of concentrated supplementation of common weaknesses and precise support for individual differences. The establishment of this principle stems from a profound understanding of the development laws of innovation and entrepreneurship capabilities. The common shortcomings reflect the systemic ability deficiencies that are commonly present in the current student population, which often stem from limitations in curriculum design or teaching methods and require targeted training through concentrated reinforcement. Individual differences reflect the diversity of students' abilities, cognitive styles, and developmental needs, which requires educational interventions to have sufficient flexibility and adaptability. Guided by this principle, the system has constructed a complete mapping logic from capability diagnosis to resource services, forming a precise empowerment system with hierarchical classification.

The implementation of mapping logic relies on multi-level data analysis and rule construction. The system first identifies common skill gaps by analyzing large-scale student ability radar charts and clustering results. Taking the findings of this study as an example, the two dimensions of resource integration and risk-taking were found to be weak in over 65% of students and identified as common weaknesses. In response to this discovery, the system automatically activates pre-set reinforcement training modules, which include specialized courses, workshops, and simulated practice projects, and pushes them to relevant student groups in a standardized manner. At the same time, the system achieves precise generation of personalized solutions by establishing matching rules between multidimensional features and resource types. These rules comprehensively consider students' ability dimension scores, group characteristics, professional background, and historical learning preferences, and construct a resource matching network containing hundreds of decision nodes to ensure that each student's improvement plan has a high degree of individual adaptability.

To ensure the effective implementation of mapping logic, the system adopts a dynamic optimization mechanism. Each ability assessment result will update the student's personal ability profile, and the system will adjust resource recommendation strategies in real-time based on the latest data. At the same time, the system continuously tracks students' usage and feedback evaluation of recommended resources, and continuously optimizes matching rules and recommendation algorithms by analyzing indicators such as resource utilization, completion, and satisfaction. This bidirectional feedback mechanism enables the improvement path to dynamically evolve with the growth of students, providing solutions to current immediate needs and foreseeing future development directions for forward-looking layout. It truly achieves a leap from static diagnosis to dynamic intervention, providing a sustained and accurate support system for the development of students' innovation and entrepreneurship abilities.

4.2 Differentiated Enhancement Strategy System

Based on accurate ability diagnosis and group segmentation, this study constructed a differentiated improvement strategy system for four typical student groups. This system is guided by the theory of ability development, fully considering the characteristic advantages and development needs of different groups, and achieving personalized teaching through systematic intervention programs. For comprehensive students, focus on providing opportunities for high-level challenging tasks and project incubation, equipped with senior mentors for one-on-one guidance, and fully leverage their exemplary and leading role; For students with active thinking, we will focus on strengthening practical skills training, providing guidance on project implementation and team collaboration practice, and promoting the transformation of creativity into results; For students with practical shortcomings, emphasis is placed on recommending internships and practical training, as well as guiding them to participate in competitions, and strengthening their execution ability through case teaching; For students with untapped potential, basic theoretical learning should be the core, combined with innovative consciousness cultivation and successful case incentives, to solidify their development foundation. This strategic system not only maintains the distinctive development paths of various groups, but also ensures the systematic and coordinated overall improvement.

In the specific implementation process, each type of strategy is equipped with corresponding resource guarantee and evaluation mechanisms. Comprehensive students will be given priority in obtaining the right to use innovation laboratories and entrepreneurial fund support, and their growth data will be included as high-quality cases in the resource library; Students with active thinking will enter the fast incubation channel, receive support for product prototype development and market testing opportunities, and receive weekly progress reports to ensure the continuous progress of the project; Students with practical weaknesses will join skill enhancement camps and participate in school enterprise cooperation practice projects, ensuring the effectiveness of their ability improvement through quantitative assessment indicators; Students with untapped potential enter the basic training camp, adopting a learning mode of small steps and fast running, and building confidence through phased achievement incentives. All strategy implementation adopts a dynamic adjustment mechanism, and the system optimizes the training plan in a timely manner based on the progress of students, ensuring that each student can achieve maximum development on the original basis and form a virtuous cycle of growth ecology.

4.3 Intelligent Intervention Realization Mechanism

The Lingnan Maker System achieves intelligent educational intervention through three core mechanisms. The intelligent recommendation mechanism is based on an improved collaborative filtering algorithm, which not only analyzes students' ability profiles and learning behaviors, but also integrates the development trajectories of similar groups to construct a multidimensional recommendation model. The system establishes precise associations between course resources, practical projects, and ability dimensions. After students complete the assessment, the algorithm will immediately calculate their matching degree with the resource feature matrix, and prioritize pushing learning content that meets their current ability

level and has development potential. The dynamic path planning engine relies on the ability development progress model to monitor the real-time improvement rate of students in various dimensions. When slow progress is detected in a certain dimension, the system will automatically adjust the learning sequence and insert auxiliary training modules to ensure that the learning path is always consistent with the personal development rhythm. The warning and feedback mechanism uses a Bayesian classifier to identify learning stagnation patterns. When a student fails to complete recommendation tasks or experiences imbalanced ability development multiple times in a row, the system triggers a graded warning and automatically generates a personalized ability development analysis report, providing students with clear improvement directions.

These three mechanisms together form a complete intelligent intervention loop. The system establishes an intervention effectiveness evaluation system by continuously collecting behavioral data and ability changes of students after intervention. Intelligent recommendation algorithms continuously optimize their parameters based on resource usage feedback, dynamic path planning engines adjust their decision rules based on successful cases, and warning mechanisms improve their recognition accuracy by analyzing the effectiveness of warnings. This self improving mechanism ensures that the system can continuously evolve with the expansion of usage scale, forming a virtuous cycle of more intelligent use. The entire intervention process has achieved full process automation from diagnosis to intervention and evaluation, which not only greatly reduces the manual burden on teachers, but more importantly, provides continuous attention and personalized guidance for each student, making it possible to teach students according to their aptitude on a large scale, fully reflecting the core value of intelligent education technology.

5. Conclusion

This study successfully constructed a "data-driven precision intervention" closed-loop framework that integrates capability diagnosis and personalized improvement. On a theoretical level, a multidimensional evaluation model for innovation and entrepreneurship abilities tailored to the characteristics of normal university students has been developed, filling the gap in group adaptability of general models. On the technical level, the "Lingnan Maker Pass" system developed has achieved full automation and intelligence from dynamic evaluation, portrait analysis to resource recommendation through intelligent algorithms. On a practical level, empirical research has confirmed that personalized improvement paths based on this framework can significantly promote the enhancement of students' key abilities and the transformation of practical results, and have received positive feedback from both teachers and students.

The deep integration of big data and artificial intelligence technology provides an effective path to solve the contradiction between scale and personalization in entrepreneurship education. The "diagnosis intervention verification" closed-loop model formed in this study not only provides a specific starting point for the innovation and entrepreneurship education reform of Lingnan Normal University, but also provides practical cases for similar universities to learn from. Future research can further explore cross school data fusion and long-term tracking to continuously optimize models and verify their long-term effects, promoting the continuous evolution and high-quality development of the innovation and entrepreneurship education ecosystem.

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