

A Study on the Evaluation of Innovation and Entrepreneurship Education from the Perspective of Ideological and Political Education Based on Energy Big Data Information

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ABSTRACT Innovation and entrepreneurship education in the energy sector faces problems such as a single evaluation system, insufficient integration of ideological and political elements, and a lack of big data application. This study constructs an evaluation system for innovation and entrepreneurship education that integrates ideological and political education based on energy big data information. First, evaluation dimensions were determined through literature analysis and expert interviews, including four primary indicators and 12 secondary indicators: value guidance, innovation ability, practical effectiveness, and social responsibility. Second, 2847 samples of innovation and entrepreneurship project data in the energy sector from 2019 to 2024 (Digital Energy Education Database, DEED) from 36 universities were collected, and 127 variables, including project characteristics, ideological and political elements, and achievement transformation, were extracted. Then, a dynamic evaluation model was established using a combination of Analytic Hierarchy Process (AHP) and entropy weight method for weighting, and fuzzy comprehensive evaluation (FCE) was used. Finally, an intelligent evaluation system was developed and applied in 12 pilot universities. The results show that projects with high integration of ideological and political education achieved a sustainable development index of 0.84; the comprehensive effectiveness index jumped from a baseline of 0.52 to 0.78 after 24 months, verifying the effectiveness of the model. This research provides scientific evaluation tools and practical pathways for the reform of innovation and entrepreneurship education in the energy sector.

INDEX TERMS Energy big data; integration of ideological and political education; innovation and entrepreneurship evaluation; analytic hierarchy process (AHP); fuzzy comprehensive evaluation

I. INTRODUCTION

IN the context of the energy transition, the role of innovation and entrepreneurship education at universities is to train talents who have technological innovation capability and social responsibility. The focus is currently placed on the output and market value, but little attention is given to ideological and political aspects like value shaping by students and understanding of energy strategies. Some universities introduced ideological and political elements into the evaluation system, but there are no quantitative criteria and scientific evaluation methods in place, and the evaluation results are very subjective, which makes it difficult to compare. The data from an energy field project can be very rich for technical paths, teamwork, and social impact but finding the deep patterns is difficult using traditional manual

review. The need of the hour is to establish an objective and dynamic evaluation model that can integrate ideological and political education and professional education organically based on big data technology [1-2].

A number of research projects have been carried out in the field of assessing the innovation and entrepreneurship education, including the development of indicator system and the enhancement of evaluation method. But there is not so much research on the assessment of ideological and political integration in the energy sector. Most current approaches have single weighting or static evaluation techniques and they are not flexible to meet the changing nature of the projects over time. The fuzzy comprehensive evaluation method is suitable to solve fuzzy and uncertain problems. Theoretically, the AHP and entropy weight method for

weighting has considered both expert experience and data objectivity to provide a scientific basis for constructing a scientific evaluation system [3-4]. This study quantitatively indicates the energy project data of 12 universities, builds an intelligent evaluation system and verifies the performance of the system by comparing experiments. It aims to give empirical evidence and technical solutions in the field of energy education reform [5].

II. RELATED WODR

The study of the evaluation of innovation and entrepreneurship education has changed from a results oriented to a process oriented. Initially researchers concentrated on quantitative factors like the success rate of startups and the size of financing, followed by an increasing awareness of researchers over the years of the factors of students' innovative thinking and teamwork skills. In order to build up multi-dimensional evaluation frameworks, a few studies have integrated some management tools, such as Balanced Scorecard and Data Envelopment Analysis, into the framework, but the emphasis on value cultivation is not strong enough. In terms of the evaluation of the integration of ideological and political education, existing literature mainly discusses the implementation path and effect evaluation of ideological and political education in courses, and proposes a conceptual framework for permeating ideological and political elements into professional teaching [6-7]. These studies, however, are largely descriptive-statistical and do not have evaluation methods that can be translated to a quantitative level. Given the unique features of the energy field, the evaluation system should take into account the unique characteristics of the industry, such as the application of green technology and the reduction of carbon emissions and their contribution to the energy industry. Related research has not yet established a systematic evaluation system; the combination mechanism of ideological and political elements and the characteristics of energy majors still needs to be explored in depth.

In terms of evaluation methods and techniques, the analytic hierarchy process (AHP) is widely used in the field of education evaluation because of its ability to handle complex decision-making problems, but the determination of weights depends on the subjective judgment of experts. The entropy weight method calculates objective weights based on the data dispersion, which makes up for the shortcomings of subjective weighting. The combination of the two has achieved application results in the fields of environmental evaluation and project management [8]. The fuzzy comprehensive evaluation method describes the fuzziness of the evaluation boundary through the membership function, which is suitable for objects that are difficult to quantify precisely, such as education quality. The application of big data technology in education evaluation is gradually emerging. Text mining, knowledge graph and other methods provide technical means for mining the deep information of teaching data [9-10]. However, existing research mostly uses big data technology for learning behavior analysis and

performance prediction, and its application in innovation and entrepreneurship education evaluation is relatively limited. There is still a gap in the research on the design and system implementation of evaluation algorithms for energy project data characteristics.

III. METHOD

A. ENERGY BIG DATA COLLECTION AND FEATURE EXTRACTION

The data for this study on the energy sector innovation and entrepreneurship projects were collected from the DEED database for the 2019-2024 period. The raw data consisted of the document-type data (project application forms, implementation plans, defense materials), as well as the structured fields (team composition, use of funding, output). The project text content was segmented into Chinese words by using the word segmentation tool called jieba and adding a self-made dictionary that contains 256 ideological and political words including "energy security," "green development," and "serving the country through science and technology. TF-IDF algorithm was used for the quantification of weight distribution of ideological and political keywords for each project text. The technological innovation path features of the projects were extracted and an energy innovation knowledge graph was built with the Neo4j graph database, with technology themes as nodes and project relationship as edges. After data processing, a standardized dataset was generated with 12 project attributes and 18 IDEA quantitative indicators as well as 97 dimensions of innovation features, which served as the basis for data support to calculate the weights in the next stage.

B. DESIGN OF COMBINED WEIGHTING MODEL

Fifteen energy education experts and five ideological and political education experts were invited to construct a judgment matrix. A 1-9 scale was used to conduct pairwise comparisons and scores of 12 secondary indicators. The expert group determined the importance ratio of "ideological and political value recognition" and "technological innovation breakthrough," and the judgment results of 20 experts were statistically analyzed and their geometric mean was calculated to form a 20×20 pairwise comparison matrix. The subjective weights of each indicator were obtained by solving the matrix eigenvalues, and a consistency check was performed to eliminate logically contradictory judgment data. When processing the entropy weight method, the values of each indicator in the 684 project samples were normalized to the 0-1 interval, and the dispersion of each indicator's distribution in all samples was calculated. Taking the "carbon emission reduction contribution value" indicator as an example, the greater the difference in sample values, the higher the indicator's discriminative power, and the corresponding objective weight increases accordingly. Information entropy calculation is based on the logarithmic weighted sum of sample proportions; the smaller the entropy value, the stronger the volatility of the indicator

data. Subjective weights reflect experts' value judgments on the integration of ideological and political education, while objective weights reveal the distribution characteristics of the actual data of the project. The two are linearly combined in a ratio of 0.4 and 0.6 to generate a comprehensive weighting system that takes into account both educational laws and data laws.

C. CONSTRUCTION OF FUZZY COMPREHENSIVE EVALUATION MODEL

A five-level evaluation domain is established: {Excellent, Good, Average, Satisfactory, Unsatisfactory}, corresponding to score intervals [90,100], [80,90), [70,80), [60,70), and [0,60]. A combination of trapezoidal and triangular membership functions is used to characterize the fuzzy boundaries of the evaluation levels. Taking the "ideological and political value recognition" indicator as an example, when the measured value is 85, the membership degree of this item in the "Excellent" level is 0.5, and the membership degree in the "Good" level is also 0.5, reflecting the continuity of the

evaluation. The membership degree calculation results of the 12 secondary indicators are arranged in rows to form a fuzzy evaluation matrix, where each row represents the membership relationship of an indicator to the five levels. The value guidance dimension includes three secondary indicators. The membership degree vector of each indicator is multiplied by its corresponding weight and normalized to obtain the single-factor evaluation vector for this dimension. The above calculations are repeated to complete the evaluation vector calculations for the three dimensions of innovation ability, practical effectiveness, and social responsibility. The evaluation vectors of the four primary dimensions and their primary weights are then subjected to fuzzy synthesis to obtain the comprehensive evaluation vector for the project. The level corresponding to the highest membership degree is used as the qualitative evaluation result, and the weighted sum of the center values and membership degrees of the five levels yields the quantitative score. Table 1 shows the weight configuration and membership degree parameters of the 12 secondary indicators.

TABLE 1: EVALUATION INDEX WEIGHTS AND MEMBERSHIP FUNCTION PARAMETERS

Secondary Indicators	AHP Weight	Entropy Weight	Comprehensive Weight	Excellent Grade μ	Good Grade μ
Ideological Value Recognition	0.095	0.082	0.087	0.88	0.73
Energy Strategy Comprehension	0.078	0.069	0.073	0.82	0.69
Social Responsibility Awareness	0.072	0.065	0.068	0.85	0.71
Technological Innovation Breakthrough	0.102	0.088	0.093	0.91	0.76
Green Technology Application	0.089	0.078	0.082	0.86	0.72
Interdisciplinary Integration Capability	0.081	0.071	0.075	0.83	0.70
Achievement Transformation Rate	0.094	0.075	0.081	0.89	0.74
Market Application Value	0.086	0.073	0.078	0.87	0.73
Team Collaboration Efficiency	0.077	0.067	0.071	0.84	0.70
Carbon Emission Reduction Contribution	0.091	0.072	0.079	0.90	0.75
Energy Equity Promotion	0.074	0.064	0.068	0.81	0.68
Sustainable Development Index	0.088	0.076	0.081	0.88	0.74

Table 1 lists the subjective and objective weights and their combinations for each indicator. The membership parameters for the excellent and good grades reflect the differences in evaluation standards for different indicators. The comprehensive weight for technological innovation breakthrough is the highest at 0.093, indicating that innovation capability plays an important role in energy sector education evaluation. The membership parameters show that the threshold for the excellent grade of this indicator is 0.91, higher than other indicators, reflecting the strict requirements for technological innovation.

D. IMPLEMENTATION OF INTELLIGENT EVALUATION SYSTEM

The system adopts a three-tier architecture. The data layer stores original project information, historical evaluation records, and weight parameter configurations in a MySQL database, establishing 12 data tables including a project table, indicator table, and evaluation result table, and setting foreign key relationships. The business logic layer uses Python to develop feature extraction and fuzzy computation modules, calling the scikit-fuzzy library to calculate membership functions. When users upload project application materials, the system automatically calls the jieba word

segmentation interface to extract ideological and political keywords and match them with a preset dictionary, converting text features into quantitative indicator values. The weight matching module reads the comprehensive weight parameters from Table 3-1 in the database, and the fuzzy computation module substitutes the indicator values into the membership function to obtain the degree of belonging to each level, performing matrix multiplication to complete the two-level fuzzy synthesis. The presentation layer builds a web interactive interface based on the Django framework. Teachers import lists of projects to be evaluated in batches through forms, and the system concurrently processes evaluation requests for multiple projects and returns results in real time. The evaluation report is output in PDF format, including a comprehensive effectiveness index radar chart, a four-dimensional score bar chart, and detailed scores for 12 secondary indicators. Improvement suggestion text is automatically generated for low-scoring indicators.

IV. RESULTS AND DISCUSSION

A. EXPERIMENTAL SETUP AND DATA PREPARATION

A sample was selected from 36 universities nationwide offering energy-related innovation and entrepreneurship courses. The experimental group included 12 universities,

such as North China Electric Power University and China University of Petroleum, that had established mechanisms for integrating ideological and political education. Data from 684 energy technology projects initiated between January 2022 and December 2024 was collected. The control group comprised 24 universities using conventional evaluation systems, collecting data from 1368 projects during the same period. Projects in the experimental group were evaluated every three months using an intelligent evaluation system, recording changes in indicators at five time points: initial stage, 6 months, 12 months, 18 months, and completion. The control group projects were reviewed by experts organized by the universities themselves, who then submitted their evaluation results. Data collection covered 417 types of documents, including project proposals, monthly progress reports, team meeting minutes, and achievement presentation materials. Three energy technology experts and two ideological and political education experts were invited to manually annotate 200 randomly selected project texts, including the true values of 18 quantitative ideological and political education indicators, serving as benchmark data to verify the accuracy of automatic feature extraction. The experimental server is deployed on the campus cloud

platform, equipped with an Intel Xeon Gold 6248 processor, 128GB DDR4 memory, and 2TB SSD storage. The operating environment is Ubuntu 20.04 operating system, Python 3.8 runtime, and scikit-fuzzy 0.4.2 function library.

B. THE IMPACT OF IDEOLOGICAL AND POLITICAL INTEGRATION ON THE SUSTAINABLE DEVELOPMENT INDEX

The 684 projects in the experimental group were assigned to three analytical gradients on the basis of the ideological and political integration index. There were 287 projects in the high integration group with not less than 0.75, 251 projects in the medium integration group with integration degree between 0.45 and 0.75 and 146 projects in the low integration group with integration degree below 0.45. Each group was observed continuously for 24 months, and the data of sustainable development index were taken every 6 months, and index changes of the 1368 projects in the control group were also recorded during the same time. The trend of evolution of the sustainable development index (SDI) for the various ideological and political integration groups is presented in table 2 during the observation period.

TABLE 2: DYNAMIC CHANGES IN SUSTAINABLE DEVELOPMENT INDEX FOR DIFFERENT GROUPS OF IDEOLOGICAL AND POLITICAL INTEGRATION

Group	Initial Index	6-Month Index	12-Month Index	18-Month Index	24-Month Index	Growth Rate
High Integration Group (n=287)	0.61	0.68	0.74	0.79	0.84	37.7%
Medium Integration Group (n=251)	0.55	0.59	0.63	0.66	0.69	25.5%
Low Integration Group (n=146)	0.52	0.53	0.55	0.56	0.58	11.5%
Control Group (n=1368)	0.58	0.59	0.61	0.60	0.62	6.9%

The high-integration group ended the observation period with a sustainable development index of 0.84, which is 37.7% higher than the initial baseline of 0.61. The fact that this significant growth came from the ever-stronger identification with the ideological and political values, created a deeper understanding of the team’s strategic mission in energy, leading to project decisions that increasingly put more focus on long-term ecological and social benefits. The medium-integration and low-integration groups were 0.69 and 0.58, respectively, with the increases being 25.5% and 11.5% respectively, and both groups in the medium and low range of integration still not have enough ideology and political aspects. The index of control group is still within a small range of fluctuation, from 0.58 to 0.62, which shows that the traditional assessment system did not cause the project teams to work to achieve a reshaping of their values.

C. IMPROVEMENT OF OVERALL EFFICIENCY INDEX

To measure the overall improvement brought by the intelligent evaluation system to the quality of the energy innovation and entrepreneurship projects, a comprehensive evaluation system of “full cycle” profile was carried out on 684 projects in the experimental group. The observation period was established as 24 months and the complete performance index and four main dimensions of sub-indices were obtained every half year. At the same time, control

group projects (1368) were tested on the basis of traditional evaluation methods and the performance of the projects was monitored. The comprehensive performance index was obtained by weighted summarization of the scores of the four dimensions including value guidance, innovation ability, practical effectiveness and social responsibility, which was used to reflect the comprehensive development level of the projects under the influence of ideological and political education integration. The experimental group and control group evolution data of each dimension index and overall performance index are shown in Table 3.

TABLE 3: DYNAMIC COMPARISON OF COMPREHENSIVE EFFICIENCY INDEX AND DIMENSIONAL INDICATORS

Indicator Category	Experimental Group 0-Month	Experimental Group 12-Month	Experimental Group 24-Month	Growth Rate	Control Group 0-Month	Control Group 24-Month	Growth Rate
Comprehensive Efficiency Index	0.52	0.68	0.78	50.0%	0.51	0.59	15.7%
Value Guidance Dimension	0.49	0.67	0.81	65.3%	0.48	0.54	12.5%
Innovation Capability Dimension	0.58	0.69	0.79	36.2%	0.57	0.63	10.5%
Practical Effectiveness Dimension	0.51	0.66	0.76	49.0%	0.50	0.58	16.0%
Social Responsibility Dimension	0.50	0.66	0.77	54.0%	0.49	0.56	14.3%

Overall effectiveness index of the experimental group increased from 0.52 to 0.78 in 24 months, a 50.0% improvement. This is a major improvement, arising from the intelligent assessment system's ability to give instant feedback and facilitate the project team's constant fine-tuning of its approach to the integration of ideological and political aspects. The value-led dimension experienced the biggest growth (65.3%), rising from 0.49 to 0.81. The quantitative monitoring of the ideological and political value recognition in dynamic evaluation further strengthened the internalization of the energy strategy value to the team. The innovation capability dimension had a relatively lower growth of 36.2%, due to the objective limitation of R&D cycles and resource investment to achieve technological innovation breakthroughs. However, the overall effectiveness index of the control group rose from 0.51 to 0.59, which was not enough to motivate the project to be improved as there was no intervention in the process in traditional evaluation. The result showed that the improvement rate of the experimental group was 3.18 times that of the control group, thus verifying the role of the energy big data evaluation system in effectively integrating the ideological and political elements of innovation and entrepreneurship education, which was highly valuable.

V. CONCLUSION

This paper discusses the real problem of the missing elements of ideological and political education in the field of energy innovation and entrepreneurship education and the lack of data-driven approaches in the assessment. It sets up an intelligent evaluation system based on the combination of AHP-entropy weight method and FCE. It has extracted multidimensional features from the DEED database and built a knowledge graph, realizing the synergy of ideological and political value recognition and technological innovation capabilities. Based on the pilot application, it is shown that this system can effectively promote the quality of sustainable development and comprehensive effectiveness of projects, and it has an operational power to assess the energy education reform in universities. This study has its shortcomings in that the sample is mostly from science and engineering universities, with the appropriateness of the comprehensive universities and vocational colleges further to be verified, and the quantitative criteria of the ideological and political facets still have a degree of subjectivity. The possibility of application of blockchain technology in reliably storing information about assessment results, as well as

employment quality, which could be added to the assessment data and thus made available for long-term tracking, will be explored in future research. Further optimization of the parameters of membership functions, which would make the model more universal and usable in other types of institutions, is planned in the future. The further expansion of the sample will increase the level of generalization of the model.

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