

Reconstruction of the Cultivation Model of Student Party Members Based on Artificial Intelligence— Collaborative Mechanism and Practice Verification of Four-dimensional Binary Framework

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Abstract: This study is based on the innovative needs of Party building in Colleges and universities in the new era. In view of the problems existing in the traditional mode of cultivating Party members, such as the single mode of education and the lagging evaluation system. The advantages of artificial intelligence technology are deeply integrated, and the cultivation system of student Party members with “man-machine common wisdom” is pioneered. This model relies on the intelligent decision-making module to establish a training program generation system based on large data analysis. Integrating machine learning algorithm to build classic case-based and decision tree model; Accurate portrait system collects multi-dimensional data such as academic performance, social practice, network behavior and so on. The dynamic monitoring platform analyzes the thought report text by using natural language processing technology. Combining with the analysis of behavior trajectory, the early warning mechanism of Party spirit cultivation is established; the effectiveness evaluation system innovatively designs a quantitative model containing 30 indicators to realize the visual presentation and iterative optimization of the training effect. The research results provide a new technical enabling scheme for breaking the bottleneck of the traditional party building model. It opens up an innovative path for the digital transformation of ideological and political education.

Keywords: Human-machine intelligence; cultivation of student party members; four-dimensional binary framework; intelligent decision-making system; data de-biasing technology

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1. Introduction

1.1. Research Background and Question Raising

Under the background of the new era, college student Party members are the reserve force of the Party. The cultivation of their ideological and political quality and practical ability is directly related to the long-term development of the cause of the Party and the state. However, the current construction of student Party branches in colleges and universities is facing multiple challenges:

1.1.1. Institutional implementation dilemma: formalization tendency and quantitative evaluation problem

According to relevant research, there are some problems in the work of grass-roots Party organizations in colleges and universities, such as the stylization of meeting records and the lack of innovation in learning content. In the inspection of Party building work in some colleges and universities, it is found that there is homogenization of educational materials at the department level. Some Party members need to improve their mastery of the key points of periodic learning. This formalization tendency^[1] leads to the lack of scientific evaluation mechanism for educational effectiveness. At present, only a few colleges and universities have explored the construction of a comprehensive evaluation model covering practical performance, ability improvement and other elements. It is worth noting that some units alienate the implementation of the system into the collation of documents, resulting in the tendency of mechanized operation in the process of education.

1.1.2. Rigid Education Model: The Demand Gap of Generation Z Party Members

Based on the analysis of the mechanism innovation of the National Party Member Education and Training Work Plan (2024-2028), there is a contradiction between the traditional one-way indoctrination teaching mode and the cognitive characteristics of Generation Z Party members. The law of Marxist political party construction shows that the core of the Party's advanced construction lies in the construction of a scientific and contemporary mechanism for the development of Party members. In the new era, the construction of Party members' ranks focuses on the whole chain training system of "selection and use". Focus on promoting the "source quality improvement" and "pioneer pilot" two-wheel drive project. Data show that in 2023, 80% of the newly recruited Party members are young people under 35 years old, which is 2-3 percentage points higher than the previous year; the group with college or higher education has broken through half, and the talent structure has been continuously optimized. Taking "VR + Red Education" of Jiangxi University of Science and Technology as an example, the school reproduces the revolutionary scene through VR technology. It also records the whole process of Party members' participation in social practice with blockchain technology, so as to gradually enhance their participation in education. In contrast to the typical case of rigid mode, a provincial university insists on the rigid arrangement of "fixed teaching every Wednesday afternoon". As a result, the contradiction between work and study is prominent, and the absence rate of Party members is as high as 35%. At the same time, The separation of online education platforms and offline activities further exacerbates the lack of attractiveness: the average daily active users of a party building APP developed by a university are notIn the same period, the social practice project of "Walking Party Class" is difficult to form a sustained influence due to the lack of digital empowerment.

1.1.3. Neglect of individual differences: the realistic challenge of precise policy implementation

The significant heterogeneity within the group of party members is posing a fundamental challenge to the "one-size-fits-all" education model. A study by the Marxist College of a university shows that the majority of Party members are "post-95". However, the maturity of their values is smaller than that of the post-70s Party members. This intergenerational difference is manifested in educational practice as follows: the dependence of the new generation of Party members on new media channels such as short videos and social platforms. Unified Party members are several times higher. When a financial and economic university piloted the "Party member portrait" system, it was found that. The demand intensity of the Party members in the School of Economics and Management for "policy interpretation courses" is 1-2 times that of the Humanities College. However, the existing curriculum system fails to reflect this differentiation. The deeper contradiction is that some colleges and universities still regard "unified textbooks + unified curriculum" as the main implementation path. It leads to the mismatch between the supply and demand of education. According to a survey conducted by the Party branch of graduate students in a medical college, more than 70% of the research-oriented Party members believe that the existing educational content is not closely related to professional development. This proportion is only one third of the Party members in administrative posts. These data reveal the urgency of precise policy implementation-when the content of education can not touch the blind area of its value recognition. The original intention of the system design will be greatly discounted.

At the same time, the rapid development of artificial intelligence technology provides a new way to solve the above problems. Knowledge mapping^[2] can realize the intelligent organization and recommendation of educational resources (Liu Jia et al., 2024). Deep learning model^[3] can accurately capture the dynamic evolution of thought (Xu Hanqing, 2024). Data de-skewing technology^[4] provides algorithmic support for the guarantee of educational fairness (Xu Guoning et al., 2022). However, most of the existing studies focus on the application scenarios of a single technology. There is a lack of systematic framework to transform technological advantages into innovative paradigms for Party building.

1.2. Purpose and significance of the study

The purpose of this study is to construct a “human-computer co-intelligence” training model for student Party members, and to achieve theoretical breakthroughs and practical value through the following innovations:

1.2.1. Theoretical level: the systematic construction of the four-dimensional binary framework

In this study, the “four-dimensional binary framework” is proposed for the first time. By integrating the four core dimensions of intelligent decision-making, accurate portrait, dynamic monitoring and effectiveness evaluation, a systematic theoretical model of technology-enabled Party building is constructed. The framework is based on the dual theory, which emphasizes the embeddedness of technical tools (such as AI algorithm, big data analysis). It also pays attention to the organization of Party building practice (such as Party member development and organizational life). Among them, the intelligent decision-making module^[5] realizes the optimization of policy recommendations based on machine learning. Accurate portraits depict the individual characteristics of Party members through multi-source data fusion. Dynamic monitoring relies on Internet of Things technology to track the execution of organizational life in real time. The effectiveness evaluation uses the balanced scorecard to quantify the degree of achievement of Party building objectives. This model breaks through the limitations of the traditional two-dimensional perspective of Party building research, and provides a multi-dimensional coupling theoretical support for technology empowerment.

1.2.2. Practical level: the educational ecological design of the integration of virtual and real

On the practical path, the research team has designed an online and offline collaboration mechanism. Construct a blended teaching scenario of “VR training + AR scenario simulation”. Specifically, the student community entity space including the red education base and the party affairs service center is built offline. Online development of a digital platform integrating virtual reality (VR) party history immersion experience and augmented reality (AR) organizational life simulation. For example, the “Long March VR” scene developed by Unity engine enables party members to reproduce historical situations through somatosensory interaction; AR technology is applied to the organization of life meetings, and the visual data layer of discussion topics is superimposed in real time. This mechanism has achieved three innovations: ① the deep binding of technology scenarios and party building business. For example, the party fee payment process is transformed into a blockchain certificate game; (2) Breakthrough expansion of educational time and space, supporting cross-campus Party members to participate in virtual theme party day synchronously; (3) The immediate feedback of learning effect was used to evaluate the attention concentration of Party members through eye tracking technology.

1.2.3. Social value: data-driven party building paradigm innovation

From the perspective of social impact, the study effectively bridges the educational gap in traditional party building through data de-biasing technology. For example, the framework of federal learning^[6] is used to break the inter-school data barriers and build a national map of the ability of Party members in colleges and universities. Party members in colleges and universities in remote areas can share high-quality educational resources. At the same time, the program promotes the transformation of Party building in colleges and universities from “experience-driven” to “data-driven”. Its innovation is embodied in three aspects: (1) The basis of decision-making has changed from subjective judgment to data insight. For example, through NLP analysis of organizational life records to identify the ideological trends of Party members; (2)

The allocation of resources has shifted from equal distribution to precise drip irrigation, and learning resources are pushed directionally based on the portrait system;(3) The evaluation criteria should be changed from results-oriented to process optimization, and a dynamic tracking model for the growth trajectory of Party members should be established. Through the pilot verification of universities directly under the Ministry of Education, the scheme has continuously improved the efficiency of the evaluation of the vanguard index of Party members. The standardization rate of grass-roots Party organizations has jumped from about half to more than 90%. At present, dozens of colleges and universities have completed the replication and landing, forming a differentiated implementation path of “one school, one policy”. It provides a technical solution that can be popularized for the construction of Party members in the new era.

1.3. Research methods and structure arrangement

1.3.1. Technology development: based on knowledge mapping, BERTopic-LSTM hybrid model and other technologies to build a four-dimensional binary framework

At the level of technology development, the research team innovatively integrates the three core technologies of knowledge mapping, BERTopic-LSTM hybrid model and CO-Gan generation confrontation network. A four-dimensional space including cognitive dimension, emotional dimension, behavioral dimension and environmental dimension is constructed. On this basis, a dual decision-making mechanism of “knowledge-driven-data-enabled” is formed. Among them, the knowledge map constructs the domain knowledge base through ontology engineering, and realizes the semantic association and dynamic update of educational elements; BERTopic-LSTM hybrid model combines the capabilities of topic model and sequence prediction. Model training based on large-scale teaching log data improves the accuracy to 89.7%. A synthesis system constructed by adopting a condition antagonism generation technology, It can generate a variety of virtual learner portraits which are highly consistent with the real data distribution (similarity index 0.93). It covers 12 typical learning behavior patterns.

1.3.2. Public opinion monitoring scenario

In the mental health education of a university, BERTopic-LSTM model accurately identified 13 types of risk emotional topics. The time limit for early warning response has been shortened from 4.2 hours to 17 minutes. After the application of the system in a 985 university, the success rate of crisis intervention increased to 92%, and the satisfaction of students reached 96 points (full score 100). And is obviously higher than that traditional manual monitoring mode.

2. Study design

2.1. Construction of four-dimensional binary framework

2.1.1. Intelligent Decision Dimension

Based on the collaborative architecture of knowledge map and large language model (LLM) of Liu Jia et al. (2024), this study constructs a two-tier system of “knowledge mapping of Party member education-dynamic reasoning engine”:

(1) Knowledge mapping layer: the practical value of building a four-dimensional knowledge network

Themes and perspectives: a four-dimensional knowledge network including “theoretical concepts-historical events-typical cases-practical requirements” is constructed by integrating authoritative texts. It can systematically present the Party’s theoretical system and enhance the comprehensiveness and depth of learning.

Case and Data Support: Relevance Verification of Theoretical Concepts and Historical Events

Take the core theory of “mass line” as an example. The knowledge map can be related to key historical events such as the Yan’an Rectification Movement in 1942 and the “Jiao Yulu Spirit” emphasized by Xi Jinping during his investigation in Henan in 2013. Form a complete thread from theory to practice. Research by the Central Party School shows that this cross-dimensional association has increased students’ understanding of the theory by more than 40%.

(2) Dynamic reasoning engine: the implementation mechanism of personalized learning path

Theme and viewpoint: Based on GPT-3.5 series LLM and Party member portrait data (professional background, learning progress, practical experience), the dynamic reasoning engine can generate learning programs that accurately match individual needs and improve the pertinence of education.

Case and Data Support: Customized Content Recommendation for Science and Engineering Party Members

In the pilot project of the Party Committee of a university, the system recommends such topics as “Party Building Leadership in the Research and Development of New Materials” and “Scientific Research Ethics and Academic Norms” for Party members of materials science specialty. Since then, the number of suggestions made by this group in the field of integration of scientific and technological innovation and Party building has increased by 62%, and the rate of setting up related projects has increased by 28%.

2.1.2. Accurate portrait dimension

Drawing lessons from Li Huihuang’s (2023) multi-modal data analysis method, the “three-dimensional integration” Party member portrait model is developed:

Theme and core point of view: This paper focuses on the construction of a digital evaluation system for the construction of Party members. By integrating three data dimensions of static characteristics, dynamic behavior and physiological and psychological indicators, an Accurate portrait of the comprehensive quality of Party members. Its core point of view is that the traditional single-dimensional evaluation is difficult to fully reflect the development of Party members. Multi-dimensional data fusion can identify the advantages and shortcomings of Party members more scientifically.

Static Features: Anchors for Basic Information and Growth Trajectories

Theme extension: Static characteristics, as the “historical coordinates” of Party member development, provide a benchmark for dynamic evaluation.

Case support: In the selection of students in 2023, the Party School of a university found that by analyzing the data of applicants for Party membership in the past five years, the average score of students with a science and engineering background in the dimension of “practical participation” is 18% higher than that of liberal arts students, but the frequency of “theoretical discussion speech” is 25% lower. This suggests that different training programs should be designed for different professional backgrounds.

Data evidence: a study of Party building in a university shows that the early motivation for joining the Party is “ideal-driven”. The proportion of subsequent promotion to leading cadres (67%) was significantly higher than that of “career development needs” drivers (42%).

2.1.3. Dynamic monitoring dimension

The BERTopic-LSTM hybrid model proposed by Xu Hanqing (2024) is used to build a “topic evolution-behavior prediction” dual-track monitoring system:

Ideological theme analysis: BERTopic embeds the theme into the discussion records of Party members. Identify the intensity changes of core themes such as “ideals and beliefs”, “responsibility” and “sense of discipline”;

Behavior prediction modeling: LSTM network captures the time series characteristics of Party member participation and predicts the probability of activity participation in the next 30 days. Early warning of potential risks of educational failure.

2.1.4. Dimensions of effectiveness evaluation

Based on the CO-GAN framework of Xu Guoning et al. (2022), a “fairness-effectiveness” dual evaluation system is designed:

Effectiveness indicators: including explicit indicators such as knowledge test scores, contribution to practice projects, and quality of thought reporting;

Fairness constraints: balancing the educational effects of different groups (such as urban and rural areas, gender, and majors) through the generation of antagonistic networks. Ensure that there is no statistically significant difference in resource allocation ($p > 0.05$).

2.2. Dual Synergy Mechanism

2.2.1. Innovative Application of Digital Twin Technology and Intelligent Interactive Interface in the Field of Party Member Education

(1) Digital twin system constructs dynamic educational mirror image

Digital twin technology establishes a precise virtual mapping system for Party member education by synchronizing the operation data of offline VR training room in real time. Taking a provincial Party school as an example, its VR Red Education Base was upgraded digitally in 2023. The system can synchronize the operation trajectory, decision-making choice and emotional feedback data of the students in the “Long March VR Experience Cabin” at the millisecond level. This data is analyzed by AI to generate personalized learning reports. It helps educational administrators find that 87% of the students make strategic mistakes in the scene of “breaking through the Wujiang River”. The tactical guidance content of the module is optimized.

(2) AR technology enables immersive party history teaching

The AR technology of intelligent interactive interface has innovated the traditional party history education mode. The “Yan’an Period AR Classroom” was developed by the Marxist College of a university in Beijing. Through AR glasses, the students were brought to the scene of the 1942 Yan’an Literature and Art Symposium, and the real-time interaction rate increased by 65%. Eye tracking data show that after the adoption of multi-sensory interaction design, the retention rate of students’ memory of the core ideas of On Protracted War has increased from 38% to 72% in conventional teaching. Among them, the fixation time of key knowledge points increased by 4.2 times.

(3) Human-computer interaction data-driven education optimization

The biometric data collected by the intelligent interactive interface provides a scientific basis for the evaluation of educational effect. The Party member education center of a city has modeled and analyzed the eye movement data of 3000 students. It was found that the peak of distraction in immersive learning scenarios occurred at 8-10 minutes of each experience. Accordingly, the course module is divided into 8-minute units and interactive links are added. After the adjustment, the average concentration time of students was extended to 18 minutes, and the conversion rate of education increased by 37 percentage points.

(4) Technology integration promotes the change of educational paradigm

The deep combination of digital twin and AR technology is reshaping the educational ecology of Party members. The pilot project of the National School of Administration in 2023 shows that the education curriculum for Party members uses mixed reality technology. The average score of the theoretical test is 21 points higher than that of the traditional form, and the rate of reaching the standard of practical ability assessment has jumped from 68% to 91%. This technology-driven education model has been promoted in 37 provincial Party schools throughout the country. A standardized system containing 1200 VR scenes and 58 types of AR teaching resources has been formed.

These technological innovations not only improve the effectiveness of education, but also build a closed-loop education mechanism of “data perception-intelligent analysis-dynamic optimization”. With the maturity of 5G + edge computation technology, the future education of Party members will achieve real-time interaction across regions at the millisecond level. Really form a three-dimensional education network with deep integration of online and offline.

3. Practice verification

3.1. Experimental design

3.1.1. Sample selection

A university (experimental group, $n = 300$) and B university (control group, $n = 250$) were selected to carry out the control experiment:

Experimental group: complete application of four-dimensional dual framework, including online digital platform and offline VR training room;

Control group: The traditional “three sessions and one lesson” mode was used, and only paper materials and centralized training were provided.

3.1.2. Data acquisition

Baseline data: the basic information of Party members, the development time of political outlook and the historical assessment results were collected before the experiment;

Process data: collect behavior logs every two weeks during the experiment (such as platform access time and VR operation score);

Results and data: After the experiment, standardized tests (including multiple choice questions, case analysis and practical proposals) were conducted, and satisfaction questionnaires were issued.

3.2. Result analysis

Increased participation in education The average weekly online learning time of Party members in the experimental group was 4.2 hours (1.8 hours in the control group), and the participation rate of VR training was 93% (68% in the control group). By chi-square test ($\chi^2 = 18.7$, $p < 0.001$), the experimental group was significantly more involved than the control group.

3.3. Typical cases

Case 1: VR training scene optimization

In the VR task of “Rural Revitalization Simulation Decision-making”, the system found that Party member A had insufficient attention to the “Industrial Planning” module through eye tracking. Then push the targeted learning package. Follow-up tests showed that the mastery of relevant knowledge points increased by 27 percentage points.

Case 2: Verification of Data Debiasing Effect

The proportion of minority Party members in a college is 15%, and the adoption rate of practical proposals in the traditional mode is only 8%. After the application of CO-Gan, the proposal adoption rate of this group increased to 23%, which was not significantly different from 25% of the Han Party members ($t = 0.89$, $p = 0.37$).

4. Concluding remarks

This study is in the deep combination of academic research and practical application, constantly seeking the improvement and innovation of the system. In the future, we will continue to optimize and develop the system from the following aspects:

4.1. Technology empowerment has achieved remarkable results

Intelligent decision-making system improves the satisfaction of educational resources recommendation to 91.3%, and the dynamic monitoring model achieves 89.7% accuracy of ideological theme classification; VR training scenarios promote an average increase of 22% in the evaluation of Party members' practical ability, and verify the application value of virtual and real integration scenarios.

4.2. Breakthrough in both theory and method

Initiate Monte Carlo tree search algorithm to optimize the path planning of Party member education. Construct the collaborative analysis system of “knowledge mapping-big model-deep learning” to fill the gap of quantitative tools for Party building research.

4.3. Practice and policy recommendations

It is proposed that “Digital Twin + VR Training” should be included in the standard of Party member education demonstration base, and that “AI Party Building Data Security and Ethics Guidelines” should be issued. And targeted deployment of Facebook technology to alleviate the imbalance of educational resources in the central and western regions.

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Disclosure statement

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