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REVIEW ARTICLE

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STUDY ON THE ORGANIZATIONAL EFFECTIVENESS MECHANISM OF INTEGRATING SCIENTISTS' SPIRIT INTO THE VALUE-LED EDUCATION IN COLLEGES AND UNIVERSITIES

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ABSTRACT

From the perspective of organizational effectiveness, this paper explores how scientists' spirit can be transformed into students' global competence through the value-led education system in universities. Based on mixed-method data from 12 universities in East China, Central China, and Southwest China (1,288 student questionnaires, 328 teacher questionnaires, 69 administrator questionnaires, and 108 interviews), this study constructs and tests a mediating model of "value guidance - organizational empowerment - goal achievement". Results from structural equation modeling show that scientists' spirit has a significant positive effect on organizational effectiveness ($\beta = 0.32, p < 0.01$), and organizational effectiveness has an even stronger effect on students' global competence ($\beta = 0.38, p < 0.01$); the mediating effect of organizational effectiveness accounts for 46.05% of the total effect (95% CI [0.182, 0.305]). Multi-group comparison reveals that the path coefficient of developmental adaptability in "Double First-Class" universities is significantly higher than that in general undergraduate universities ($\Delta\chi^2 = 5.03, p < 0.05$), while general undergraduate universities are more dependent on goal achievement ($\Delta\chi^2 = 4.51, p < 0.05$). A pre-test and post-test experiment further indicates that systematic education on scientists' spirit can significantly enhance students' willingness to serve national strategies (Cohen's $d=0.32$). This research provides reproducible quantitative evidence for the implementation of macro strategies in the microscopic field of universities, and also offers policy implications for classified governance, resource coordination, and the construction of digital education platforms.

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INTRODUCTION

Education, science and technology, and talent are the fundamental and strategic support for building China into a modern socialist country in all respects. Scientists' spirit has been entrusted with the epochal mission of "cultivating an innovative culture and fostering a sound academic atmosphere". However, in the field of university education, how scientists' spirit can transcend promotional narratives and be transformed into measurable, diffusible, and sustainable talent training effectiveness remains an unsolved question in existing research. Domestic research in China mainly focuses on interpreting spiritual connotations and developing curriculum cases (Yuan Yi et al., 2022). A small number of empirical studies have explored students' cognitive differences regarding scientists' spirit (Shen, 2019), but there is a lack of causal inference on the educational transformation mechanism. Western studies on "scientific ethos" and "interdisciplinary research" emphasize the norms of the scientific community (Merton, 1973), but rarely involve the

organizational process of spiritual factors in the higher education system. In terms of organizational effectiveness research, Cameron (1986) proposed a multi-dimensional model, which was later introduced into university governance by subsequent scholars (Zhong, 2021). However, it has not been integrated with spiritual capital and global competence into a unified analytical framework. This paper attempts to address the following questions: (1) Can scientists' spirit significantly improve the organizational effectiveness of value-led education in universities? (2) Does organizational effectiveness mediate the impact of scientists' spirit on students' global competence, and to what extent? (3) Are there differences in the action paths among universities of different levels? Answering these questions can provide a micro-mechanism explanation for "promoting the cause of education, science and technology, and talent in an integrated manner", and offer empirical reference for the classified governance and resource allocation of universities in the future.

LITERATURE REVIEW

Research on scientists' spirit can be roughly divided into three categories: the first is the intellectual history approach, which emphasizes the spiritual generation and historical context (Han, 2021); the second is the policy interpretation approach, focusing on spiritual content and publicity strategies (Yuan Yi *et al.*, 2022); the third is the educational application approach, which concerns curriculum cases and teaching interventions (Zhang, 2020). However, existing research is dominated by qualitative interpretation, lacking operational measurement and causal inference of spiritual variables. Research on university organizational effectiveness has evolved from an "input-output" efficiency perspective to a "governance-result" system perspective (Cameron, 1986). Chinese scholars have introduced the concept of "all-round education" and proposed dimensions such as coordination and integration (Feng, 2017), but a standardized scale has not been formed, nor has scientists' spirit been incorporated as an antecedent variable.

The global competence framework has undergone a discourse evolution from "international perspective" to "global literacy" and then to "global competence" (OECD, 2018). Based on the three dimensions of knowledge, skills, and attitudes, Chinese scholars have added "national identity" as the core value (Zhang, 2020). However, empirical research mostly remains at the level of current situation investigation, with insufficient attention to the interaction between spiritual antecedents and organizational contexts. In summary, existing literature has the following gaps: (1) Lack of operational measurement and quantitative testing of scientists' spirit; (2) University organizational effectiveness research has not been integrated with spiritual capital and global competence; (3) Lack of cross-university and cross-group comparative research. This paper attempts to fill these gaps by constructing and verifying a mediating model of "scientists' spirit → organizational effectiveness of value-led education → global competence".

RESEARCH METHODS

A sequential explanatory mixed-method research design was adopted: the first phase tested hypotheses through questionnaire surveys; the second phase explained the mechanism through interviews. The research followed the "Guidelines for Ethical Review in Chinese Universities", and all participants signed electronic informed consent forms. Stratified-purposive sampling was used to select 12 universities according to regions (East, Central, Southwest) and university levels ("Double First-Class" universities and general undergraduate universities); questionnaires were distributed to three groups (administrators, teachers, and students) within the universities. The sample structure is shown in Table 1.

Table 1 Sample Distribution (N = 1685)

Group	Distributed	Valid	Effective Recovery Rate (%)
Students	1500	1288	85.9
Faculty	400	328	82.0
Administrators	80	69	86.2
Total	1980	1685	85.1

Data source: Questionnaire survey of this study.

Self-designed scales were used to collect data in this study. The Scientists' Spirit Scale consists of 6 dimensions with 22 items ($\alpha = 0.89$); the Organizational Effectiveness Scale of Value-Led Education includes 4 dimensions with 21 items ($\alpha = 0.91$); the Global Competence Scale comprises 6 dimensions with 22 items ($\alpha = 0.89$). All scales adopted a 5-point Likert scoring method. Confirmatory factor analysis showed that the construct validity of the three scales was acceptable (CFI > 0.90, RMSEA < 0.08).

Questionnaires were distributed through an online platform with IP restrictions and response time thresholds; samples with response sets

and missing values > 5% were excluded. Semi-structured interview outlines were used, with each interview lasting 45-60 minutes. Full recording and transcription were conducted with the interviewees' consent.

SPSS 27.0 and Mplus 8.3 were used for descriptive statistics, regression analysis, and Bootstrap mediation testing; multi-group SEM was employed to compare differences between "Double First-Class" universities and general undergraduate universities. The significance level was set at $\alpha = 0.05$.

RESULTS

The three-factor measurement model showed a good fit: $\chi^2/df = 3.12$, CFI = 0.90, TLI = 0.88, RMSEA = 0.07, SRMR = 0.05. All factor loadings were > 0.55, AVE > 0.50, and CR > 0.80, meeting the requirements of convergent validity and discriminant validity. To verify the mediating model hypothesis of "scientists' spirit → organizational effectiveness of value-led education → students' global competence", this study constructed a structural equation model using Mplus 8.3 based on data from 1,288 student questionnaires, focusing on analyzing the path relationships and significance among core variables. The model fit results showed that $\chi^2/df = 3.12$, CFI = 0.90, TLI=0.88, RMSEA = 0.07, SRMR = 0.05.

All indicators met psychometrically acceptable standards, indicating that the model had a good fit with the empirical data, and further path coefficient analysis could be carried out. The specific results are shown in Table 2.

Table 2 Structural Equation Path Coefficients (N = 1288)

Path	β	SE	t	p
Scientists' Spirit → Organizational Effectiveness	0.32	0.086	3.72	0.002
Organizational Effectiveness → Global Competence	0.38	0.091	4.17	0.003
Scientists' Spirit → Global Competence (Direct)	0.22	0.082	2.68	0.015

Data source: Questionnaire survey of this study.

As shown in Table 2, all three core paths passed the significance test ($p < 0.05$), and the hypotheses were fully supported. Firstly, scientists' spirit had a significant positive impact on the organizational effectiveness of value-led education ($\beta = 0.32$, $p < 0.01$), indicating that integrating the connotations of scientists' spirit such as patriotism, innovation, and seeking truth into the university education system can effectively improve the organization's ability in goal achievement, process coordination, resource integration, and developmental adaptability. For example, teachers mentioned in interviews that "by exploring the deeds of scientists in the discipline to design teaching cases, the enthusiasm of inter-departmental collaboration in curriculum development has significantly increased", which confirms the leading role of spiritual core in organizational effectiveness. Secondly, the positive effect of organizational effectiveness on students' global competence was stronger ($\beta = 0.38$, $p < 0.01$), indicating that high-performance educational organizations are the key link connecting spiritual values and students' abilities. When universities break down departmental barriers and integrate internal and external resources, students' improvement in global knowledge reserve and cross-cultural communication is more significant. In addition, scientists' spirit also had a significant direct impact on global competence ($\beta = 0.22$, $p < 0.05$), indicating that scientists' spirit can not only indirectly empower through organizational effectiveness but also directly affect students' values. For example, students enhance their national identity and global perspective by learning about scientists' patriotic dedication.

The model explained 42.7% of the variance in students' global competence. Further, the bias-corrected Bootstrap method (5,000

repeated samplings) was used to test the mediating effect of organizational effectiveness. The results showed that the mediating effect value was 0.239, with a 95% confidence interval of (0.182, 0.305) (does not include 0), indicating that the mediating role of organizational effectiveness was significant, and the mediating effect accounted for 46.05% of the total effect. This result clarifies the core position of "organizational empowerment" in spiritual transformation and provides a quantitative basis for universities to improve educational effectiveness by optimizing organizational mechanisms in the future. To explore the impact of university levels on the path of "scientists' spirit - organizational effectiveness - global competence", this study conducted a multi-group structural equation model analysis with "Double First-Class" universities (5 universities) and general undergraduate universities (7 universities) as groups, focusing on comparing the differences in the effects of various dimensions of organizational effectiveness on global competence. The results are shown in Table 3.

The path differences between the two types of universities were concentrated in two core dimensions: Firstly, on the path of "developmental adaptability → global competence", the path coefficient of "Double First-Class" universities ($\beta = 0.24$) was significantly higher than that of general undergraduate universities ($\beta = 0.16$) ($\Delta\chi^2 = 5.03, p < 0.05$). This is closely related to the positioning of "Double First-Class" universities, which often connect with national major strategies, carry out international scientific research cooperation, and need to quickly respond to changes in the external environment (such as adjusting educational modules around "dual carbon" and "self-reliance and self-improvement in science and technology"). Thus, the educational effectiveness of developmental adaptability is more likely to be highlighted. In contrast, general undergraduate universities focus on applied training and respond slowly to cutting-edge trends, resulting in a weaker role of this dimension. Secondly, the path of "goal achievement → global competence" showed the opposite characteristic: the coefficient of general undergraduate universities ($\beta = 0.38$) was significantly higher than that of "Double First-Class" universities ($\beta = 0.30$) ($\Delta\chi^2 = 4.51, p < 0.05$). Students in general undergraduate universities need to perceive value guidance through specific goals (such as sharing scientists' deeds in classes and practicing in local research institutes), and the educational effect is more direct after the goals are achieved. Students in "Double First-Class" universities have access to more high-end resources and have more personalized needs for value guidance, so the impact of simple goal assessment is relatively limited. In addition, there were no significant differences in the path coefficients of the "process coordination" and "resource integration" dimensions between the two types of universities (β values were 0.32 vs 0.30, 0.28 vs 0.25, respectively, $p > 0.05$), indicating that regardless of the university level, breaking down departmental barriers and integrating educational resources are common needs for improving organizational effectiveness. In summary, the two types of universities need to adopt differentiated policies: "Double First-Class" universities should strengthen developmental adaptability to meet international competition and strategic needs, while general undergraduate universities should prioritize consolidating goal achievement to implement value guidance, which provides empirical basis for the classified governance of universities.

Table 3 Differences in Standardized Path Coefficients between Multi-Groups

Dimension	"Double First-Class" β	General Undergraduate β	$\Delta \chi^2 (\Delta df = 1)$
Goal Achievement → Global Competence	0.30	0.38	4.51*
Developmental Adaptability → Global Competence	0.24	0.16	5.03*

Note: * $p < 0.05$. Data source: Questionnaire survey of this study.

A paired-sample t-test was conducted on 126 students who participated in a 6-week special education on scientists' spirit. The results showed that the post-test score of willingness to serve national strategies ($M = 4.12, SD = 0.72$) was significantly higher than the pre-test score ($M = 3.89, SD = 0.75$), $t(125) = 2.85, p = 0.005$, Cohen's $d = 0.32$, with a medium effect size.

Through in-depth interviews with 24 administrators, 36 full-time teachers, and 48 students from 12 universities, thematic analysis was used to code and analyze the interview transcripts, and finally three core action mechanisms of integrating scientists' spirit into value-led education in universities were extracted. Each mechanism showed distinct practical characteristics in the expressions of different groups. The "spirit-context resonance" mechanism has become a key path to solve the problem of abstract value guidance. Many students mentioned that pure theoretical lectures are likely to create a sense of distance, while specific scientific research stories can make the abstract spiritual core perceptible. Some teachers also stated that when preparing teaching content related to scientists' spirit, by exploring the growth trajectories and scientific research choices of scientists in the discipline, they themselves have deepened their value identity, which in turn enables them to more naturally integrate spiritual connotations into the teaching process.

The "organization-resource coupling" mechanism provides systematic support for spiritual integration. In interviews, administrators and teachers generally believed that inter-departmental collaboration is the core to breaking down the barriers of scattered resources. A professional course teacher from a "Double First-Class" university gave an example: "When I introduced the case of Academician Shi Changxu overcoming technical difficulties in superalloy in the course 'Mechanics of Materials', the Scientific Research Office helped me contact researchers from the academician's team for online Q&A, and the Academic Affairs Office included the case in the model curriculum ideological and political resource library. This cross-departmental support doubled the teaching effect." On the contrary, teachers from some general undergraduate universities reported that due to the lack of effective coordination mechanisms, "education on scientists' spirit is mostly carried out independently. Ideological and political course teachers talk about theories, professional course teachers do not know how to integrate, and the practical activities participated by students are disconnected from the curriculum, making it difficult to form a lasting impact." This contrast highlights the key role of organizational coordination design in resource integration.

The "evaluation-incentive cycle" mechanism has effectively enhanced the participation motivation of teachers and students. At the teacher level, the policy orientation of linking professional title evaluation and appointment with the effectiveness of curriculum-based ideological and political education has stimulated teaching investment. For students, incentive measures such as postgraduate recommendation bonus points and awards for excellence have strengthened their willingness to practice. At the same time, interviews also found that the effectiveness of the incentive mechanism is inseparable from scientific evaluation standards. Some universities have overly focused on formal indicators (such as the number of activities participated) in evaluation, leading to a utilitarian tendency of "participating for bonus points", which has instead weakened the substantive effect of spiritual integration.

DISCUSSION

The mediating model of "scientists' spirit - organizational effectiveness - global competence" constructed in this study systematically reveals the internal mechanism of transforming spiritual capital into talent capabilities for the first time, providing a new analytical framework for solving the academic problem of "how to implement spirit", and enriching the theoretical research in related fields. From the perspective of spiritual capital theory, this study

breaks through the previous research limitations of regarding scientists' spirit as a pure value concept, and confirms that as a kind of "spiritual capital" with practical transformation value, it can be transformed into measurable educational effectiveness through organizational empowerment. The 46.05% mediating effect ratio indicates that organizational effectiveness is not a simple "transmission carrier", but a core "converter" and "amplifier" in the process of spiritual capital transformation. This finding responds to the research hypothesis proposed by Wagner *et al.* (2011) that "spiritual factors can only exert a lasting impact through organizational processes", and clarifies the key role of organizational coordination, integration, and adaptation in spiritual transformation. Different from the traditional perspective that emphasizes individual cognitive differences, this study shifts the focus to the organizational system of universities, revealing the transmission path through which macro strategies act on micro individuals through organizational design, and providing empirical support for the application of spiritual capital theory in the field of higher education.

In terms of organizational effectiveness theory, this study expands the scope of antecedent variables and outcome variables of university organizational effectiveness. Previous studies have mostly focused on the impact of internal organizational factors such as structure and systems on effectiveness, while this study incorporates scientists' spirit, a spiritual factor with distinct characteristics of the times, into antecedent variables, enriching the research on the influencing factors of organizational effectiveness. At the same time, taking students' global competence as an important outcome variable of organizational effectiveness also breaks through the single evaluation dimension of "efficiency-oriented" or "goal achievement-oriented" in traditional organizational effectiveness research, which is in line with the fundamental task of "fostering morality and cultivating people" in higher education in the new era. In addition, the results of multi-group comparison show that there are differences in the action paths of organizational effectiveness among universities of different university levels. This finding refines the application scenarios of organizational effectiveness theory in the field of higher education, provides theoretical basis for classified governance, and responds to Cameron's (1986) view that "organizational effectiveness should be analyzed in combination with specific contexts".

From the perspective of global competence theory, this study constructs a path for cultivating global competence with Chinese characteristics. Existing research mostly explores strategies for improving global competence from the perspectives of knowledge transmission and skill training, while this study confirms the direct and indirect impact of scientists' spirit, a spiritual factor, on global competence, and especially emphasizes the dialectical unity of national identity and global perspective. The study finds that the patriotic spirit in scientists' spirit has laid a solid value foundation for students' global competence, and spirits such as innovation and collaboration have improved students' core capabilities in participating in international competition and cooperation. This conclusion enriches the research on the antecedent variables of global competence and provides theoretical support for solving the practical problem of "how to coordinately cultivate family and country feelings and global perspective". Compared with the global competence framework proposed by OECD (2018), this study highlights the interaction between spiritual factors and organizational contexts, reflecting the distinctive feature of "value guidance" in Chinese higher education, and providing new ideas for the localized development of global competence theory.

Based on the research findings, this study puts forward the following targeted policy recommendations to provide practical guidance for the classified governance, resource coordination, and educational model innovation of universities. In terms of classified governance, it is necessary to formulate differentiated policy orientations according to the development positioning and path characteristics of universities of different university levels. For "Double First-Class" universities, the construction of "developmental adaptability" in organizational effectiveness should be focused on. As the core position for

cultivating top-notch innovative talents in the country, these universities are facing more intense international competition and technological change challenges, and need to further improve the organizational dynamic adjustment and innovation mechanism. It is recommended that relevant departments tilt resource allocation and policy support towards interdisciplinary collaboration, international exchanges and cooperation, and the opening of cutting-edge scientific research platforms in "Double First-Class" universities, encouraging them to dynamically optimize the paths and carriers of integrating scientists' spirit around national major strategic needs (such as "dual carbon" and self-reliance and self-improvement in science and technology), so as to cultivate top-notch innovative talents with international competitiveness. At the same time, a monitoring and evaluation index system for the developmental adaptability of "Double First-Class" universities should be established to guide them to enhance the organization's sensitivity and response ability to changes in the external environment while maintaining academic advantages.

For general undergraduate universities, priority should be given to improving "goal achievement" and consolidating the foundation of value guidance. The talent training of these universities focuses more on applied and compound talents, and it is necessary to closely combine the core connotations of scientists' spirit (such as patriotism, seeking truth, and dedication) with students' career development and social practice. It is recommended that competent educational departments guide general undergraduate universities to formulate a clear value-led goal system, integrate scientists' spirit into professional talent training programs, and enable students to form sound values while mastering professional skills through concrete forms such as case teaching, connections with local scientific research resources, and lectures by industry scientists. At the same time, the goal assessment mechanism of general undergraduate universities should be improved, and students' value identity and practice willingness should be included in the evaluation of educational effectiveness, guiding them to focus on core goals and avoid formalized integration models.

In terms of resource coordination, efforts should be made to solve the problems of scattered educational resources of scientists' spirit and insufficient digitalization level in current universities. According to the survey data, there are significant differences in the resource integration degree of the four core educational platforms (see Table 4): although the resource integration degree of cultural platforms ($M=3.90$) and curriculum platforms ($M=3.85$) is relatively high, the score of digital platforms is the lowest ($M=3.55$, 5-point scale), which has become a shortcoming in resource integration. In the future, the construction of digital educational platforms should be taken as a key task, and investment in digital resources such as virtual simulation experiments, online international collaboration projects, and digital museums of scientists' spirit should be increased. It is recommended that competent educational departments take the lead in building a national-level digital educational platform for scientists' spirit in collaboration with universities, research institutes, and technology enterprises, integrating high-quality online courses, scientific research cases, and virtual research resources to realize resource sharing across regions and universities. At the same time, universities are encouraged to strengthen the coordination and integration of internal resources, break down the barriers between departments and colleges, establish a resource library for educating people with scientists' spirit, and transform "point-like resources" such as academician lectures, laboratory resources, and scientists' deeds in university history into regular and systematic educational resources. In addition, attention should be paid to the development and utilization of external resources, promoting universities to establish long-term cooperative relationships with patriotic education bases, high-tech enterprises, and research institutes, and building a three-dimensional resource network of "internal + external" and "online + offline".

In terms of educational mechanism innovation, it is necessary to improve the "evaluation-incentive" cycle and stimulate the participation motivation of teachers and students. At the teacher level,

it is necessary to further deepen the reform of educational evaluation, take the effectiveness of integrating scientists' spirit into teaching as an important basis for professional title evaluation and appointment, and set up special reward funds to commend and support teachers who have performed outstandingly in integrating spirit into teaching and innovating curriculum-based ideological and political education. At the student level, the comprehensive quality evaluation system should be optimized, and participation in practical activities, scientific research training, and voluntary services related to scientists' spirit should be included in the evaluation indicators, linked to postgraduate recommendation and employment recommendation, guiding students to shift from "passive acceptance" to "active practice". In addition, a dynamic quality monitoring and feedback mechanism should be established to timely grasp the actual effect of integrating scientists' spirit through various methods such as questionnaire surveys, student interviews, and third-party evaluations, and adjust policy measures according to existing problems, forming a virtuous cycle of "policy formulation - practice promotion - effect evaluation - optimization and improvement".

Table 4 Comparison of Resource Integration Scores of Various Scientists' Spirit Educational Platforms (N=1685)

Platform Type	M	SD	Ranking
Cultural Platform	3.90	0.78	1
Curriculum Platform	3.85	0.82	2
Practical Platform	3.62	0.85	3
Digital Platform	3.55	0.91	4

Note: 1. The scale adopts a 5-point Likert scoring method (1 = strongly disagree, 5 = strongly agree), and a higher score indicates a higher degree of resource integration and educational effectiveness of the platform; 2. Analysis of variance showed that the differences in scores among the four types of platforms are statistically significant ($F=12.36$, $p < 0.01$). Post-hoc multiple comparisons show that the score of digital platforms is significantly lower than that of cultural platforms and curriculum platforms ($p < 0.05$), and there is no significant difference from the score of practical platforms ($p > 0.05$).

Data source: Questionnaire survey of this study.

Regarding methodological limitations, the sample is limited to 12 universities, and self-reported scales are used. In the future, behavioral data or objective indicators (such as patents and international competition awards) can be introduced for cross-validation.

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