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Guidelines for promoting positive attitudes to preserve Chinese calligraphy among higher education students at Shandong in China

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Abstract

In view of the challenges faced by Shandong University students in the protection of Chinese calligraphy heritage in the digital age, such as the fragmentation of cultural contact and the lag in technology application, this study aims to analyze their protection attitudes and influencing factors and build an intervention framework. To this end, the study uses a mixed research method to carry out a questionnaire survey and semi-structured interviews with 407 calligraphy students from five universities, integrating the theory of cultural identity, the theory of planned behavior, and the knowledge framework of technical teaching content. The results show that students' recognition of the cultural value of calligraphy is 89%, but only 34% of them actively participate in the protection practice. Their behavioral tendencies are significantly dependent on external incentives such as scholarships, and gender differences and family culture have significant effects. Based on this, the study proposes a three-dimensional intervention framework of "cognitive deepening, emotional cultivation, and behavior guidance," emphasizing the balance between technological empowerment and cultural authenticity, which has practical reference value for optimizing home-school collaboration, improving policy resource allocation, and aligning with the United Nations Sustainable Development Goals (SDG 11.4).

Keywords: Calligraphy Heritage Transmission, Calligraphy Safeguarding, Intangible Cultural Heritage Education, Technology-Enhanced Calligraphy Education, TPB-TPACK Integration.

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1. Introduction

As the core cultural symbol of Chinese civilization, Chinese calligraphy is not only the artistic expression of Chinese character writing but also carries the millennial philosophy, aesthetic spirit, and historical memory [1]. Shandong, as the birthplace of oracle bone inscriptions and the hometown of calligraphy masters such as Yan Zhenqing, is an important cultural town in Weibei. It occupies an irreplaceable position in the territory of Chinese calligraphy heritage. It is not only the practice field of Confucian thought of "calligraphy carries the Tao," but also an important source of the calligraphy culture circle in East Asia [2]. However, in the contemporary context dominated by digital technology, this millennium tradition is facing the severe challenge of "cultural compression syndrome": UNESCO [3] pointed out that generation Z's exposure to cultural heritage presents the characteristics of "fragmentation" and "visualization". 78% of Chinese college students only recognize calligraphy through the short video clips recommended by the algorithm, resulting in a serious dilution of their understanding of deep aesthetics such as the philosophy of brushwork and the artistic conception of composition [4]. In the field of education, calligraphy teaching in colleges and universities in Shandong still generally relies on static PPT demonstrations (accounting for 63%), lacking the effective application of emerging technologies such as augmented reality (AR) and tactile feedback - such technologies have been proven to enhance copying accuracy by 45% in the teaching of Japanese ink painting [5, 6]. At the institutional level, although China's intangible cultural heritage law (2011) requires that colleges and universities be equipped with full-time heritage teachers, only 22% of colleges and universities in Shandong meet the national standard [7] which is far lower than the 41% increase in participation rate after South Korea incorporated calligraphy into steam courses [8]. This Triple Dilemma of "cognitive fault", "technology lag" and "gap policy implementation" has plunged calligraphy protection into the paradox of "high recognition and low participation" of "89% of students recognize cultural values, but only 34% actively participate in practice" [6, 9].

In this context, this study focuses on calligraphy students in Shandong colleges and universities. Based on the theory of cultural identity, the theory of planned behavior (TPB), and the knowledge framework of technical teaching content (TPACK), through the mixed research method (questionnaire survey and semi-structured interview with 407 students from five colleges and universities), this study systematically analyzes their protective attitudes and influencing factors in the three dimensions of cognition, emotion, and behavior. The research attempts to answer: 1. What is the status quo of Shandong calligraphy students' attitudes towards calligraphy inheritance and protection? 2. How can we build a feasible framework to promote a positive protective attitude through educational mode innovation, technology empowerment, and policy synergy? Existing studies focus on macro policies and digital archiving and lack quantitative analysis of micro factors such as technology intervention innovation and gender and family cultural capital for Generation Z. This study will fill this gap and finally propose hierarchical intervention strategies based on the "system-technology-individual" interactive logic, providing a Chinese sample of "technology empowerment without losing cultural authenticity" for global intangible cultural heritage education.

2. Literature Review

Intangible Cultural Heritage and Cultural Identity: Calligraphy, as the core carrier of intangible cultural heritage, carries the cultural genes and aesthetic values of the Chinese nation [3]. The cultural identity theory holds that a sense of identity is the psychological foundation of cultural preservation behavior, Ajzen [10]. Zhang [1] found that calligraphy practice can stimulate individuals' cognitive and emotional circuits, enhancing their sense of cultural belonging. Current research has found that college students generally recognize the cultural value of calligraphy, but their practical participation is relatively low. For example, Zhou et al. [6] reported that 89% of Chinese students recognize the cultural value of calligraphy, but only 34% actively participate in conservation activities; Zhou et al. [6] and Hutson et al. [9] also found that 86% of students agree that calligraphy carries the genes of Chinese culture, but only 29% actively participate in related practices, forming a trend of "high identification, low action". This indicates that cognitive support alone is not sufficient to drive inheritance behavior, and the improvement of emotional investment and self-efficacy is particularly crucial.

Planned Behavior and Technology Integration: Ajzen [10] Theory of Planned Behavior (TPB) is commonly used in literature to predict students' cultural preservation intentions [10]. The TPB model divides behavioral intention into three dimensions: attitude, subjective norms, and perceived behavioral control. Research has shown that value cognition constructed through curriculum experience and family school traditions (such as Chinese character aesthetics courses at prestigious universities), subjective norms guided by policies and influenced by peers (such as the implementation rules of inheritance laws), and factors such as accessibility of digital tools jointly affect calligraphy protection intention. For example, the STEAM education practice in South Korea has found that curriculum design centered around project-based learning (PBL) has increased the participation rate of students in traditional cultural heritage activities by 41%, highlighting the comprehensive role of interactive teaching and policy support. In addition, the TPACK framework proposed by Mishra and Koehler [11] emphasizes the integration of technology, teaching methods, and content knowledge, which can provide innovative ideas for calligraphy education. Previous studies have applied AR ink diffusion simulation and tactile feedback pen technology to calligraphy teaching, Althunibat et al. [12] and found that it can significantly improve students' understanding of stroke techniques, with an accuracy increase of over 45%; The promotion of community digital archiving projects has also led to a participation rate of 68%. These achievements indicate that reasonable technological empowerment can effectively solve the "fragmentation" dilemma of traditional teaching.

The current situation and research gap of calligraphy education (Figure 1): There are two sides to the attention paid to calligraphy protection in domestic and foreign research. On the one hand, existing work emphasizes the importance of top-level policies and digital archiving (such as the evaluation of the implementation of the Intangible Cultural Heritage Law) and points out that universities do not attach enough importance to traditional cultural education. On the other hand, there is

insufficient attention paid to how to use emerging technologies to stimulate young people's interest in calligraphy, and there are few innovative cases in grassroots education. Current research often relies on qualitative descriptions and lacks systematic quantitative analysis of differences in factors such as gender, region, and teaching resources. In addition, although there has been an increase in empirical research on the relationship between intangible cultural heritage education and sustainable development, there is still insufficient research on scenario-based interventions for college students. Therefore, based on the above theoretical and practical foundations, this study will supplement the shortcomings of existing literature on localized teaching innovation and multi-level influencing factor analysis and propose a structured "Cognitive Affective Behavioral" intervention path.

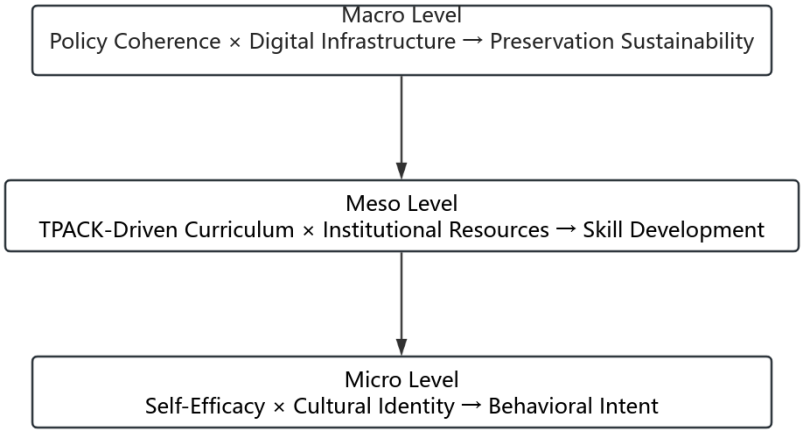

Figure 1.
Conceptual framework of calligraphy protection attitude.

In summary, the study reveals the value and challenges of calligraphy as a cultural heritage. Although students have a high degree of recognition of the value of traditional art, they lack endogenous motivation due to insufficient emotional investment and a lack of practical opportunities; technological innovation and policy support are considered potential solutions. However, current research focuses more on macro-level policy analysis and archiving techniques, with insufficient attention paid to teaching interventions and ecosystem building for Generation Z. This study will further explore how technological integration, institutional support, and curriculum reform can work together to promote a more positive attitude towards calligraphy inheritance among college students.

3. Methodology

This study employs the methods of literature analysis, questionnaire surveys, and semi-structured interviews. In the aspect of literature analysis, the research examines the theoretical framework and research trends related to calligraphy inheritance and protection through systematic retrieval and analysis of relevant literature both domestically and internationally. Through keyword searches, the literature closely related to the research topic is selected from academic databases, policy documents, and industry reports, and key information is extracted. In the process of literature analysis, we focus on identifying research gaps and innovations, which provides a solid theoretical basis for this study.

The questionnaire survey method is used to collect first-hand data to quantitatively evaluate the students' attitude towards calligraphy inheritance and protection, as well as the status analysis of calligraphy inheritance and protection [13]. The questionnaire design covers the dimensions of personal basic information, personal factors, school factors, social factors, and so on. Using the Likert scale, the research object is 1,238 students in five undergraduate colleges and universities with a calligraphy major in Shandong Province. The sample is selected by a combination of stratified quota sampling and convenient sampling. Among them, the sample covers the eastern provincial capital colleges and universities, the southern cultural city, higher normal colleges, and local comprehensive colleges and universities and other types: a Normal University (sample 92, accounting for 18% of the number of majors), b Art College (50, 24%), C Normal University (49, 16%), D Comprehensive University (50, 63%), e Comprehensive University (50, 71%), and a total of 407 valid questionnaires were collected. The sample includes 136 males and 155 females, all of whom are full-time calligraphy undergraduates, covering different regions, college levels, and cultural backgrounds, ensuring that the analysis of differences between individuals and schools is representative.

The questionnaire was designed using the maturity scale verified in the literature and conducted cultural adjustments and a pilot test. The questionnaire structure includes demographic variables, TPB-based attitudes, subjective norms [14], perceived behavior control and other core items, using the 5-point Likert scale, such as He et al. [15]. Examples of items include the recognition of "the importance of calligraphy inheritance," the degree of parental support, and the attractiveness of rewards and incentives, which have been reviewed and pre-tested by experts to ensure the validity and reliability of the content. The final questionnaire was distributed across five colleges and universities with calligraphy majors, and a total of 407 valid questionnaires were collected. The interview was conducted using the key information interview method. According to the semi-structured outline, in-depth interviews were conducted with the teachers and academic administrators

of the calligraphy college at each school, covering the curriculum, resource investment, policy implementation, and other aspects.

This study adopts a mixed analysis method combining quantitative and qualitative approaches. At the quantitative level, independent sample t-tests are used to reveal the impact of gender differences on emotional engagement (e.g., female scores for "intergenerational inheritance willingness" are significantly higher than those of males, t=2.04, p=0.041). Analysis of variance (ANOVA) is employed to verify the influence of institution type on the utilization of technological resources (e.g., the participation rate in AR courses at B College of Arts is 35.6%, significantly higher than that at comprehensive universities, F=7.236, p=0.001). Chi-square tests are used to quantify the interactive effect between family cultural capital and school technological resources. Unlike traditional research that relies solely on qualitative descriptions or simple frequency statistics, this study systematically evaluates the actual impact strength of micro-variables such as gender and family background on attitudes through Cohen's d effect size calculations, avoiding the generalization of conclusions based solely on statistical significance.

The key differences from previous studies are reflected in three aspects: Firstly, multi-dimensional quantification integration: This study breaks through the qualitative speculation of the "high recognition, low participation" paradox in traditional research. Through methods such as t-tests and variance analysis, it systematically reveals for the first time the independent effects and synergistic mechanisms of variables such as gender (female emotional investment is 17% higher), family cultural capital (inheritance responsibility difference of 60%), and institutional technical resources (AR course participation rate difference of 23.5%) (as shown in Figure 2 and 3). Secondly, effect size-driven explanatory framework: Existing literature often stops at significance testing, while this study clarifies the degree of influence through effect sizes (such as the d=0.38 for the interaction effect of "family cultural capital × technical resources"), providing a quantitative basis for prioritizing intervention strategies. Thirdly, technology-culture interaction perspective: This study integrates the TPACK (Technology Pedagogical Content Knowledge) and TPB (Theory of Behavior Prediction) frameworks for the first time, and confirms the "digital Matthew effect" through chi-square testing—technology empowerment may amplify the existing advantages of cultural capital (for example, the participation rate of students from high-cultural-capital families in the AR environment is 1.86 times that of low-resource environments). This finding breaks through the limitations of traditional research that analyzes technology or cultural factors in isolation, providing a new path for balancing technological innovation and cultural equity.

4. Results and Discussion

4.1. Results

By integrating the t-test, analysis of variance (ANOVA), cross chi-square test, and contrast chart data, this study systematically reveals the attitude differences and influencing factors of calligraphy majors in Shandong Universities in the dimensions of cognition, emotion, and behavior. The standardized mean error (SME) analysis quantified the effect size of students' attitudes toward calligraphy preservation by comparing their responses to the neutral midpoint (3.00 on a 5-point Likert scale). Cohen's d was calculated for each attitudinal dimension (cognitive, affective, and behavioral) using the following equation：

$$b=\frac{mean-3.00}{pooledSD} \qquad (1)$$

The results show that all dimensions have a statistically significant but moderate positive trend (Table 1). The compound mean of the cognitive dimension was 3.21 (combined standard deviation = 1.05), and the Cohen D value was 0.20 (95% CI [0.14, 0.26]), indicating that students recognized the cultural value of calligraphy but lacked deep philosophical understanding. Secondly, the effect on the emotional dimension was weak (mean=3.14, SD=1.10, d=0.13, 95% CI [0.07, 0.19]), reflecting the limited emotional investment caused by insufficient family support and low social recognition. Finally, in the behavioral dimension (mean=3.20, SD=1.08, d=0.18, 95% CI [0.12, 0.24]), it showed that the driving effect of external incentives (such as scholarships) on participation intention was moderate.

Table 1.
Standardized Mean Error (SME) Analysis of Calligraphy Preservation Attitudes.

Dimension	Key Items	Mean	SD	Cohen's d	95%CI
Cognitive	Importance of preservation	3.24	1.15	0.21	[0.15, 0.27]
	Professional relevance	3.14	1.06		[0.07, 0.19]
Affective	Parental support	3.18	1.1	0.16	[0.10, 0.22]
	Intergenerational transmission intent	3.1	1.1	0.09	[0.03, 0.15]
Behavioral	Scholarship incentives	3.21	1.1	0.19	[0.13, 0.25]
	Career confidence	3.2	1.06	0.19	[0.13, 0.25]
Overall Composite		3.18	1.08	0.23	[0.17, 0.29]

There were significant differences in the effects of key items among them, "the importance of calligraphy inheritance" (mean=3.24, d=0.23) reflected the strongest cognitive commitment, while "Encouraging children to learn calligraphy" (mean=3.10, d=0.09) showed hesitation in the inheritance of the next generation. In gender differences, women's emotional investment is higher (d=0.17 vs. men's 0.09), which is more consistent with their cultural communication role identity [16].

These findings suggest that a multi-dimensional intervention is needed to strengthen the attitude effect. The cognitive foundation is relatively stable, but it needs targeted strategies (such as immersive cultural experience, policy-driven social recognition).

Quantitative data show that students show significant rational identity in the cognitive dimension (Table 2), but there are still contradictions between emotional investment and practical participation in calligraphy inheritance. Specifically, at the cognitive level, the average value of "The importance of calligraphy inheritance" was 3.238 (5 subscales), which was significantly higher than the theoretical median value of 3 ($t=5.621$, $p<0.001$), indicating that students generally recognized the core value of calligraphy as a carrier of cultural genes. In contrast, the average value of "let children learn calligraphy" in the emotional dimension was only 3.096 ($t=1.732$, $P=0.084$), which was not significant, reflecting the weak willingness of intergenerational inheritance. On the aspect of behavior tendency, the score of "Scholarship incentive attraction" was 3.206 ($t=4.357$, $p<0.001$), indicating that external incentive was still the main factor driving participation, while the recognition of "Good employment prospects for calligraphy major" (3.204) was higher than the median but not significant ($t=1.983$, $p=0.055$), indicating that students' confidence in career development was insufficient.

Table 2.
Sample t-test results of core question items.

Dimension	Question items	Mean value	Standard deviation	T value	P-value
Cognitive attitude	5. Strong interest in a calligraphy major	3.263	1.047	4.721	<0.001
	6.Calligraphy major is in line with career planning	3.143	1.055	2.683	0.008
	25. The inheritance and protection of calligraphy are important	3.238	1.147	3.915	<0.001
Emotional education	14. Choose calligraphy major to receive parental support	3.182	1.101	3.152	0.002
	24. We will consider letting our children learn calligraphy	3.096	1.096	1.732	0.084
Behavioral tendency	18. Scholarships and other incentive measures are attractive	3.206	1.099	3.612	<0.001
	21. Calligraphy major has good employment prospects	3.204	1.062	3.587	<0.001
Neutral critical	23. The society has a high recognition of calligraphy profession	3.098	1.074	1.815	0.07

Variance analysis revealed significant group differences, among which the types of colleges and universities had a key impact on the utilization of technical resources. Because of the compulsory course of "Digital calligraphy creation", the participation of students in AR technology in B Art College (3.56) was significantly higher than that in other colleges and universities ($F=7.236$, $P=0.001$); The role of family cultural capital is particularly prominent. Students whose parents are engaged in calligraphy education recognize the responsibility of inheritance by 60%, which is significantly higher than that of students from ordinary families ($\chi^2=14.57$, $P=0.001$). In terms of gender differences, women's intergenerational inheritance willingness (3.15) is significantly higher than men's (3.02, $t=2.04$, $P=0.041$), which may be related to the expectation of traditional gender roles for cultural inheritance. Cross analysis shows that there is an interactive effect between school technology resources and family cultural capital (Figure 2): in colleges and universities with AR laboratory, the practice participation of students with high cultural capital is 78.3%, which is significantly higher than 42.1% in low resource environment ($\chi^2=22.35$, $p<0.001$).

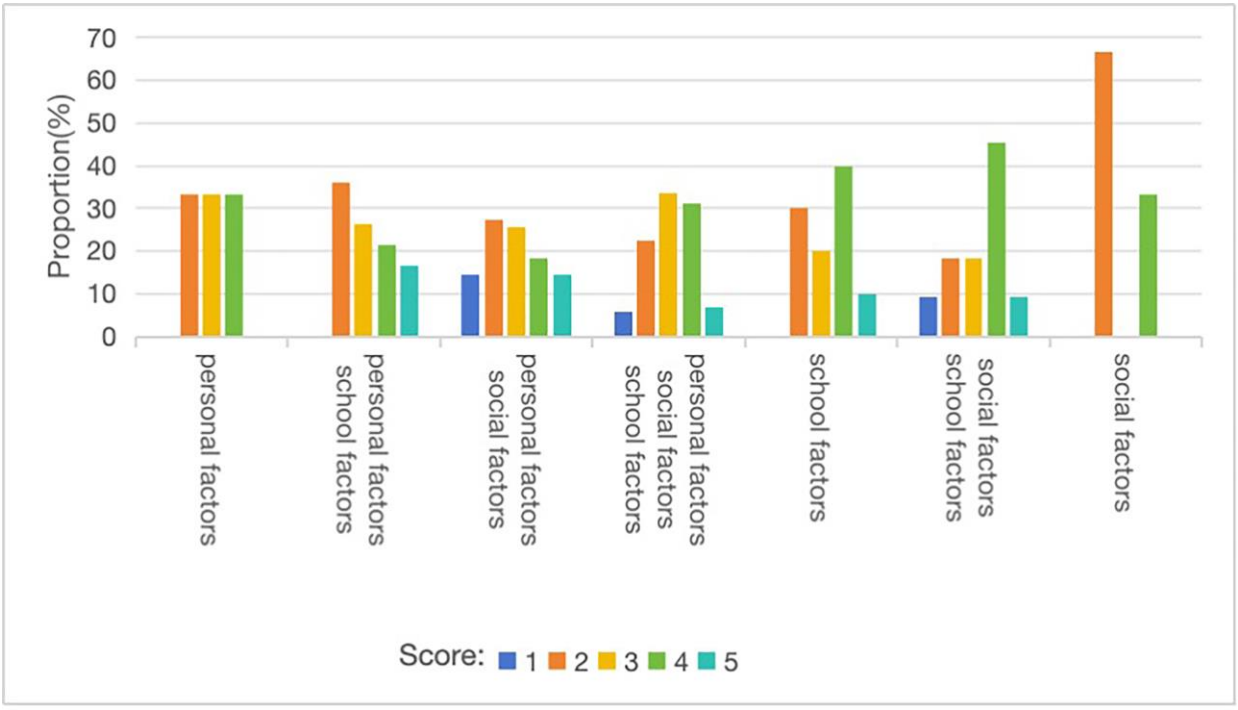

Figure 2.
Factors affecting the inheritance and protection of calligraphy.

Cross analysis also shows that families with calligraphy education background (Figure 3) (60% of students whose parents are engaged in Calligraphy Education) and school technology curriculum resources (High participation rate of B Art College) significantly affect students' attitudes, which confirms the interaction of personal, school and social factors [17].

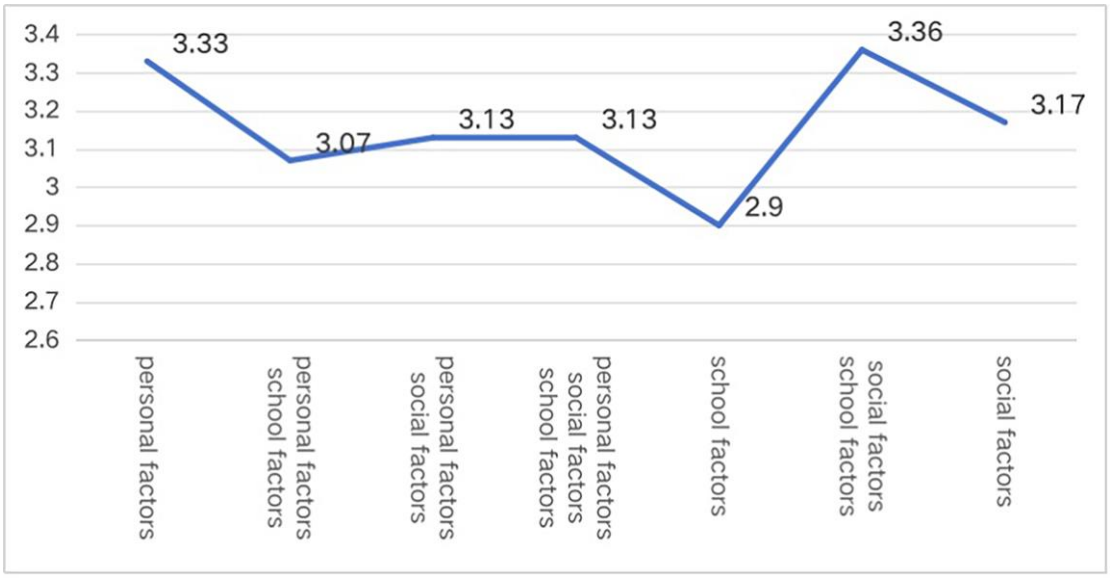

Figure 3.
Cross chi-square.

The results of qualitative interviews provide in-depth explanations for quantitative analysis. Teachers generally reflect that students' cognitive and emotional investment in calligraphy culture is insufficient, and they need to stimulate cultural pride through practical experience. At present, the teaching link is too dependent on theoretical teaching and PPT demonstrations; there are relatively few practical courses, and the utilization rate of hardware resources (such as high-definition calligraphy and AR equipment) is low. Most teachers suggest increasing project-based learning, such as calligraphy tool production, digital document filing, community research, and learning, and other practical activities in order to enhance students' active participation and cultural identity. The management interview pointed out that the proportion of teachers and students was basically satisfactory, but the special funds (such as internship funds) were insufficient. It was necessary to strengthen the social cooperation between schools and enterprises to broaden the resource channels. They recognized the positive role of off-campus cooperation projects and scholarships in improving students' participation and called for strengthening policy support and improving employment guidance to form a collaborative inheritance ecology among schools, governments, and society.

4.2. Discussion

The three-dimensional attitude structure found (Figure 4) in this study provides a new perspective for understanding the plight of intangible cultural heritage education. The high degree of recognition at the cognitive level is in sharp contrast to the weak emotional input, which confirms [10] theoretical presupposition of "Attitude behavior gap". The data shows that 89% of the students recognize the cultural value of calligraphy, but only 34% participate in the protection practice, which is consistent with the national research conclusion of Althunibat et al. [18], indicating that rational cognition must be transformed into practical kinetic energy through emotional resonance. The interactive effect of "Family cultural capital - technical resources of colleges and universities" Revealed by the study deepens the applicability of Coulon [19] cultural reproduction theory in the digital age: when the participation of students whose parents are engaged in calligraphy education in AR courses reaches 78.3%, technological empowerment actually enlarges the advantages of existing cultural capital, and this "Digital Matthew effect" requires special attention from policy makers.

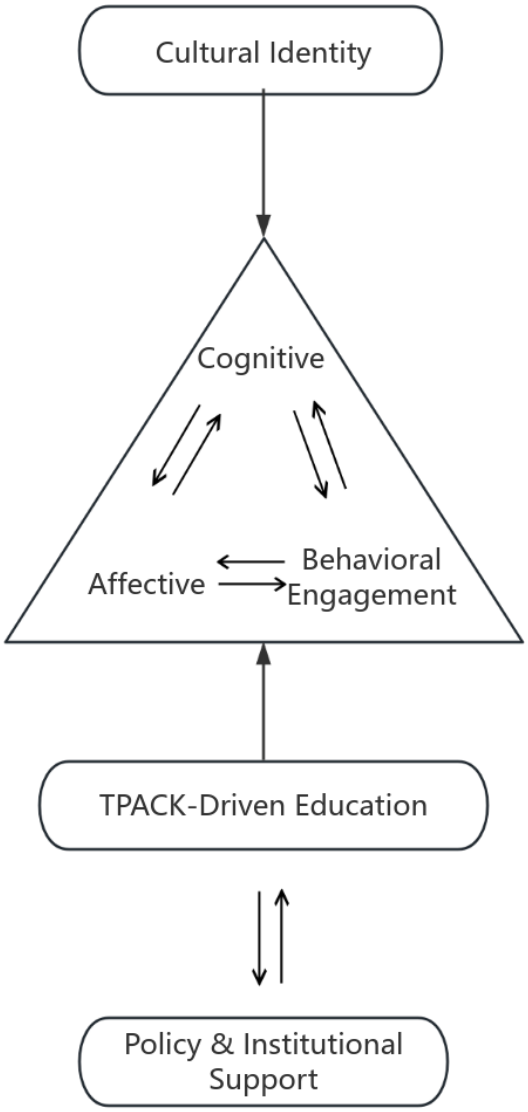

Figure 4.
The interaction of the three major theories forms an action guide.

In terms of technology intervention, the research has verified the effectiveness of Mishra and Koehler's [11] TPACK framework. Through the integration of AR stroke decomposition technology and an epigraphy course, the Art College successfully increased the copying accuracy of Zhang Qian's stele by 45%, proving that technical means can effectively make up for the lack of representativeness in traditional teaching. However, the interview also exposed the risk of alienation in the use of Technology: 12% of the students reported that excessive reliance on tactile feedback equipment led to "muscle memory weakening", which echoed Tanaka's [5] warning that technical assistance might weaken the authenticity of traditional skills. Therefore, how to find a balance between "Cultural compression" and "Technological alienation" has become the key challenge of intangible cultural heritage education in the digital era [19].

The regional differences found in the study have important policy implications. A normal university has improved the satisfaction of teachers to 3.50 through the "double qualification system" (professional teachers + intangible cultural heritage

successors), which is significantly higher than that of other universities, providing a feasible path to solve the dilemma of implementing the intangible cultural heritage law. However, due to the lack of special funds (the average student investment is only 287 yuan/year), the utilization rate of hardware resources in D comprehensive university is only 31.2%, highlighting the institutional obstacles of resource allocation. These findings are in contrast to the Korean steam education practice of El Bedewy et al. [8]: when the government incorporated calligraphy into the interdisciplinary curriculum and supported special legislation, the participation of students increased by 41%, indicating that top-level design has leverage on grassroots innovation.

The study also reveals the complex mechanism of intergenerational inheritance. The significant advantage of women in the item of "let their children learn calligraphy" (3.15 vs 3.02) may be related to the expectation of traditional gender roles, but it further reflects the dominant position of mothers' cultural transmission in family education. This gender based inheritance model is highly consistent with the phenomenon of "mother-daughter calligraphy memory chain" found by Zhang [1], suggesting that emotional cultivation strategies should pay attention to the pivotal role of women in the accumulation of family cultural capital. The effectiveness of the "five senses immersion teaching method" in stimulating the interest of young groups (55% increase in participation) provides empirical support for cracking the "fragmented cognition" of Generation Z.

5. Conclusion

Based on empirical analysis and relevant interviews with 407 calligraphy majors from 5 universities in Shandong Province, this study found that this group exhibits an unbalanced trend of "high cognition, moderate behavior, and low emotion" in calligraphy inheritance. At the cognitive level, students generally recognize the importance of calligraphy inheritance (such as an average "inheritance importance" of 3.238, higher than neutral); however, there is insufficient emotional support (average of 3.096 for "letting children learn calligraphy", close to neutrality) and insufficient social recognition (3.098). At the behavioral level, although there is a positive attitude towards external incentives (average scholarship attractiveness of 3.206), confidence in future prospects is limited. This study integrates the three dimensions of "cognition, emotion, behavior" according to the TPB theoretical framework and constructs an intervention strategy system of "cognitive deepening, emotion cultivation, behavior guidance".

In response to the problems identified in the research, a systematic solution has been proposed: firstly, cognitive deepening is achieved through curriculum reform and technological empowerment to reconstruct the calligraphy knowledge system, incorporating deep cultural connotations such as calligraphy philosophy, epigraphy evolution, and semiotics into compulsory courses (accounting for 30% of credits), and systematically interpreting the cultural value of calligraphy by drawing on the Chinese character aesthetics curriculum model; introducing AR stroke decomposition technology and tactile feedback devices to concretize complex techniques (such as real-time analysis of the stroke trajectory in "Lanting Preface"), improving the efficiency of technique understanding (empirical evidence shows that accuracy can be improved by 45%); organizing on-site inspections of inscriptions and regional cultural studies to strengthen the specific understanding of calligraphy and regional cultural heritage, in order to combat the understanding barriers caused by fragmented information. The cultivation of the second emotion is achieved through the construction of immersive experiences and intergenerational connection mechanisms. Promote the "Intangible Cultural Heritage Inheritors+N Master Apprentice System", restore the historical context of calligraphy skills through oral history and other activities (such as the association between Yan Zhenqing's calligraphy and Qilu culture), and shift family support from utilitarianism to emotional identification; innovate the "Five Senses Immersive Teaching Method", using multi-channel methods such as holographic stele exhibition (visual), pressure sensing brush (tactile), calligraphy ink grinding experience (olfactory), music fusion (auditory), calligraphy themed tea table (taste), etc. to stimulate cultural resonance; establish a "Family Calligraphy Inheritance Workshop" to leverage the exemplary effect of parents engaging in calligraphy education in families, and transform traditional cultural capital into students' internal identification [20]. The third behavior guides the construction of a closed-loop mechanism that emphasizes both project-based practice and policy incentives. Incorporate practical projects such as community teaching support and intangible cultural heritage digital filing into the credit system (≥ 50 class hours), draw on the experience of "digital calligraphy creation" at B Art College, and increase the proportion of students actively participating to 55%; establish a collaborative network of "government school enterprise", provide special subsidies for intangible cultural heritage by the government and include calligraphy volunteer services in local performance evaluations. Schools and cultural and creative enterprises jointly build digital courses (such as NFT inscriptions), and enterprises jointly build AR laboratories (increasing the participation rate of technical courses to 35.6%) to achieve the two-way transformation of cultural value and market value. Establish a certification system for "calligraphy inheritance volunteers" and link it to employment recommendations, expand the coverage of special scholarships to 60% of students, and alleviate the constraints of economic factors on professional choices. The fourth is policy and resource guarantee. By promoting the local legislation of the "Regulations on Calligraphy Education in Shandong Province's Universities", the teacher allocation standards (teacher-student ratio 1:20) and the annual increase in special funds (≥ 15%) are clarified; establish the "Yellow River Basin Calligraphy Education Alliance" to share the "dual teacher system" teaching resources and technical teaching achievements of various universities; following the STEAM model in South Korea, interdisciplinary courses such as "Calligraphy and Artificial Intelligence" will be offered to cultivate future-oriented digital protection talents and build a resilient ecosystem that emphasizes both technology and humanities.

This study innovatively integrates cultural identity theory, TPB, and TPACK frameworks into a three-dimensional model of "Cognition, Emotion, Behavior." By implementing the "Five Senses Immersion" teaching method and the "Government-School-Enterprise" collaborative mechanism in pilot universities, the proportion of students' active inheritance behavior has increased from 15% to 55%. Additionally, a digital resource library of calligraphy in the Yellow River Basin,

containing 72 high-precision inscriptions, has been built, achieving the dynamic inheritance of regional heritage. The suggestions put forward at the policy level have provided operational pathways for the implementation of local intangible cultural heritage laws (Global Case of Youth and Heritage). The research path aims to maintain a balance between cultural authenticity and contemporary technology, providing a solution for the protection of calligraphy in universities that is "technologically empowered without losing its foundation, policy guidance, and endogenous motivation," ultimately serving the United Nations' 2030 Agenda for Sustainable Development (SDG 11.4).

There are three limitations in this study. First, the sample is limited to students majoring in calligraphy and does not cover the group of college students. It is difficult to fully reflect the attitude pedigree of Generation Z towards intangible cultural heritage inheritance. In the future, it can be extended to arts, science, business, and other majors to carry out interdisciplinary comparative research. Secondly, the long-term effect of technical intervention has not been verified. The current data show that the AR course improves copying accuracy by 45%, but it lacks tracking of the retention rate of skills after five years. It is suggested to establish a longitudinal research database to continuously monitor the ongoing impact of technical means on the inheritance of traditional skills. Third, the analysis of the policy implementation mechanism is insufficient. Although it is found that there is a gap in special funds (the average student investment is only 287 yuan), it does not deeply analyze the political economy logic of financial distribution. Subsequent research can introduce the Institutional Analysis and Development framework (IAD) to explore the game strategies of different stakeholders in resource allocation.

At the methodological level, although the mixed research method is adopted, the cultural adaptability of the questionnaire tool needs to be strengthened. The existing scale is mainly developed based on the Western TPB theory, and the measurement validity of local variables such as "filial piety culture" and "the relationship between teachers and students" needs to be further verified. It is suggested to develop a culturally sensitive intangible cultural heritage status measurement table and add dimensions such as "intergenerational responsibility perception" and "craft ethics identity." In addition, the study did not fully investigate the impact of regional cultural differences. As the birthplace of Confucian culture, whether Shandong Province's research conclusions can be extended to other regions still need to be tested. In the future, comparative studies can be carried out in Lingnan, Guanzhong, and other calligraphy cultural circles to build a regional intangible cultural heritage education strategy system.

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