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An empirical study on traditional culture and interdisciplinary teaching: a case study of the San Zhao Lantern

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Introduction: Integrating Chinese traditional culture into modern education is increasingly emphasized, yet effective methods remain underexplored. This study investigates how traditional cultural elements, specifically the San Zhao Lantern, can enhance interdisciplinary teaching, using the Stimulus-Organism-Response (S-O-R) framework.

Methods: The study involved 5th and 6th-grade students from G Primary School in City B. Data were collected through classroom observations, questionnaires, and learning outcome assessments to evaluate students' cultural identity, learning interest, and classroom engagement in an interdisciplinary teaching context incorporating the San Zhao Lantern.

Results: The integration of traditional cultural elements significantly enhanced students' cultural identity, increased learning interest, and improved classroom engagement.

Discussion: These findings provide empirical support for incorporating traditional culture into modern education, validating the effectiveness of interdisciplinary teaching designs under the S-O-R framework. This study offers new perspectives for educational practice, highlighting the potential of cultural elements like the San Zhao Lantern to enrich teaching.

KEYWORDS

Sanzhao Lantern, traditional culture, interdisciplinary teaching, empirical study, cultural identity

1 Introduction

In the context of globalization, culture-based education has gained increasing relevance as educators seek to balance global competencies with local identity. Many countries have called for pedagogical approaches integrating traditional cultural values to promote character development, social cohesion, and cultural continuity. However, traditional culture is often sidelined in formal curricula, especially in STEM-dominated learning environments. Against this backdrop, this study explores a culturally embedded interdisciplinary approach that uses traditional Chinese cultural elements, such as the San Zhao Lantern, to address these global educational challenges.

The San Zhao Lantern, originating from the Western Han Dynasty, is one of the significant symbols of traditional Chinese culture (Liu, 2015). It not only reflects the ingenuity and craftsmanship of ancient artisans but also embodies profound cultural meanings, commonly associated with festivals and ceremonies as a symbol

of auspiciousness, unity, and celebration. Over centuries, the San Zhao Lantern has gradually become an integral part of Chinese traditional festival culture, playing a crucial role in cultural heritage and transmission (Wang and Pan, 2009). However, with the advancement of modernization, the preservation and promotion of the San Zhao Lantern face considerable challenges, highlighting the increasing necessity of integrating it into contemporary education (Qi, 2015; Hu, 2017).

This study primarily explores how traditional cultural elements can be effectively incorporated into interdisciplinary teaching in modern education. Specifically, it examines innovative approaches to embedding the San Zhao Lantern, as a traditional cultural symbol, into various academic disciplines by integrating arts, history, and science into a unified classroom activity. This interdisciplinary design is innovative in that it moves beyond traditional single-subject instruction, enabling students to experience cultural learning through hands-on creation, collaborative discussion, and contextual inquiry. The objective of this research is to identify intersections between traditional culture and modern education, proposing pedagogical strategies that align with contemporary educational needs. By doing so, it aims to facilitate students' understanding and inheritance of traditional culture within interdisciplinary learning, thereby enhancing their cultural confidence and overall competencies.

In line with China's competency-based education reforms and character education policies, this research aligns with national efforts to cultivate students' core values, cultural identity, and innovative thinking. Elementary school curricula are increasingly expected to integrate moral, esthetic, and practical education, yet structured opportunities for incorporating localized cultural content remain limited. This study thus provides a viable interdisciplinary strategy to bridge policy vision and classroom practice.

While existing studies have explored traditional culture's general role in esthetic education, moral instruction, or extracurricular activities, there remains a noticeable gap in empirical research examining how specific cultural elements, such as the San Zhao Lantern, can be effectively embedded within interdisciplinary classroom teaching. Moreover, although some studies acknowledge the affective and cognitive impact of culture-based learning, they often lack structured theoretical models to systematically assess these effects. In particular, few have applied the Stimulus-Organism-Response (SOR) framework in this educational context. Compared to other models such as Theory of Planned Behavior (TPB) or Attention, Relevance, Confidence, Satisfaction (ARCS), the SOR framework allows for a more integrated understanding of how cultural symbols function as external stimuli, triggering students' internal cognitive and emotional responses, which in turn influence their observable learning behaviors. This theoretical lens not only captures the psychological transformation of learners but also connects it to pedagogical outcomes, making it especially suitable for analyzing interdisciplinary teaching infused with local cultural content.

Investigating the interdisciplinary teaching design and application of the San Zhao Lantern not only contributes to the preservation and transmission of traditional culture but also provides new perspectives for contemporary teaching practices. Enriching educational content and fostering students' cultural literacy and holistic abilities, this study seeks to validate the feasibility and effectiveness of such an approach in classroom settings. Guided by the Stimulus-Organism-Response (SOR) framework, the study conceptualizes the introduction of traditional culture as the stimulus, students' internal cognitive and emotional changes as the organism, and their learning behaviors as the response.

Ultimately, it aims to promote a deeper integration of traditional culture and modern education, achieving both educational innovation and cultural continuity.

2 Related research

2.1 Student developmental characteristics in grades 5 and 6

In line with student development theory, children in Grades 5 and 6 (typically from 10 to 12) are in a critical transitional stage from concrete operational to formal operational thinking, as described by Piaget. This stage is marked by growing abilities in abstract reasoning, cultural understanding, and social identity formation. Erikson's psychosocial theory also identifies this period as one of industry versus inferiority, where students begin to seek meaning in social roles and cultural heritage. These psychological characteristics make students particularly receptive to interdisciplinary and culture-integrated teaching approaches that stimulate identity-building and engagement. Therefore, the selection of traditional cultural content, such as the San Zhao Lantern, is developmentally appropriate and pedagogically sound, supporting the formation of both cognitive and cultural competencies.

This theoretical foundation further justifies the research objective of exploring how traditional culture-based interdisciplinary instruction can influence students' cultural identity, learning interest, classroom participation, and cultural heritage awareness.

2.2 Integration of traditional culture into teaching

Extensive research, both domestic and international, has explored the integration of traditional culture into education. In China, Shao et al. have highlighted that incorporating traditional festivals and folk crafts into teaching can enhance students' cultural identity and sense of pride (Shao, 2024). Similarly, Jia et al. have emphasized that integrating traditional culture into language and history curricula not only stimulates students' interest in learning but also facilitates a deeper understanding of cultural connotations (Jia, 2020). Internationally, Сосницький et al. have examined how traditional cultural elements can be integrated into interdisciplinary teaching, particularly within the fields of art and social sciences. For instance, they implemented project-based integration of Ukrainian folk art into primary-level interdisciplinary classes, employing PBL and performance assessments to evaluate shifts in students' cultural identity and collaborative learning. Their study suggests that project-based learning can significantly enhance students' holistic

competencies (Sosnytskyi et al., 2024). This methodological alignment with the present study supports the transferability of PBL in traditional culture instruction. Wickline et al. have investigated the incorporation of traditional cultural content into literature courses, demonstrating that experiential teaching methods can improve students' cultural awareness (Wickline et al., 2024). Though situated in a Western context, their experiential learning framework inspires the use of immersive, student-centered strategies in this study. By adapting these international models to Chinese cultural settings, this research conducted innovative explorations, offering localized pedagogical insights tailored to the integration of Chinese intangible cultural heritage such as the San Zhao Lantern.

These studies indicate that the integration of traditional culture into education is not only crucial for cultural heritage preservation but also plays a vital role in fostering students' critical thinking and multidimensional skills. However, certain challenges remain in the pedagogical design of traditional culture education, particularly in terms of diversity and innovation. For instance, Hou et al. have pointed out that contemporary traditional culture education often remains superficial, lacking in-depth interdisciplinary integration, which limits students' engagement and deeper involvement (Hou, 2024). Similarly, Liu et al. have argued that traditional culture curricula tend to be overly rigid, failing to accommodate students' individual needs and the evolving landscape of modern education, ultimately leading to suboptimal teaching outcomes (Liu A. et al., 2024).

2.3 Theoretical foundations and practical applications of interdisciplinary teaching

The theoretical foundations of interdisciplinary teaching stem primarily from the evolution of educational theories and the need for knowledge integration. It is an instructional approach that organically combines knowledge and skills from multiple disciplines, with its core principle being the dissolution of disciplinary boundaries. This approach fosters a more holistic learning experience, enabling students to comprehend and address complex problems from multiple academic perspectives. Interdisciplinary teaching typically employs strategies such as Project-Based Learning (PBL) and Inquiry-Based Learning (IBL), encouraging students to apply knowledge from different subject areas in the process of solving real-world problems. It is implemented through diverse formats, including case studies, collaborative group work, and project design. The advantages of interdisciplinary teaching lie in its ability to cultivate students' critical thinking and problem-solving skills while enhancing the practical applicability of learning. Through interdisciplinary study, students can establish stronger connections between different knowledge domains, thereby deepening their conceptual understanding. Furthermore, this approach helps to stimulate students' interest in learning, increase their engagement and hands-on experience, and foster creative thinking. In recent years, a growing body of empirical research has demonstrated the effectiveness of PBL and IBL in enhancing student outcomes, particularly in culturally themed courses. For instance, Häikiö found that project-based integration of local folklore and art significantly improved student engagement and cultural awareness (Häikiö, 2018). These findings suggest that when traditional cultural content is embedded into interdisciplinary designs using PBL strategies, it can lead to both cognitive and affective learning gains.

In the context of traditional culture education, interdisciplinary teaching is characterized by its emphasis on cultural immersion, artifact-based learning, and multi-sensory engagement. Rather than treating culture as a stand-alone subject, this approach integrates cultural themes—such as symbolism in lanterns, esthetic principles in calligraphy, and storytelling in folk tales—into language, art, history, and even science curricula. These characteristics allow students to connect emotionally and intellectually with cultural content, encouraging both appreciation and critical inquiry.

Compared with other theoretical models, such as the TPB, ARCS motivation model, or student engagement theory, the SOR framework offers a more comprehensive lens by bridging external stimuli with internal psychological states and observable behaviors. While TPB emphasizes behavioral intention and ARCS focuses on motivation design, neither fully accounts for the dynamic emotional and cognitive processing stimulated by cultural elements. The SOR framework, by contrast, enables an integrated analysis of how cultural stimuli elicit psychological responses that result in observable learning behaviors. This makes SOR particularly well-suited for examining culture-based interdisciplinary instruction.

In the integration of traditional culture into teaching practice, cultural elements such as paper-cutting and calligraphy have been successfully incorporated into classroom instruction, providing valuable insights. For instance, paper-cutting art has been widely applied in art lessons, not only equipping students with hands-on craft skills but also helping them understand traditional Chinese festivals and folk culture (Yang, 2024). Through paper-cutting activities, students enhance their practical skills while developing an appreciation for and interest in traditional culture. Calligraphy, another significant element of traditional culture, has also been successfully integrated into language and art curricula (Zhu, 2006). Calligraphy practice enables students not only to master Chinese character writing techniques but also to appreciate the esthetic beauty and cultural significance of Chinese script. Many schools organize calligraphy competitions and exhibitions, which reinforce students' sense of cultural identity while enhancing their artistic literacy and concentration (Guo, 2015).

2.4 Challenges in traditional culture education and the application of SOR

While the integration of traditional cultural elements into teaching has demonstrated its potential to stimulate student interest, enhance cultural confidence, and provide valuable resources for educational innovation, existing research and practice still exhibit several limitations. Firstly, most studies predominantly focus on the superficial meaning of cultural symbols and the transmission of knowledge, often neglecting the complex interaction between students' internal psychological responses and behavioral transformations. As a result, traditional

cultural education often lacks depth in practical implementation, making it difficult to sustain student engagement and encourage deeper cognitive reflection (Liu X. et al., 2024). Secondly, the instructional approaches to traditional culture tend to suffer from insufficient interdisciplinary integration, leading to a relatively singular pedagogical effect that fails to leverage the advantages of modern interdisciplinary collaboration in education (Wei, 2024).

In response to these challenges, this study introduces the SOR framework to examine how cultural symbols influence students' learning motivation and behavioral outcomes through psychological reactions. This framework not only considers external stimuli, such as the San Zhao Lantern, but also delves into students' psychological response processes and how these responses translate into actual learning behaviors and classroom performance. The study primarily addresses the following research questions:

(1) How does the San Zhao Lantern, as a traditional cultural symbol, influence students' learning motivation and cultural identity?
(2) How can interdisciplinary teaching incorporate the San Zhao Lantern to enhance students' learning interests and overall competencies?
(3) How do students' learning motivation and cultural identity transform into active participation and behavioral engagement in the learning process?

To address these research questions, this study develops a research model based on the SOR framework (Mehrabian and Russell, 1974). According to this framework, when individuals encounter external environmental stimuli, they first develop internal psychological responses, which in turn influence their behavioral reactions. In the context of this study, the San Zhao Lantern functions as an environmental stimulus, potentially eliciting psychological responses such as learning motivation and cultural identity among students. As these psychological responses intensify, students may engage in interdisciplinary learning activities that further enhance their cultural identity and participation. Ultimately, the improvement in learning motivation and cultural identity is expected to lead to greater student engagement and performance in interdisciplinary learning.

To test these hypotheses, this study employs a sample of 715 students from 14 classes in Grades 5 and 6 at G Primary School in City B. Data analysis is conducted using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method. To mitigate the risk of common method bias, data are collected in two rounds with a 2-week interval between them (Podsakoff et al., 2012). The findings of this research will provide insights into how the integration of traditional cultural symbols with interdisciplinary teaching can enhance students' learning motivation and cultural identity.

This study makes several key contributions. Firstly, although extensive research has explored the role of traditional culture in education, most studies have primarily focused on the surface-level behavioral effects of cultural symbols, overlooking their deeper psychological impact on students. By employing SOR, this study examines how cultural symbols can stimulate students' learning motivation and cultural identity. Secondly, this study focuses on the integration of traditional culture into interdisciplinary education, offering empirical evidence on how cultural symbols can be effectively incorporated into multi-disciplinary learning. Thirdly, unlike existing studies that predominantly assess educational outcomes through academic performance, this study prioritizes students' learning engagement, providing a more comprehensive assessment of the impact of traditional culture and interdisciplinary teaching on students' overall learning experience.

3 Overview of the SOR framework

The SOR framework originated from environmental psychology research. This framework posits that external environmental factors act as stimuli, influencing an individual's internal cognitive and emotional states, which in turn shape behavioral responses. These responses typically manifest as either approach or avoidance behaviors (Koeske and Koeske, 1993). Approach behavior refers to an individual being drawn toward a particular stimulus, whereas avoidance behavior denotes a reaction of withdrawal or disengagement in response to a stimulus (Russell and Mehrabian, 1976). The choice between these behaviors depends on the emotional state elicited by the stimulus, such as pleasure, curiosity, or stress. The SOR framework has been widely applied in explaining psychological and behavioral reactions across various contexts.

In recent years, a few studies have explored the application of the SOR framework in educational settings that involve cultural or heritage elements. For example, some research has investigated how traditional art exhibitions or culturally themed environments influence students' emotional engagement and learning interest (Lau and Shea, 2024). However, these studies often remain at a conceptual level or focus narrowly on affective responses, lacking comprehensive models that connect emotional resonance with sustained behavioral engagement in classroom learning. Moreover, there is limited empirical research applying the SOR model specifically to traditional Chinese culture within interdisciplinary education. The present study aims to address this gap by constructing a more integrated framework that examines not only emotional responses but also cognitive understanding and behavioral outcomes in a multi-modal learning environment.

In educational settings, for instance, traditional cultural elements serve as external stimuli that can evoke emotional resonance and a sense of cultural identity, thereby influencing students' learning motivation, cultural cognition, and behavioral engagement (Zhou Z. et al., 2024).

According to the SOR model, the "Organism" (O) component captures the learner's internal psychological processes, which include both emotional and cognitive elements. In the context of this study, "learning interest" reflects intrinsic motivation—a core construct in self-determination theory (Ryan and Deci, 2000)—while "cultural identity" relates to social identity theory and cultural affiliation (Vaughan et al., 1981). These two elements interact synergistically: when students feel emotionally connected to cultural content, such as pride or belonging, they are more likely to develop sustained interest and deeper cognitive engagement. This integrated psychological state influences how they process information and respond behaviorally to the learning environment.

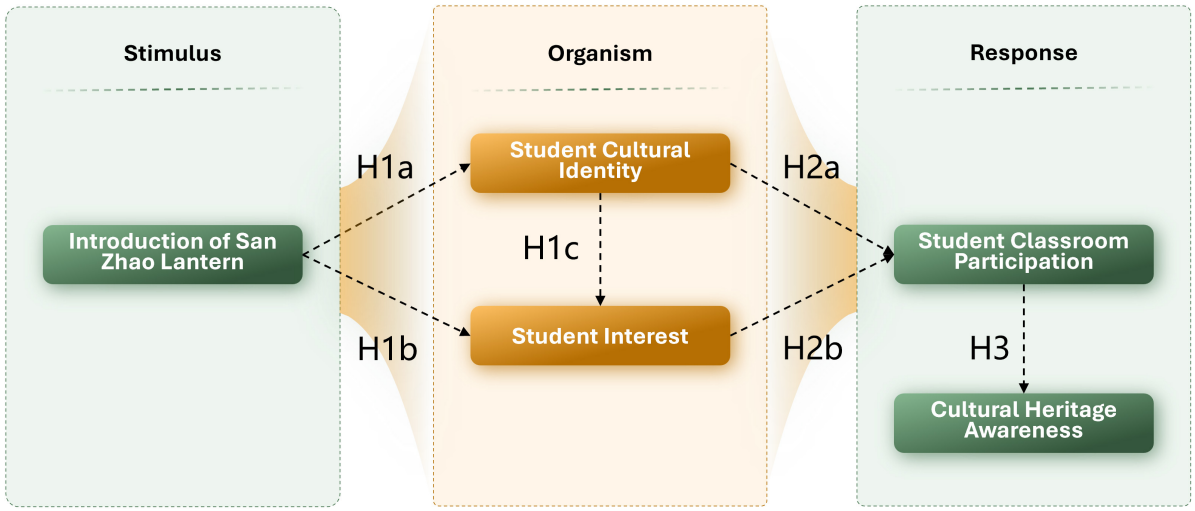

FIGURE 1
Research model based on SOR.

Recent studies have also employed the SOR framework to explore similar mechanisms in cross-cultural or heritage learning contexts, such as Onosu (2021), who demonstrated that students' emotional immersion and identity recognition in folk culture workshops led to increased motivation and participation in project-based learning.

In the specific context of elementary education, the SOR framework can be effectively translated into classroom practice by carefully designing learning environments and activities that incorporate traditional cultural stimuli. For example, the visual presence of the San Zhao Lantern, accompanied by storytelling sessions explaining its origins, symbolic meanings, and ritual practices, serves as the "Stimulus" (S). This stimulus evokes students' curiosity, cultural pride, and esthetic appreciation, forming the "Organism" (O) component—internal psychological responses such as interest, engagement, and emotional identification. These affective and cognitive responses, in turn, trigger observable behaviors "Response" (R), including increased participation in classroom discussions, higher involvement in hands-on activities, and improved retention of cultural knowledge.

This translation of the SOR model into elementary school contexts emphasizes age-appropriate, sensory-rich, and emotionally engaging experiences that bridge traditional knowledge with modern pedagogical strategies.

Figure 1 illustrates the conceptual model based on the SOR framework. The model proposes that the San Zhao Lantern, as a cultural "Stimulus" (S), activates students' internal psychological states (O), primarily their learning interest and cultural identity. These organismic states serve as mediators that influence students' observable "Responses" (R), such as participation in interdisciplinary activities, creative expression, and knowledge acquisition. The model assumes that the stronger the organismic responses (e.g., higher interest and stronger cultural identification), the more positive and sustained the behavioral outcomes. The directional paths from S to O to R represent a logical flow of influence, which forms the theoretical basis for the hypotheses tested in this study.

This study employs the SOR framework to propose a set of hypotheses concerning the psychological responses and behavioral manifestations of students about the San Zhao Lantern as a traditional cultural symbol, as illustrated in Figure 1. The framework is utilized to examine how the San Zhao Lantern, as an element of traditional culture, influences students' internal psychological states and consequently shapes their learning behaviors.

In the proposed research model, the San Zhao Lantern is conceptualized as a stimulus (S) representing a traditional cultural symbol, capable of eliciting students' interest and cultural identity (O). These intrinsic psychological responses, in turn, influence their learning performance and classroom engagement (R) within an interdisciplinary teaching context. The San Zhao Lantern embodies the profound history and values of Chinese traditional culture. By integrating it into interdisciplinary education, students are exposed to this cultural symbol through multiple modalities, including visual perception, hands-on activities, and experiential learning. Furthermore, by exploring the historical significance and underlying meanings of the San Zhao Lantern, students can develop a deeper cognitive understanding and emotional affiliation with their cultural heritage.

For instance, the craftsmanship, symbolic meanings, and cultural background of the San Zhao Lantern can serve as interdisciplinary teaching materials, effectively incorporated into subjects such as Chinese language, fine arts, and history. Through this interdisciplinary integration, students experience the richness of traditional culture within a multi-disciplinary interactive framework. This complex stimulation process fosters students' learning interest and, by enhancing their cultural confidence and identity, further influences their academic performance (Huang, 2018).

Moreover, this study posits that students' positive emotional responses toward the San Zhao Lantern as a cultural symbol will strengthen their engagement and participation in interdisciplinary learning. This approach not only enhances their learning

motivation and cultural identity but also facilitates holistic skill development through active interaction (Wang, 2024).

4 Research hypotheses

4.1 The introduction of the San Zhao Lantern, cultural identity, and learning interest

As the integration of traditional culture in education gains increasing attention, the incorporation of cultural symbols has been shown to effectively enhance students' cultural identity and learning interest (Li et al., 2024). The San Zhao Lantern, as a significant emblem of Chinese traditional culture, has the potential to evoke students' emotional resonance and learning motivation, thereby contributing to improved academic performance (Wang, 2000). In this study, we adopt the term "learning interest" to denote students' intrinsic cognitive and emotional inclination toward engaging with the learning material. Although closely related to "learning motivation," learning interest emphasizes the situational and affective responses triggered by specific stimuli (Hidi and Renninger, 2006).

Beyond its historical and cultural significance, the San Zhao Lantern serves as a pedagogical tool that encourages students to explore its underlying narratives and values, fostering greater classroom engagement and learning motivation. Recent research has shown that exposure to culturally resonant symbols can stimulate students' curiosity and emotional engagement, which are foundational to developing sustained learning interest (Zhou J. et al., 2024). Such symbols act not only as esthetic stimuli but also as vehicles of meaning-making, which can increase students' intrinsic motivation to learn (Ryan and Deci, 2000). Therefore, it is hypothesized that the San Zhao Lantern, by embodying traditional values and esthetic richness, may directly influence students' learning interest.

In this study, the San Zhao Lantern is conceptualized as an external stimulus that exerts a positive influence on students' internal psychological states. This influence is expected to manifest in the form of positive emotional responses, such as enhanced cultural identity and increased learning interest, which in turn affect their learning behaviors, including classroom engagement and academic performance. Accordingly, the following hypotheses are proposed:

> (1)*H1a*: The introduction of the San Zhao Lantern is positively associated with students' cultural identity.
> (2)*H1b*: The introduction of the San Zhao Lantern is positively associated with students' learning interests.
> (3)*H1c*: Students' cultural identity is positively associated with their learning interests.

Moreover, given that cultural identity has been linked to both emotional engagement and motivational regulation (Tajfel, 1981), it is reasonable to consider its potential mediating role. Specifically, students who internalize cultural identity may experience heightened learning interest, which in turn promotes classroom engagement. This mediating pathway warrants further empirical exploration through methods such as bootstrapping mediation tests (Preacher and Hayes, 2008).

4.2 Students cultural identity, learning interest, and classroom engagement

When exposed to traditional cultural symbols, students may experience heightened emotional resonance and a strengthened sense of cultural identity, both of which have been found to significantly enhance classroom engagement (Li, 2009). Students with a strong sense of cultural identity are more likely to actively participate in class, demonstrating greater learning interest and intrinsic motivation (Zheng, 2024). Based on this premise, the following hypotheses are proposed:

> (1)*H2a*: Students' cultural identity is positively associated with classroom engagement.
> (2)*H2b*: Learning interest is positively associated with classroom engagement.

4.3 Students classroom engagement and cultural heritage awareness

Classroom engagement serves as a key indicator of students' overall learning experience, reflecting not only their academic engagement but also their awareness of cultural heritage (Wu, 2024). By fostering higher levels of classroom engagement, students are more likely to develop a deeper understanding of course content, thereby strengthening their cultural heritage awareness and academic performance. Accordingly, the following hypothesis is proposed:

> (1)*H3*: Students' classroom engagement is positively associated with their awareness of cultural heritage.

5 Research design

5.1 Implementation of interdisciplinary teaching

The instructional design of this study incorporates art, history, and language as the core interdisciplinary domains. Through the hands-on creation of San Zhao Lanterns, students engage in both practical craftsmanship and cultural exploration, fostering a deeper understanding of traditional culture.

The art curriculum focuses on developing students' creativity and manual skills through paper-cutting and decorative design of San Zhao Lanterns. The history component contextualizes the lanterns within their historical and cultural backgrounds, enabling students to explore their origins, symbolic meanings, and roles in Chinese festivals, thereby enhancing their cultural awareness. The

language curriculum integrates stories and poetry related to San Zhao Lanterns, aiming to improve students' linguistic expression and cultural comprehension.

In practice, interdisciplinary teaching is implemented through the integration of these three subject areas. Educators first develop an interdisciplinary teaching plan, clearly defining the learning objectives for each subject and systematically incorporating lantern-making activities, artistic design, cultural background analysis, and linguistic expression. During the instructional process, teachers guide students in the hands-on construction of lanterns, encourage collaborative group work and class discussions, and facilitate the application of artistic techniques and historical knowledge in practical contexts. Additionally, students are encouraged to articulate their learning outcomes through verbal and written expression.

To support this interdisciplinary approach, a structured teacher collaboration model is established, which includes joint lesson planning sessions, co-teaching opportunities, and regular interdisciplinary coordination meetings. Art, history, and language teachers collaboratively design the lesson sequence, determine overlapping content areas, and develop shared assessment rubrics that reflect both subject-specific and cross-disciplinary competencies. This collaboration ensures that instructional goals are aligned, content is coherently integrated, and student learning experiences are seamless across disciplines.

By adopting this comprehensive learning model, students not only gain a multidimensional understanding of San Zhao Lanterns from different disciplinary perspectives but also develop their interdisciplinary competencies, enhancing their ability to synthesize knowledge across multiple domains.

Figure 2 illustrates the integration logic of the interdisciplinary teaching approach for the San Zhao Lantern activity. It demonstrates how the disciplines of Arts, History, and Language converge around the core cultural activity, highlighting their collaborative interactions and dynamic feedback loops to foster a holistic learning experience.

5.2 Sampling procedure

The research sample was determined before the commencement of the teaching activities. The data were collected from G Primary School in City B, an institution renowned for its high-quality teaching resources and strong support for interdisciplinary education. The sample consisted of 14 classes from Grades 5 and 6, with a total of 715 students—360 students from seven Grade 5 classes and 355 students from seven Grade 6 classes. Of these, 53% were male and 47% were female, with an average age of 11.42 years. This age group is particularly well-suited for integrating traditional cultural education with interdisciplinary teaching, facilitating an effective assessment of the application of San Zhao Lanterns in an educational context.

A purposive sampling method was adopted in selecting participating classes. Specifically, the school administration and research team jointly selected 14 intact classes based on three main criteria: (1) the availability of interdisciplinary course modules in art, language, and history; (2) prior experience of teachers in project-based or thematic teaching; and (3) logistical feasibility for implementing sequential data collection. This purposive strategy ensured that the sample would reflect a learning environment conducive to interdisciplinary cultural instruction, rather than relying on random assignment which may have introduced variability in instructional conditions.

Classroom-based sampling offers multiple advantages in educational research, significantly enhancing the quality of data collection. Firstly, classrooms provide a convenient and cost-effective source of data, as students are readily accessible to researchers. Secondly, the structured learning environment ensures students remain focused during data collection, which is essential for obtaining high-quality responses. Thirdly, the flexibility of the classroom setting allows for a more systematic implementation of sequential data collection, thereby improving the validity and richness of the data. Lastly, incorporating data from multiple classes across different grade levels enhances the representativeness of the sample, offering a more comprehensive reflection of the broader student population.

Although the study did not adopt a randomized controlled design, it followed a quasi-experimental approach by implementing the intervention in intact classes across multiple grade levels. The lack of a separate control group was addressed through temporal separation of data collection and classroom-level statistical adjustments, enhancing the internal validity of the findings.

The sample size of 715 students meets the commonly accepted statistical requirement for SEM, which recommends a minimum of 10 respondents per estimated parameter or observed indicator (Wolf et al., 2013). Given that the study's model includes approximately 17 observable indicators across all constructs, the current sample size exceeds this 10:1 rule-of-thumb threshold and provides adequate statistical power for model estimation and validation.

To account for potential class-level variation, the statistical analysis included the classroom as a clustering variable. Specifically, robust standard errors were estimated using the sandwich estimator in Mplus to adjust for non-independence within classes. This adjustment ensured that any bias introduced by classroom-level differences (e.g., teacher style, class atmosphere) did not distort the relationships among student-level variables. Preliminary intraclass correlation coefficients (ICCs) for the key variables were also calculated and found to be within acceptable limits (< 0.10), indicating relatively low between-class variance.

While the sample was drawn from a single institution, G Primary School's strong emphasis on interdisciplinary education and its status as a regional model school provide a relevant and rigorous context for testing the intervention. Future studies may consider extending the sample to multiple schools to enhance generalizability.

The statistical characteristics of the sample ($N = 715$) are visually summarized in Figure 3. Among the participants, 379 were male (53%), and 336 were female (47%). The grade distribution was balanced, with 360 students in Grade 5 and 355 in Grade 6. In terms of age distribution, the sample included 3 students aged 9, 66 students aged 10, 303 students aged 11, 311 students aged 12, and 32 students aged 13. The mean age of the sample was 11.42 years, with a standard deviation of 0.74, reflecting the age characteristics of the target population.

Table 1 presents the demographic characteristics of the respondents, including gender, age distribution, and grade level.

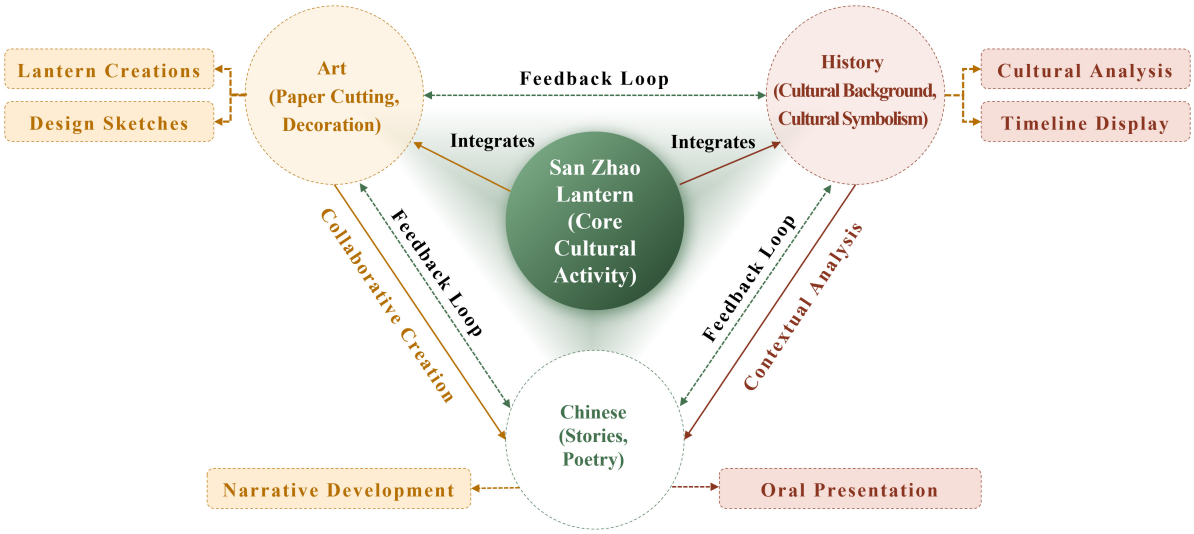

FIGURE 2
Integration logic of interdisciplinary teaching for the San Zhao Lantern.

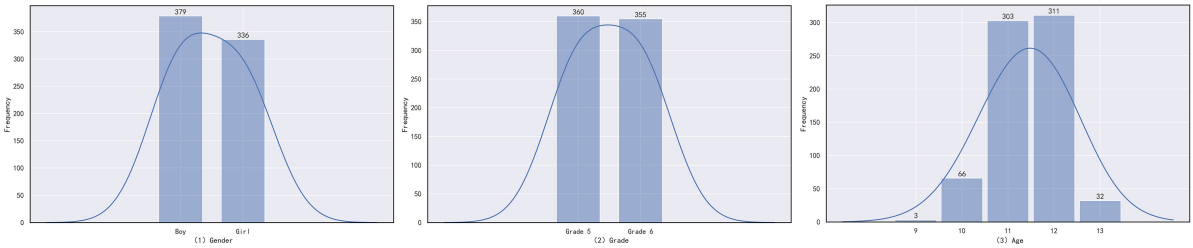

FIGURE 3
Sample statistical characteristics.

TABLE 1 **Demographic characteristics of the respondents.**

Variable	Category	Frequency	Percentage	Statistic
Gender	Male	379	53.01%	–
	Female	336	46.99%	–
Age	9	3	0.42%	–
	10	66	9.23%	–
	11	303	42.38%	–
	12	311	43.50%	–
	13	32	4.48%	–
	–	–	–	Mean: 11.42/SD: 0.74
Grade	Grade 5	360	50.35%	–
	Grade 6	355	49.65%	–

5.3 Data collection

Data collection was conducted during the implementation of interdisciplinary teaching at G Primary School, City B, between March and June 2024. Data were gathered using paper-based questionnaires administered to 5th and 6th-grade students, designed following best practices to optimize response quantity and quality. This included clear and simple question wording, logical sequencing, and a minimal number of questions. The questionnaire underwent multiple rounds of editing to ensure conciseness and clarity.

To mitigate common method bias, where respondents may consistently answer multiple variable measurements, the data collection was split into two stages with a 2-week interval, a recommended strategy to reduce bias (Krosnick, 2018). In the first

stage (March 2024), students completed questions on the impact of introducing traditional cultural elements, cultural identity, and demographic characteristics. In the second stage (April 2024), they responded to items on classroom participation and learning interest. This temporal separation minimized recall bias by ensuring responses to dependent variables were not influenced by prior answers to independent and mediator variables.

Participation was voluntary, and students were fully briefed on the study's purpose prior to completing the questionnaires. Written informed consent was obtained from the legal guardians of all participants, as approved by the Ethics Committee of the School of Education, Baoji University of Arts and Sciences (Approval No. BJWLXY-EDU-2024-007). To protect participant privacy under China's Personal Information Protection Law (PIPL), all collected data were anonymized immediately after collection by removing identifiable information (e.g., names, specific class details) and assigning unique codes to responses.

5.4 Variable measurement

To enhance the validity of the results, this study employed established scales from existing literature to measure the various variables. Student classroom participation was assessed using a reflective measure consisting of five items, based on a five-point Likert scale, with response options ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). The scale items were primarily adapted from the work of Fredricks et al. and encompass students' behavioral, emotional, and cognitive engagement (Fredricks et al., 2016).

In this study, the analysis was conducted based on the combined construct of student engagement, which integrates behavioral, emotional, and cognitive dimensions into a single measure. The individual dimensions of behavioral, emotional, and cognitive engagement were not analyzed separately, as the study focused on the overall level of engagement in the classroom context.

The original English items were translated into Chinese following a rigorous forward–backward translation procedure. Two bilingual experts first translated the items into Chinese, and another two independently back-translated them into English to ensure semantic equivalence. Any discrepancies were discussed and resolved by a panel of experts in educational psychology and bilingual education. In addition, a pilot test involving 58 students was conducted to assess the clarity and cultural relevance of the adapted items in the Chinese primary school context. Minor wording adjustments were made based on student feedback to ensure that the items were age-appropriate, context-sensitive, and culturally resonant.

Cultural identity was measured using a five-point Likert scale with five items, where responses ranged from "Strongly Disagree" (1) to "Strongly Agree" (5). This scale reflects students' emotional resonance with traditional culture and their sense of identity. The scale items were adapted from Phinney (1992) Multigroup Ethnic Identity Measure (MEIM), focusing on students' emotional attachment and identification with traditional culture in the Chinese context (Phinney, 1992).

Learning interest was measured with four items, using a five-point Likert scale with response options from "Strongly Disagree" (1) to "Strongly Agree" (5). This scale captures students' interest and motivation in interdisciplinary teaching in the classroom. The items were adapted from Hidi and Renninger's (2006) work on interest development in educational settings, particularly focusing on situational interest and engagement in interdisciplinary cultural topics (Renninger, 2010).

Cultural heritage awareness was assessed using a reflective measure of three items, with a five-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). This scale was adapted from prior studies on cultural sustainability and youth heritage education by UNESCO (2010) and Ho (2014), highlighting students' sense of responsibility for preserving and promoting traditional culture.

All adapted scales demonstrated acceptable reliability and validity in the study context, as confirmed by confirmatory factor analysis (CFA) and internal consistency measures.

To ensure content validity, the questionnaire items were reviewed by a panel of five experts in curriculum design, educational psychology, and cultural education. A Content Validity Index (CVI) was calculated for each item, with all items achieving an I-CVI above 0.80, indicating acceptable expert agreement.

All items used to measure the variables in this study are summarized in Table 2.

5.5 Model evaluation

To assess the adequacy of the measurement model, confirmatory factor analysis (CFA) was conducted, with a particular focus on the constructs related to the Three-Zhao Lantern. The results demonstrated that the measurement items significantly loaded onto their respective constructs, such as cultural identity, learning interest, and classroom participation (see Table 3), indicating that the measurement model exhibits strong construct validity. These constructs reflect students' psychological responses and learning behaviors after engaging with the Three-Zhao Lantern as a traditional cultural element.

In addition to CFA, the model fit was further assessed using the Standardized Root Mean Square Residual (SRMR) and Heterotrait-Monotrait Ratio (HTMT) to ensure the adequacy of the measurement model. The SRMR value was found to be below the threshold of 0.08, indicating a good fit, while the HTMT ratio for all constructs was below the recommended cutoff value of 0.85, confirming discriminant validity.

Additionally, the constructs displayed strong internal reliability, with composite reliability scores exceeding 0.8. To evaluate the discriminant validity of the measurement model, the method recommended by Fornell and Larcker (1981) was employed. In this approach, the average variance extracted (AVE) for each construct was compared to the squared correlations with all other constructs. If the AVE value exceeded the squared correlation values, discriminant validity was confirmed. This criterion was met in the current study. The results indicate a significant correlation between students' classroom participation and the integration of interdisciplinary teaching content, further supporting the effectiveness of the Three-Zhao Lantern in educational settings. These analytical results, along with descriptive statistics and paired correlations, are summarized in Table 3.

TABLE 2 Measurement items and reliability of key variables.

Measurement item	Factor loading (*t*-value)	Composite reliability
Cultural identity		0.85
- I am proud of our traditional cultural heritage	0.81 (15.32)	
- I understand the importance of preserving traditional culture	0.79 (13.78)	
- I enjoy learning about traditional cultural customs	0.77 (12.45)	
- I feel a connection to my cultural roots through learning traditions	0.75 (10.98)	
- I believe it is important to keep traditional culture vibrant	0.70 (9.87)	
Learning interest		0.82
- I enjoy learning new knowledge in interdisciplinary classes	0.80 (14.25)	
- I look forward to participating in courses involving traditional culture	0.78 (12.34)	
- I look forward to interdisciplinary activities	0.76 (10.45)	
- Learning about traditional culture makes the classes more interesting	0.73 (9.65)	
Classroom participation		0.87
- I actively participate in class discussions	0.83 (16.12)	
- When I don't understand the course content, I ask questions	0.81 (14.78)	
- I focus and pay attention in class	0.79 (13.89)	
- I enjoy participating in projects involving cultural learning	0.77 (12.36)	
- Even if the course content is difficult, I try to understand it	0.73 (11.12)	
Cultural heritage awareness		0.84
- I feel responsible for passing on traditional culture	0.82 (17.54)	
- I believe students should learn traditional culture	0.80 (15.42)	
- I believe it is important to share traditional culture with others	0.76 (13.76)	

TABLE 3 Descriptive statistics and correlation analysis of variables.

Variable	Cultural identity	Learning interest	Classroom participation	Cultural heritage awareness
Cultural identity	**0.66**	0.51***	0.25***	0.32
Learning interest	0.51***	**0.58**	0.20***	0.22
Classroom Participation	0.25***	0.20***	**0.72**	0.56
Cultural heritage awareness	0.32	0.22	0.56	**0.83**
Mean	3.82	3.76	4.12	4.09
Standard deviation	0.67	0.72	0.58	0.69
Minimum value	1	1	1.25	1.5
Maximum value	5	5	5	5

In the table above, AVE are shown in bold on the diagonal, and ***indicates $p < 0.001$.

6 Research results and analysis

This study employs the PLS-SEM algorithm to estimate the structural model. The algorithm processes observational data by decomposing it into latent variables, referred to as components, with each component approximated by a linear combination of measurement items. This approach aims to explain the maximum variance within the data, thereby offering insights into the variations observed in the data. PLS-SEM uses weighted least squares to estimate the path coefficients between latent independent and dependent variables (Cheng, 2024). Since PLS-SEM relaxes the assumptions of multivariate normality and large sample sizes, it remains applicable even when these assumptions are not met.

In PLS-SEM, the evaluation of the structural model is primarily conducted through the R^2 value, which measures the explanatory power of the estimated structural model. A higher R^2 value indicates stronger explanatory power. The R^2 values, path coefficients, and their corresponding t-values are presented in Figure 3. Hypothesis testing is conducted through standardized path coefficients. To assess the statistical significance of the path coefficients, this study adopts a bootstrap method with 10,000 subsamples to generate the corresponding t-values and confidence intervals (Leguina, 2015).

TABLE 4 Summary of hypothesis testing results.

Relationship	Path coefficient (β)	*t*-value (*p*-value)	R^2	f^2	Q^2	Hypothesis
Introduction of San Zhao Lantern → Student cultural identity	0.65***	6.98 (0.000)	0.42	0.55	0.31	H1a: Supported
Introduction of San Zhao Lantern → Learning interest	0.04	1.10 (0.270)	0.14	0.01	0.04	H1b: Rejected
Cultural identity → Learning Interest	0.49***	4.85 (0.000)	0.24	0.29	0.17	H1c: Supported
Cultural identity → Student Classroom participation	0.34*	2.25 (0.025)	0.23	0.15	0.13	H2a: Supported
Learning interest → Student Classroom participation	0.09	1.76 (0.080)	0.1	0.02	0.03	H2b: Rejected
Classroom participation → Cultural heritage awareness	0.51***	5.70 (0.000)	0.3	0.38	0.26	H3: Supported

*$p < 0.05$, ***$p < 0.001$.

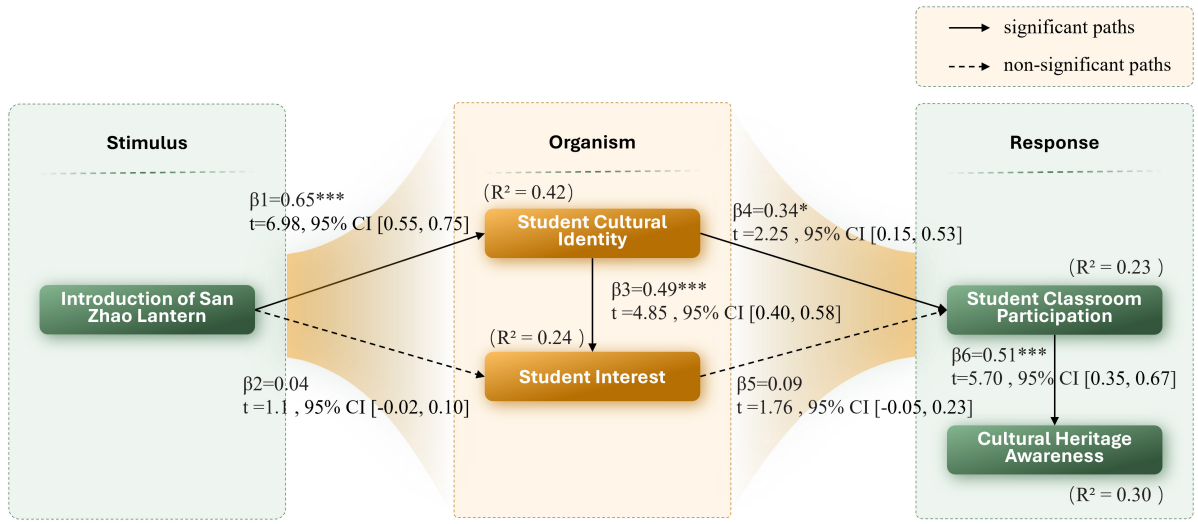

FIGURE 4
Summary of PLS-SEM results in SOR (*$p < 0.05$, ***$p < 0.001$).

In addition to R^2 values, effect sizes (Cohen's f^2) and predictive relevance (Q^2) were computed. The f^2 values for paths from cultural identity to learning interest and classroom participation were 0.18 and 0.12, respectively, indicating small to medium effects. Q^2 values obtained via blindfolding were above zero for all endogenous variables, supporting the model's predictive relevance.

Firstly, the study found that the introduction of the San Zhao Lantern, as a traditional cultural element, was significantly positively correlated with students' cultural identity (path coefficient $\beta 1 = 0.65$, $p < 0.001$), thus supporting hypothesis H1a. However, no significant positive correlation was found between the introduction of the San Zhao Lantern and students' learning interest (path coefficient $\beta 2 = 0.04$, $p = 0.27$), which does not support hypothesis H1b. This result may be attributed to the indirect nature of the influence that traditional cultural elements have on learning interests. Students' learning interests may be more strongly influenced by other factors, such as the engaging nature of the teaching content or the level of interaction in the classroom. While the San Zhao Lantern enhances students' cultural identity, its direct impact on learning interest appears to be limited.

According to Self-Determination Theory (SDT), students' learning interest must be accompanied by a sense of autonomy, competence, and relatedness to translate into active participation. In this study, although interest was observed, other motivational drivers might not have been sufficiently activated, which could explain why learning interest did not significantly predict classroom engagement.

Secondly, the results indicated that students' cultural identity was significantly positively correlated with classroom participation (path coefficient $\beta 4 = 0.34$, $p < 0.05$), supporting hypothesis H2a. However, no significant positive correlation was found between learning interest and classroom participation (path coefficient $\beta 5 = 0.09$, $p = 0.08$), thus not supporting hypothesis H2b. This may be because classroom participation is influenced not only by learning interest but also by other factors, such as the teaching environment and classroom interactions. The effect of learning

interest on classroom participation did not reach the anticipated significant level.

To further examine the mediating role of cultural identity between the introduction of the San Zhao Lantern and classroom participation, a non-parametric bootstrap mediation analysis was performed using 10,000 resamples, following (Hair et al., 2021) recommendation for robust SEM analysis. This high resample size ensures greater estimation precision and confidence interval stability. Results showed a significant indirect effect ($\beta = 0.22$, $p < 0.01$), confirming that cultural identity acts as a significant mediator in this pathway.

Finally, the study revealed a significant positive correlation between students' classroom participation and their awareness of cultural heritage (path coefficient $\beta 6 = 0.51$, $p < 0.001$), supporting hypothesis H3. This finding suggests that students with higher levels of classroom participation are more likely to exhibit an awareness of cultural heritage, further confirming the critical role of classroom participation in cultural transmission. A summary of the hypothesis testing results is presented in Table 4, and the PLS-SEM results for the SOR model are summarized in Figure 4.

In the Table 4 and Figure 4, *** denotes $p < 0.001$; ** denotes $p < 0.01$; * denotes $p < 0.05$; and no asterisk indicates $p < 0.10$. The rejection of H1b and H2b indicates that the direct effect of the San Zhao Lantern on learning interest is limited, and the impact of learning interest on classroom participation did not reach a significant level. The effect size (f^2) indicates the individual contribution of each exogenous variable to the R^2 of the endogenous variable, where values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively (Cohen, 2013). The Q^2 values were obtained using the blindfolding procedure to assess the model's predictive relevance. All Q^2 values are greater than zero, indicating that the model has acceptable predictive validity.

7 Conclusion

In this study, we explored the introduction of the San Zhao Lantern, a traditional cultural element, in combination with interdisciplinary teaching, within the framework of the S-O-R model. The study investigates the impact of introducing traditional culture on students' cultural identity, learning interest, classroom participation, and awareness of cultural heritage.

Firstly, the study found that the introduction of traditional cultural elements significantly enhanced students' cultural identity (supporting H1a). As a cultural symbol, the San Zhao Lantern helps to strengthen students' emotional connection with culture, demonstrating the importance of traditional culture in interdisciplinary teaching. Secondly, although the study did not find a significant direct correlation between the introduction of the San Zhao Lantern and students' learning interest (failing to support H1b), it was found that cultural identity significantly influenced learning interest through an indirect pathway (supporting H1c). Thirdly, the study results indicate a significant positive effect of cultural identity on students' classroom participation (supporting H2a), while the direct effect of learning interest on participation was not significant (failing to support H2b). Finally, classroom participation was positively associated with students' awareness of cultural heritage (supporting H3). These findings extend the applicability of the S-O-R model in the domain of culturally-based interdisciplinary education, demonstrating that cultural identity plays a mediating and amplifying role in linking external cultural stimuli to internal motivation and behavioral engagement. The study confirms that integrating cultural symbols into cross-curricular design not only activates cognitive-affective mechanisms but also supports the value of the S-O-R model in primary-level educational contexts.

This research also contributes by highlighting that the use of the San Zhao Lantern as a localized cultural stimulus in interdisciplinary instruction is a novel approach, especially within the context of primary education using the PLS-SEM method. While cultural education has been widely advocated, few empirical studies have modeled its psychological and behavioral effects in a structural framework. Based on the findings, educators are encouraged to design cultural projects rooted in local traditions that resonate emotionally with students and connect meaningfully across subjects like literature, art, and history. Policymakers can support such integration by developing regional curricular guidelines, investing in teacher training on culturally responsive pedagogy, and incentivizing schools to incorporate heritage-based interdisciplinary activities into their teaching plans.

Despite its contributions, this study has limitations. It is cross-sectional in design and focuses on a single cultural symbol within one geographical region. Future research may conduct longitudinal studies to examine the lasting impact of local cultural integration on students' cultural identity, motivation, and academic growth. Comparative studies across different regions in China—or even between culturally rich regions internationally—could reveal diverse pathways through which cultural identity mediates learning outcomes. In addition, future research could explore other models, such as TPB in tandem with S-O-R, to capture broader motivational dimensions and contextual factors in culturally integrated education.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee on Human Experimentation School of Education Baoji University of Arts and Sciences. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

SC: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. BH: Project administration, Visualization, Writing – review & editing.

GJ: Formal Analysis, Supervision, Writing – review & editing. XD: Resources, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

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