

# Cultural Heritage Education Through the Lens of Qiang Architectural Development in Sichuan of China

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## Abstract

This study investigates the role of Qiang architectural development in promoting cultural heritage education in Sichuan, China. Qiang architecture, with its iconic stone watchtowers, wooden beam houses, and ritual spaces, is not merely a material legacy but a living pedagogical system embedded in community life. Using a qualitative ethnographic approach, the research was conducted in Taoping Qiang Village, a recognised heritage site known for its preserved architectural landscape. Data were collected through in-depth interviews with 30 purposively sampled informants ranging from master builders and artisans to returning youth and educators, as well as through participant observation and document analysis. Thematic analysis revealed three core educational functions of Qiang architecture: 1) the transmission of indigenous knowledge through architectural practices, 2) intergenerational learning via community rituals and rebuilding events, and 3) the integration of architectural heritage into rural tourism and formal education initiatives. These findings highlight how architecture acts as a living curriculum, supporting cultural identity, environmental awareness, and intergenerational cohesion. The study concludes that embedding traditional architectural knowledge in education, both informal and formal, can foster cultural resilience and sustainability. It recommends heritage-based curriculum development, youth engagement in community practices, and policy support for architectural education as a form of cultural preservation.

**Keywords:** architecture, cultural heritage, ethnographic, rural tourism, indigenous knowledge transmission

## 1. Introduction

Qiang architecture, found in the mountainous regions of Sichuan Province, is not merely a form of shelter but a profound expression of cultural identity, craftsmanship, and ecological adaptation. With its iconic stone towers, wooden beam houses, and communal courtyards, this architectural form encapsulates centuries of ethnic wisdom (Al-Adilee, 2024; Fan et al., 2025; Liu, 2025). However, amid the forces of rapid urbanization, demographic shifts, and modern construction technologies, traditional Qiang architecture faces a critical turning point. Its visible structures may endure through conservation efforts, but the intangible knowledge embedded in its construction, ritual use, and symbolic meaning is at risk of fading away (Hafstein, 2018; Makvandi et al., 2024). Addressing this concern requires a new approach, one that views Qiang architecture not only as cultural heritage to be preserved but also as a source of education that can engage younger generations in the values and traditions of their community (Li, 2020; Qiang et al., 2024). This study aims to investigate the potential of Qiang architectural development as a medium for cultural heritage education in contemporary Sichuan.

### 1.1 Introduce the Problem

The decline of traditional Qiang architecture is not just a result of structural decay but also a consequence of disrupted knowledge transmission. As rural communities modernise, younger generations are increasingly distanced from traditional practices, both physically and ideologically (Knapp, 2024; Wilson et al., 2018). This disconnection stems from the adoption of concrete, steel, and prefab materials, which gradually replace the indigenous construction techniques passed down through generations. Furthermore, natural disasters such as earthquakes have accelerated the loss of original structures and discouraged traditional rebuilding. As the physical and cultural landscapes of Qiang villages transform, opportunities to learn about traditional architecture, its ecological principles, symbolic elements,

and communal functions are diminishing (Chippagiri et al., 2022; Daly et al., 2023; Ding, 2021). Without intentional educational mechanisms in place, a vital part of the Qiang people's cultural memory is on the verge of being lost.

### *1.2 The Importance of the Problem*

Preserving cultural heritage is essential to maintaining the identity, continuity, and resilience of ethnic communities. The disappearance of architectural knowledge among the Qiang population signifies not just the loss of a building style, but the erasure of historical narratives, ritual practices, and ecological wisdom accumulated over centuries. This loss weakens the social fabric and cultural confidence of younger generations who may grow up disconnected from their roots (Ghahramani et al., 2020; Yang, 2020). By embedding heritage knowledge into educational processes, whether through formal school curricula or informal community learning, there is potential to reverse this trend. Qiang architecture provides a practical and symbolic entry point for education, one that combines hands-on learning, storytelling, and moral instruction grounded in the indigenous worldview (Jones & Brady, 2022; Yan & Chiou, 2021). Therefore, finding ways to utilise Qiang architectural development as a tool for cultural heritage education is a pressing concern that deserves scholarly and policy attention.

### *1.3 Relevant Scholarship*

Existing literature has focused mainly on the historical significance, aesthetic characteristics, and post-disaster reconstruction of Qiang architecture. Research has also explored how tourism development has revitalised interest in cultural landmarks, including Qiang villages with preserved architectural features. However, there remains a gap in academic and applied discourse regarding the educational dimensions of traditional architecture (Ankomah, 2020; Cattaneo et al., 2018; Petrevska & Nestoroska, 2023). Few studies have examined how local schools, heritage sites, or rural communities use architecture to pass on cultural values and practical knowledge to younger generations. In the broader context of heritage education, the integration of vernacular architecture into pedagogy has proven effective in fostering identity, critical thinking, and environmental awareness (Lin et al., 2024; Villa & Knutas, 2020).

Nonetheless, Qiang architecture, despite its rich symbolism, technical ingenuity, and ecological embeddedness, has rarely been examined as an educational resource within its community context. This lack of attention overlooks the potential of Qiang architectural spaces, practices, and narratives as powerful mediums for cultural transmission and learning.

Specifically, the study examines how building sites function as experiential learning spaces and how traditional structures embody pedagogical functions that are tied to community values. By doing so, the study contributes a novel perspective to both heritage education and vernacular architecture discourse, demonstrating that Qiang architecture is not only a cultural artifact but also a living educational framework. These findings challenge the prevailing focus on conservation alone and underscore the importance of integrating educational dimensions into cultural preservation strategies.

### *1.4 Hypotheses*

This study hypothesises that Qiang architectural development contributes meaningfully to cultural heritage education by acting as a living repository of knowledge, values, and identity. Through community participation in construction, ritual events associated with buildings, and intergenerational storytelling linked to architectural forms, Qiang architecture functions as a pedagogical environment. It offers educational value not only through its physical form but also through the processes, practices, and cultural meanings it encompasses. To explore this hypothesis, a qualitative ethnographic approach was employed. The research design included interviews with key informants, observation of community events, and review of local educational and cultural policies. These methods allow for an in-depth understanding of how traditional architecture operates within the cultural education of the Qiang community.

### *1.5 Research Objective*

To investigate the role of Qiang architectural development in promoting cultural heritage education in Sichuan, China.

### *1.6 Research Question*

What role does the development of Qiang architecture play in promoting cultural heritage education in Sichuan, China?

## 2. Method

This study adopted a qualitative ethnographic approach to explore the role of Qiang architectural development in promoting cultural heritage education in Sichuan, China. Ethnography was chosen to capture the lived experiences, traditional knowledge systems, and intergenerational practices embedded in architectural construction and use within the Qiang community (Alnaim, 2024; Dadizadeh & Doğan, 2024; Nam & Thanh, 2024).

### 2.1 Research Site

Taoping Qiang Village was selected as the primary research site due to its reputation as a living museum of Qiang architectural heritage. The village has been officially recognised for its historical and cultural significance and serves as a focal point for ethnic tourism, reconstruction efforts, and community-based heritage education.

### 2.2 Participants and Sampling

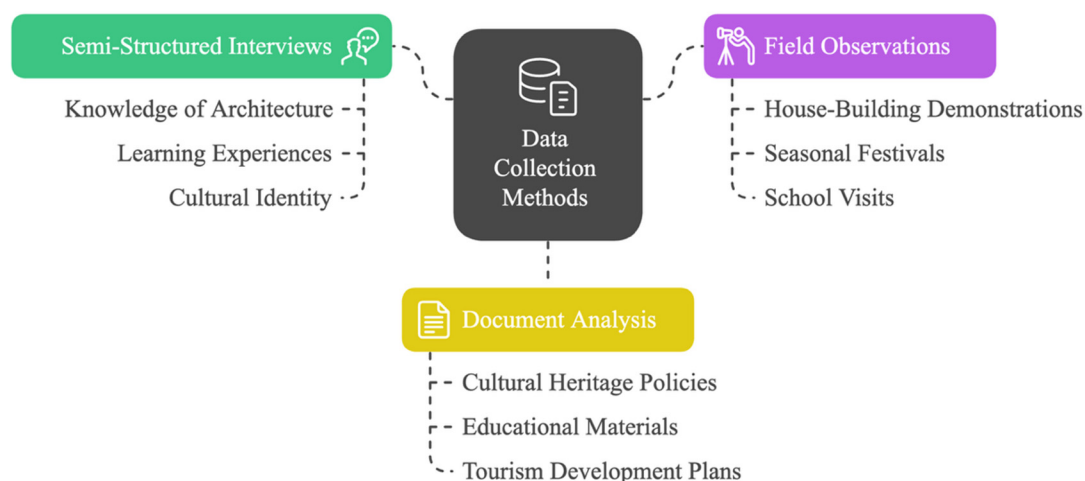
The sample consisted of 30 informants, selected using purposive sampling to ensure a rich diversity of perspectives. Informants were categorised into three groups based on their involvement with Qiang architectural culture, as shown in Table 1.

**Table 1.** Participants and Sampling

Group	Number	Participant Characteristics
Key Information	5	Experts and inheritors of Qiang architectural culture with deep historical knowledge
Temporary Information	10	Artisans, local administrators, and cultural organisers with practical engagement
General Information	15	Returning youth, tourists, and observers offering reflective and external perspectives

### 2.3 Data Collection Methods

These methods were strategically chosen to gather rich, nuanced data regarding the knowledge, learning experiences, and cultural perspectives surrounding Qiang architectural features and symbolism. The combination of these approaches aimed to provide a comprehensive understanding of the lived pedagogical function of architecture within the Qiang community, as shown in Figure 1.



**Figure 1.** Data Collection Methods

### 2.4 Data Analysis

All data were coded manually using a structured codebook, and findings were validated through cross-referencing between interviews, observations, and documentary evidence. Data were analysed using thematic analysis, following Braun and Clarke's approach, as shown in Table 2.

**Table 2.** Research Steps

Stage	Description
Familiarisation	Reading transcripts and notes multiple times to become immersed in the data
Coding	Labeling meaningful units related to architecture, education, tradition, and values
Theme Generation	Grouping codes into broader themes, such as "Architecture as Living Curriculum"
Theme Refinement	Reviewing and defining themes to align with the research objective and question
Interpretation	Synthesising themes to develop insights into how architecture serves educational roles

### 3. Results

The findings from this ethnographic study underscore the central role of Qiang architectural development in fostering cultural heritage education in Sichuan Province. Drawing on 30 interviews, field observations, and document analysis, the results reveal how traditional architectural forms and practices are embedded with cultural knowledge, offering a multidimensional educational experience. The analysis is structured into three key themes: architectural practices as educational content, community participation and intergenerational learning, and the educational impact of rural tourism initiatives. Each theme is elaborated below with supporting evidence from informants and fieldwork, alongside illustrative tables for clarity.

#### 3.1 Architectural Practices as Educational Content

Qiang architecture functions as a tangible repository of indigenous knowledge systems. Informants consistently emphasized that structures such as stone watchtowers, multi-level dwellings, and wooden beam constructions serve not merely residential functions but also embody lessons in environmental adaptation, social structure, and spiritual belief. Table 3 below summarises the types of architectural elements and their associated educational functions:

**Table 3.** Educational Value of Qiang Architectural Elements

Architectural Feature	Knowledge Transmitted	Mode of Learning
Stone Watchtowers	Defense, heritage, spatial planning	Observation, oral narration
Wooden Beams	Joinery, measurement, symbolism	Apprenticeship, ritual practice
Roof Design	Weather adaptation, drainage logic	Guided demonstration

Field data indicated that learning typically occurred through practical involvement and observation rather than formal instruction. Apprenticeship under family members or master builders enabled younger generations to absorb both technical skills and symbolic meanings embedded in construction.

For instance, symbolic stone alignments and wood joinery were explained in relation to cosmological beliefs and communal values. These interactions transformed architectural work into culturally rich, situated learning experiences.

#### 3.2 Community Participation and Intergenerational Learning

Cultural learning is not confined to the building process but extends into broader communal events tied to architecture. Rituals and festivals surrounding architectural development serve as occasions for the intergenerational transfer of knowledge. Informants described seasonal events such as house-raising ceremonies and fire-worship rituals as pivotal moments when elders retell ancestral stories, songs are sung, and traditional values are reinforced, as shown in Table 4.

**Table 4.** Community Events and Educational Components

Event Type	Participants	Educational Impact
House-Raising Ceremony	Elders, youth, builders	Transmission of values, skills, and historical memory
Fire Worship Ritual	Families, religious leaders	Cosmological understanding, moral education
Rebuilding post-disaster	Entire village community	Cooperation, resilience, oral history

These events act as living classrooms where community members learn cultural traditions through participation. One informant described learning construction techniques while helping rebuild a wall post-landslide, linking hands-on skills to ancestral teachings.

Such collaborative moments illustrate how communal involvement in architectural activities reinforces cultural values and social cohesion while simultaneously educating younger generations.

### 3.3 Educational Integration Through Rural Tourism

With the rise of rural tourism in Taoping Qiang Village, the educational functions of Qiang architecture have extended into more formal and externally facing domains. Several local initiatives now embed architectural knowledge into educational and tourism frameworks, enhancing both heritage visibility and community learning, as shown in Table 5.

**Table 5.** Educational Initiatives Enabled by Rural Tourism

Initiative	Stakeholders	Educational Output
School Curriculum Integration	Local schools, NGOs	Experiential learning, cultural literacy
Heritage Tour Guide Training	Youth, tourism offices	Skill development, narrative skills
Bilingual Cultural Workshops	Tourists, educators	Cross-cultural understanding

Local schools conduct heritage tours and construction workshops, while returning youth become cultural interpreters for visitors. Informational materials, such as signage and pamphlets, support both tourist education and resident pride.

Several young guides reported that explaining architectural features to tourists deepened their own understanding of cultural significance, fostering a feedback loop of learning through teaching.

Collectively, the results confirm that Qiang architecture operates as a dynamic pedagogical resource. It bridges formal and informal education, sustains intergenerational transmission, and aligns cultural preservation with economic and social revitalisation.

These insights validate the hypothesis that Qiang architectural development makes a meaningful contribution to cultural heritage education in contemporary Sichuan.

## 4. Discussion

The findings of this study reaffirm the central hypothesis that Qiang architectural development operates as a vital conduit for cultural heritage education in Sichuan Province, China. Echoing previous scholarship that views vernacular architecture as a vessel for cultural transmission (Knapp, 2024; Villa & Knutas, 2020), this research shows that Qiang structures not only embody historical knowledge and aesthetic values but also serve pedagogical functions. The data from Taoping Qiang Village provide compelling ethnographic evidence that architecture is an educational medium encompassing skill acquisition, spiritual symbolism, environmental adaptation, and communal memory.

Consistent with theoretical principles in heritage education and informal learning (Jones & Brady, 2022; Yan & Chiou, 2021), this study demonstrates how knowledge embedded in architecture is transmitted through lived practices rather than through institutionalised schooling alone. For instance, the apprenticeship model in masonry and beam-joining techniques reflects an intergenerational pedagogy rooted in participation and storytelling. These practices align with Villa and Knutas's (2020) argument that cultural identity and ecological awareness can be fostered through localised, place-based education.

The integration of Qiang architectural knowledge into rural tourism initiatives also aligns with contemporary approaches to sustainable heritage development (Petrevska & Nestoroska, 2023). Tour guide training, bilingual workshops, and educational signage serve dual purposes: they economically revitalise rural communities while also deepening local cultural literacy. Informants' reflections on how guiding tourists enhanced their understanding of Qiang heritage underscore the reflexive learning made possible through artistic interpretation. This supports Lin et al.'s (2024) findings on how alternate pedagogical spaces outside formal schools can enhance learning engagement and identity development. Tourism can enhance heritage practices, but it also introduces risks of cultural

commodification. Oversimplified representations of architectural elements can disconnect them from their original spiritual and communal functions. Scholars warn that heritage tourism can erode intangible knowledge when community narratives are tailored to meet external expectations. A balanced approach is needed, promoting tourism as a platform for authentic, community-led education rather than cultural consumption. Empowering local stakeholders to curate interpretive narratives can protect against meaning erosion while still benefiting from tourism exposure.

However, the study also highlights tensions between preservation and adaptation. While community rituals and traditional construction methods reinforce heritage, external pressures, such as urbanization, modern building codes, and the aftermath of natural disasters, threaten the continuity of architectural knowledge (Daly et al., 2023; Ding, 2021). These findings are consistent with Hafstein's (2018) critique of heritage practices that prioritise material conservation at the expense of intangible cultural processes. Without institutional recognition and integration into curricula, Qiang's architectural knowledge risks marginalisation. Community-based heritage governance models, policy reforms, and educational institutions can help preserve cultural integrity in architectural practices. These models involve collaboration among villagers, elders, educators, and artisans, ensuring flexible building codes, heritage skill training, and certifications for traditional builders.

Methodologically, the use of purposive sampling and thematic analysis proved effective in capturing the diversity of educational experiences linked to architecture. The triangulation of interviews, observations, and documents helped validate the data and enrich the interpretations. However, limitations include the potential regional specificity of Taoping Village and the reliance on self-reported reflections, which may carry subjective bias. Future research could expand to other Qiang communities to compare how geographic, economic, and policy factors influence architectural education. Moreover, quantitative studies measuring learning outcomes from heritage-based curricula could complement these qualitative insights.

## 5. Conclusion

This study contributes to the growing body of literature on cultural heritage education by framing Qiang architecture as a dynamic learning environment. It advances the notion that architectural heritage should be understood not only as a conservation concern but also as a pedagogical asset. The study highlights that cultural knowledge is actively transmitted through direct engagement with traditional architectural practices, rituals, and community participation, emphasising learning that is experiential, place-based, and intergenerational.

Policymakers and educators are encouraged to develop curriculum frameworks that incorporate vernacular knowledge systems, mainly by embedding traditional architectural elements into school subjects such as environmental education, social studies, and local history. Specifically, Qiang architectural content can be integrated into upper primary and lower secondary school levels (Grades 4–9), where students begin to explore relationships between cultural identity and the human environment. Teaching methods could include interdisciplinary project-based learning, fieldwork in heritage villages, collaborative model-making of traditional structures, and storytelling activities guided by local elders. This integration can foster cultural identity, ecological awareness, and critical thinking among students.

Furthermore, the study suggests that teacher training programmes should include modules on intangible cultural heritage and participatory teaching strategies, enabling educators to use community spaces and practices as learning environments. This includes training teachers to co-develop lesson plans with community artisans and heritage custodians, facilitating mutual respect and local empowerment in the learning process. In doing so, architecture can fulfil its potential as both a cultural artefact and an active educational tool for resilience, identity, and sustainability. Such efforts support not only heritage preservation but also inclusive and locally relevant education policies that strengthen community ties and promote lifelong learning.

The study examines the role of Qiang architecture in cultural heritage education; however, its findings may not fully represent the perspectives of other Qiang communities. The research was primarily conducted in Taoping Qiang Village, a popular heritage site, and may introduce subjective bias. Future research should adopt a comparative design and quantitative studies to examine cultural continuity and the long-term impacts of tourism-driven educational programs.

## References

- Al-Adilee, S. M. S. (2024). The influence of culture and heritage on architectural design. *The American Journal of Interdisciplinary Innovations and Research*, 6(08), 56-74. <https://doi.org/10.37547/tajir/Volume06Issue08-06>
- Alnaim, M. M. (2024). Cultural imprints on physical forms: an exploration of architectural heritage and identity. *Advances in Applied Sociology*, 14(3), 141-160.
- Ankomah, W. S. (2020). Diverse Classrooms: Social Justice, Equity, and Diversity Competencies for Teacher Candidates. *World Journal of Education*, 10(2), 15-26. <https://doi.org/10.5430/wje.v10n2p15>
- Cattaneo, T., Giorgi, E., & Ni, M. (2018). Landscape, architecture and environmental regeneration: A research by design approach for inclusive tourism in a rural village in China. *Sustainability*, 11(1), 128. <https://doi.org/10.3390/su11010128>
- Chippagiri, R., Bras, A., Sharma, D., & Ralegaonkar, R. V. (2022). Technological and sustainable perception on the advancements of prefabrication in construction industry. *Energies*, 15(20), 7548. <https://doi.org/10.3390/en15207548>
- Dadizadeh, N. A., & Doğan, E. (2024). Community engagement and sustainable heritage tourism: Mediating role of archaeological heritage interpretation. *Conservation and Management of Archaeological Sites*, 26(2-3), 175-206. <https://doi.org/10.1080/13505033.2024.2400627>
- Daly, P., Ninglekhu, S., Hollenbach, P., McCaughey, J. W., Lallemand, D., & Horton, B. P. (2023). Rebuilding historic urban neighborhoods after disasters: Balancing disaster risk reduction and heritage conservation after the 2015 earthquakes in Nepal. *International Journal of Disaster Risk Reduction*, 86, 103564. <https://doi.org/10.1016/j.ijdr.2023.103564>
- Ding, H. (2021). Research on architectural function of Taoping Qiang village based on functionalism. *Open Access Library Journal*, 8(6), 1-9. <https://doi.org/10.4236/oalib.1107601>
- Fan, D., Maliki, N. Z. B., He, C., Bi, Y., & Yu, S. (2025). Cultural gene characterization and mapping of traditional tibetan village landscapes in Western Sichuan, China. *npj Heritage Science*, 13(1), 317. <https://doi.org/10.1038/s40494-025-01877-7>
- Ghahramani, L., McArdle, K., & Fatorić, S. (2020). Minority community resilience and cultural heritage preservation: A case study of the gullah geechee community. *Sustainability*, 12(6), 2266. <https://doi.org/10.3390/su12062266>
- Hafstein, V. T. (2018). *Making intangible heritage: El Condor Pasa and other stories from UNESCO*. Indiana University Press. <https://doi.org/10.2307/j.ctv4v3086>
- Jones, I. D., & Brady, G. (2022). Informal education pedagogy transcendence from the 'academy' to society in the current and post COVID environment. *Education Sciences*, 12(1), 37. <https://doi.org/10.3390/educsci12010037>
- Knapp, R. G. (2024). China's vernacular architectural heritage and historic preservation. *Built Heritage*, 8(1), 44. <https://doi.org/10.1186/s43238-024-00153-0>
- Li, B. (2020). Research on the Protection of the Architectural Culture of the Traditional Villages of the Qiang Nationality-Taking Taoping Qiang Village as an Example. *Open Access Library Journal*, 7(10), 1-9. <https://doi.org/10.4236/oalib.1106876>
- Lin, H. C. K., Lu, L. W., & Lu, R. S. (2024). Integrating digital technologies and alternate reality games for sustainable education: Enhancing cultural heritage awareness and learning engagement. *Sustainability*, 16(21), 9451. <https://doi.org/10.3390/su16219451>
- Liu, G. (2025). Exploration of the Formation and Cultural Essence of Qiang Ethnic Architectural Features from the Perspective of Cultural Geography: A Case Study of the Qiang Villages in the Lower Reaches of Zagunao River. *International Journal of Cultural and Religious Studies*, 5(1), 27-48. <https://doi.org/10.32996/ijcrs.2025.5.1.4>
- Makvandi, M., Li, W., Li, Y., Wu, H., Khodabakhshi, Z., Xu, X., & Yuan, P. F. (2024). Advancing Urban Resilience Amid Rapid Urbanization: An Integrated Interdisciplinary Approach for Tomorrow's Climate-Adaptive Smart Cities-A Case Study of Wuhan, China. *Smart Cities*, 7(4), 2110-2130. <https://doi.org/10.3390/smartcities7040084>
- Nam, N. T., & Thanh, N. N. (2024). The role of local communities in the conservation of cultural heritage sites: A case study of Vietnam. *Journal of Asian Scientific Research*, 14(2), 179.

<https://doi.org/10.55493/5003.v14i2.5057>

- Petrevska, B., & Nestoroska, I. (2023). Reviving the past and inspiring the future: exploring rural architecture and tourism in north macedonia. *Journal of the International Society for the Study of Vernacular Settlements*, 10(6), 1-14.
- Qiang, W., Majid, B. A., & Zuhairi, A. (2024). Crafting Cultural Sustainability: Exploring Intangible Cultural Heritage Preservation through Product Design in Henan Nigugu, China. *Pakistan Journal of Life & Social Sciences*, 22(1), 945-959. <https://doi.org/10.57239/PJLSS-2024-22.1.0066>
- Villa, M., & Knutas, A. (2020). Rural communities and schools-Valuing and reproducing local culture. *Journal of Rural Studies*, 80, 626-633. <https://doi.org/10.1016/j.jrurstud.2020.09.004>
- Wilson, G. A., Hu, Z., & Rahman, S. (2018). Community resilience in rural China: the case of Hu Village, Sichuan Province. *Journal of rural studies*, 60, 130-140. <https://doi.org/10.1016/j.jrurstud.2018.03.016>
- Yan, W. J., & Chiou, S. C. (2021). The safeguarding of intangible cultural heritage from the perspective of civic participation: The informal education of Chinese embroidery handicrafts. *Sustainability*, 13(9), 4958. <https://doi.org/10.3390/su13094958>
- Yang, M. (2020). *Re-enchanting modernity: ritual economy and society in Wenzhou, China*. Duke University Press. <https://doi.org/10.1515/9781478009245>

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