HERITAGE-INSPIRED DESIGN: RESEARCH-BASED EDUCATION ON MORTISE-TENON STRUCTURES

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Abstract. This study explores a research-based learning curriculum designed to enhance understanding and preservation of traditional Chinese timber architecture, focusing on mortise-tenon structures. Centered on Shanxi's architectural heritage, the 3-hour experiential curriculum integrates theoretical knowledge with hands-on learning, emphasizing the role of design in cultural transmission. Participants engage with the dougong system and Luban lock, fostering both technical skills and emotional connections to heritage. Findings indicate increased awareness of intangible cultural heritage and engagement through tactile learning. This interdisciplinary approach demonstrates how design education can bridge historical craftsmanship with contemporary applications, reinforcing its role in heritage preservation.
Keywords. Design, educational game, constructor, mortise-tenon structure, Luban lock, Chinese culture, research-based learning, cultural heritage.

Introduction. Shanxi is known as the "Province with the Most Cultural Relics Above Ground in China," with over 80% of China's pre-Yuan Dynasty wooden architecture still existing (China News Service, 2011), including iconic examples like the Yingxian Wooden Pagoda and the Fogong Temple, which fully demonstrate the wisdom of traditional mortise-tenon techniques. However, current tourism development often focuses on visual consumption, lacking a deep understanding and transmission of the construction techniques.

This study addresses these challenges through an innovative 3-hour experiential curriculum designed to (1) help participants understand the essence of traditional Chinese timber architecture through the innovative design of mortise-tenon structures, (2) explore the educational functions of mortise-tenon structure products design, and (3) analyze how the design of mortise-tenon structures, inspired by the ancient dougong system, can contribute to the preservation and transmission of cultural heritage. This approach blends traditional craftsmanship with modern design principles, bridging the gap between cultural heritage and contemporary applications.

Theoretical Part

The theoretical foundations of this research-based learning curriculum, which focuses on the cultural and technical aspects of ancient Chinese timber architecture through mortise-tenon structures, integrate educational theory, cultural transmission, and heritage preservation to empower learners and deepen their understanding of technical craftsmanship and cultural significance. Gryshchenko et al. (2024) examine how a research-based, cross-cultural design education program enhances graduate students' competence in interdisciplinary research and creative practices, emphasizing the integration of science, art, and engineering.

The Educational Potential of Traditional Craftsmanship. The study of ancient Chinese timber architecture, particularly the mortise-tenon joint system, serves as a powerful educational tool. The hands-on, participatory nature of the curriculum aligns with John Dewey's "learning by doing" principle (Dewey, 1997), emphasizing experiential learning to deepen understanding.
Bridging Theory and Practice in Architectural Education. The hands-on assembly experience in the mortise-tenon structure curriculum aligns with literature on the role of sensory channels (visual and tactile) in children's cognitive development. Tactile exploration promotes the perception of spatial relationships (Fan, 2024). Through assembling dougong structures, learners engage their sense of touch, deepening their understanding of traditional craftsmanship and improving their spatial awareness (Figure 1.).
Cultural Transmission and Intangible Heritage Preservation. Traditional Chinese carpentry techniques, such as the Luban lock and dougong brackets, embody cultural wisdom passed down through generations. The innovative design of the Luban lock reinterprets these ancient techniques for modern use, making them relevant to contemporary audiences. By blending traditional craftsmanship with modern design, this product helps preserve cultural heritage, ensuring its transmission to future generations while engaging a broader audience in the process. Students from Shanxi Provincial Experimental High School appreciated and experienced the innovative design of the Luban lock structure during the course (Figure 2).

Figure 1. Children assembling a dougong model during the course practice (YangNa, 2022)
Figure 2. Students are experiencing the innovative design of the Luban lock structure during the course (YangNa, 2021)

Methodology. This study uses a case study approach to assess the effectiveness of a 3-hour curriculum focused on Shanxi's architectural heritage and design innovation. The curriculum, centered around the Yingxian Wooden Pagoda, is structured into two parts:
Cultural and Technical Education: Participants first engage with theoretical knowledge, exploring the historical and cultural significance of mortise-tenon and dougong systems, their architectural roles. (Figure 3.).
Hands-On Learning and Team Challenge: The hands-on component includes assembling simplified dougong kits and the Luban lock, a Luban lock product innovatively designed based on traditional forms (Figure 4). Luban lock is a constructor-type educational game. It can cultivate an emotional bond with cultural heritage through tactile engagement. The methodology aligns with the educational philosophy of Sistema Lupo (Gonzalez, 2017).

Figure 3. The course group under the Yingxian Wooden Pagoda in Shanxi (YangNa, 2024)
Figure 4. Course group immersed in the fascinating intricacies of mortise-tenon structures (YangNa, 2024)

Result. The curriculum's effectiveness was assessed using qualitative research methods, including case studies, participant feedback, and observational data. The key findings from these methods are summarized as follows:

Case Studies

The integration of the Luban lock design not only reinforced traditional skills but also demonstrated how design can innovate upon cultural heritage, deepening participants' understanding of heritage preservation and design innovation.

Participant Feedback. Most participants felt more connected to Shanxi's architectural heritage and reported increased awareness of the importance of preserving intangible cultural heritage. More than half of participants expressed interest in visiting additional heritage sites related to ancient Chinese architecture within three months.

Observational Data. Case studies show that 90% of the groups completed the assembly of the Luban lock within 30 minutes. Participants showed high engagement during the hands-on activities, with the group assembly of the Luban lock fostering teamwork and reinforcing both technical skills and emotional connections to the heritage.

Conclusions. The curriculum bridges the gap between "seeing" and "understanding" heritage by engaging participants in hands-on activities. The innovative Luban lock design, blending traditional craftsmanship with modern design, enhances appreciation for cultural heritage while serving as an educational tool that offers both learning and engagement for participants and tourists alike.

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