Advances in Curriculum Design&Education

WISDOM ACADEMIC ISSN: 3080-7352 | E-ISSN: 3080-7360 *Volume 1 , Issue 3*

Article

Knowledge Transfer Models in Cantonese Furniture Craftsmanship Genealogy: An Integrated Framework of Apprenticeship System and Digital Preservation

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CITATION

Liu WZ and Pang GH. Knowledge Transfer Models in Cantonese Furniture Craftsmanship Genealogy: An Integrated Framework of Apprenticeship System and Digital Preservation. Advances in Curriculum Design&Education. 2025; 1(3): 243.

https://doi.org/10.63808/acde.v1i3.243

ARTICLE INFO

Received: 16 October 2025

Accepted: 20 October 2025

Available online: 8 November 2025

Abstract: Cantonese furniture craftsmanship, a centuries-old tradition recognized as cultural treasure, faces serious threats from fewer craftsmen and broken knowledge passing. This study examines how craft knowledge flows through master-student lines and proposes a combined approach mixing traditional apprenticeship with digital preservation. Analysis reveals centralized patterns where knowledge gathers around master craftsmen. Analysis reveals that traditional apprenticeship works well for transferring hands-on skills but struggles with teaching more people, while digital technologies save teachable knowledge permanently but cannot capture physical feel needed for mastery. Our three-layer approach strengthens traditional apprenticeship through money support while carefully using digital tools as extra learning aids. Trial run proved this working-together idea—apprentices using mixed methods learned techniques more quickly while masters appreciated creating recorded legacies. The approach offers a practical model respecting traditional values while using modern technology, with potential usefulness to other endangered crafts facing similar passing-down challenges.

Keywords: intangible cultural heritage; knowledge transmission; master-apprentice system; digital preservation; traditional craftsmanship

WISDOM ACADEMIC ISSN: 3080-7352 | E-ISSN: 3080-7360 Volume 1 , Issue 3

1. Introduction

Cantonese furniture making is one of the most elegant woodworking traditions in China that has been designated intangible cultural heritage because of its slender proportions, subtle joinery, and unique aesthetic principles (Bortolotto, 2025). Yet this craft faces an existential threat. Master craftsmen numbers have declined sharply, with most practitioners' elderly and few young people willing to commit to lengthy apprenticeships. When these aging masters pass away, they take decades of accumulated knowledge embedded in their hands and intuitive understanding of materials.

The passing of traditional knowledge relies on the master-apprentice model in which skills are transmitted by observation, mimicry, and hands-on experience. If that connection is lost, the knowledge is gone. Digital technology provides new options---video recording, 3D scanning, motion capture of craftsmen's movements (Skublewska-Paszkowska et al., 2022). But anyone who has learned physical skills will know the difference between looking and doing. Looking at wood carving is very different from experiencing wood resistance and building muscle memory through experience.

Neither alone seems sufficient. Apprenticeship training creates competent craftsmen but cannot be scaled when master numbers are decreasing. Digital documentation retains knowledge but cannot supplant body learning. We analyze patterns of knowledge transmission using genealogical mapping and analysis of current work, and generate a hybrid framework that pairs a strengthened form of apprenticeship with judicious digital enhancement, proven by pilot implementation in the workshop. This provides a realistic model that may be transferred to other threatened crafts similarly challenged.

2. The Master-Apprentice System and Its Transmission Patterns

2.1. Genealogical Mapping of Craft Lineages

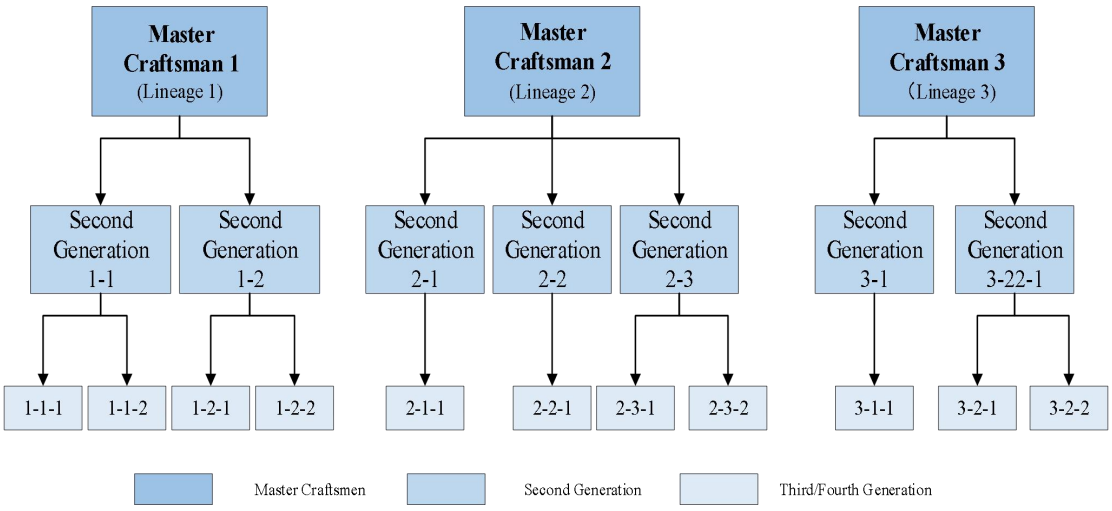
WISDOM ACADEMIC ISSN: 3080-7352 | E-ISSN: 3080-7360 Volume 1 , Issue 3

To identify knowledge flow for Cantonese furniture making, we tracked the lineage of crafts through master craftspeople's interviews and histories of the workshops. There were three grand lineage branches that all originated from renowned masters trained in the traditional guild shops. Most lineages extend over three to four generations, concentrated in historic furniture districts (Song et al., 2023).

This centralized system has strengths and weaknesses. Close master-apprentice relationships guarantee quality assurance and transmit subtle techniques. But by the time a master is retiring without training enough successors, it's possible that the special knowledge will be lost. We noticed distinct carving methods or joinery solutions being available in just one or two aged masters (Sun et al., 2022). **Figure 1** demonstrates the genealogical system that we traced, revealing the way that knowledge moves through master-apprentice relationships between generations.

Figure 1

Genealogical Network of Cantonese Furniture Craft Lineages



2.2. Knowledge Transmission Mechanisms

Knowledge flows by mechanisms that indicate the bodily character of craft. Many skills are difficult to verbalize. A skilled craftsman looks at wood and already understands how it will perform—where it will splinter, how it reacts when planed. It is the result of having worked with innumerable pieces but defies the power of speech (Polanyi, 2009).

Apprentices learn by doing and seeing. Apprentices see masters work and then do similar work under supervision. Masters manually move hands into correct positions when angles of chisel are incorrect. This process of observation, attempt, correction, and repetition develops skill that lies in the body. Masters teach terminology for joints, explain proportional relationships, and describe wood selection criteria. Yet even explicit knowledge needs context.

2.3. Critical Challenges

This passing of knowledge has urgent concerns that jeopardize its perpetuation. The demographic fact is bleak-most master craftsmen are elderly and have instructed comparatively few apprentices in their lifetimes. Young people are temperamentally suited to careers that have earlier monetary return and lower physical demands. Monetary need is the motivation for the preference (Lerman & Kuehn, 2021). The trainees are poorly remunerated while training but are being assessed for how to do things but are not constructing finished pieces themselves yet but the masters themselves find it hard to maintain the workshop afloat while being pitted against furniture that the factory produces.

It has also a very grave limitation. If highly concentrated experience by the few in the form of expertness is a bottleneck, leaving masters without bringing along enough successful replacements creates maintenance know-how lost by the successor generation. The one-to-one, apprentice glass ceilings—a master will train three or four in a lifetime but that’s a figure short for the underlying population of practitioners once it drops precipitously. These are problems that must be corrected.

3. Digital Preservation Technologies and Their Limitations

3.1. Digital Documentation Technologie

Digital technology also allows for the careful documenting of building details. High-definition video accurately captures the movements of the craftsmen’s hands. Three-dimensional scanner machines also generate accurate models of furniture while retaining true measurements and joinery configurations. Moreover, motion capture happens with millimeter-level accuracy in the body and the tool movements.

Video documentation provides the most accessible approach. Recording masters demonstrating techniques creates permanent records viewable repeatedly from multiple angles. Slow-motion playback reveals subtle movements. A single recording serves unlimited viewers across distances, overcoming one-to-one apprenticeship's scalability problem.

We prepared video records for a number of technologies where the blunders and the corrections are utilized for educational purposes. It is necessary to comment the key moments where the pressure must be corrected and where the direction of the grain must be established.

Three-dimensional scanning satisfies a multitude of needs. Components of a chair encapsulate knowledge through their measurements and construction methods (Liu, 2022). Computer models maintain this information while physical pieces are damaged, permitting analysis from otherwise impossible perspectives—with their alteration and prolongation of relationships without the necessity of disassembling important pieces.

The motion capture system produces detailed records of the movements that reveal patterns of body placement. The work management software also constructs the work in usable, labeled databases, grouped by technique type and ordered by level of technical sophistication. **Table 1** gives the predominate attributes of a number of digital document technologies and the nature of the knowledge that such technologies are successful in documenting.

Table 1

Comparison of Digital Documentation Technologies

Technology	Strengths	Limitations	Knowledge Type
HD Video	Multiple angles, slow-motion	Cannot convey haptic feedback	Explicit, visual
3D Scanning	Precise dimensions, permanent	Only captures finished objects	Structural, design
Motion Capture	Detailed movement data	Lacks force/resistance info	Kinematic patterns

3.2. Advantages of Digital Approaches

Digital recordings do not forget or fade, safeguarding knowledge when masters die. Scalability is another benefit—the same recording plays for a single student or thousands, rectifying apprenticeship's limitation where masters instruct a few students.

Digital texts are accessible to students anywhere, dissolving geographical constraints. Analyzing several craftsmen's methods finds differences and underlying principles. For tacit knowledge such as design principles, digital preservation is useful. Digital recording provides backup insurance that knowledge endures when traditional transmission breaks down.

3.3. Critical Limitations

Yet gaps emerge considering what digital systems cannot capture. The fundamental issue involves embodied knowledge. When craftsmen feel wood resistance and adjust pressure, they use knowledge existing in their bodies. Recordings show what they do but not what they feel.

Students observe hands move but do not experience wood resistance or vibration of tools. Recordings document positions of movements that obey those forces. Documentation dominates over context. Instruction occurs in workshop spaces where tools are worn and social relationships are present. This situated experience conditions learning that recordings overlook. Most aging masters experienced digital technology for the first time. Workshops that struggle financially lack equipment that costs. Most importantly, records are poor substitutes for practice. Students who observed footage continued to struggle making attempts. Muscle memory is established by virtue of doing things, not by viewing.

4. Integrated Framework for Knowledge Transfer

4.1. Theoretical Foundation

The strengths and weaknesses are distinct for apprenticeship and digital preservation. The key point of complementarity is the fact that their methods address different typologies of knowledge and learning needs. Competing is less efficient than their complementarity when each element remains less than complete.

The traditional apprenticeship excels in the transmission of tacit, body-centered knowledge resistant to full verbalization. A feel for proper technique, unconscious judging of wood's behavior, accumulated experience by practice—are transmitted by personal touch and hands-on experience. Computer recording captures explicit

knowledge that has been visually or verbally codified: principles of design, procedural sequences, proportionalities (Nonaka & Takeuchi, 1995).

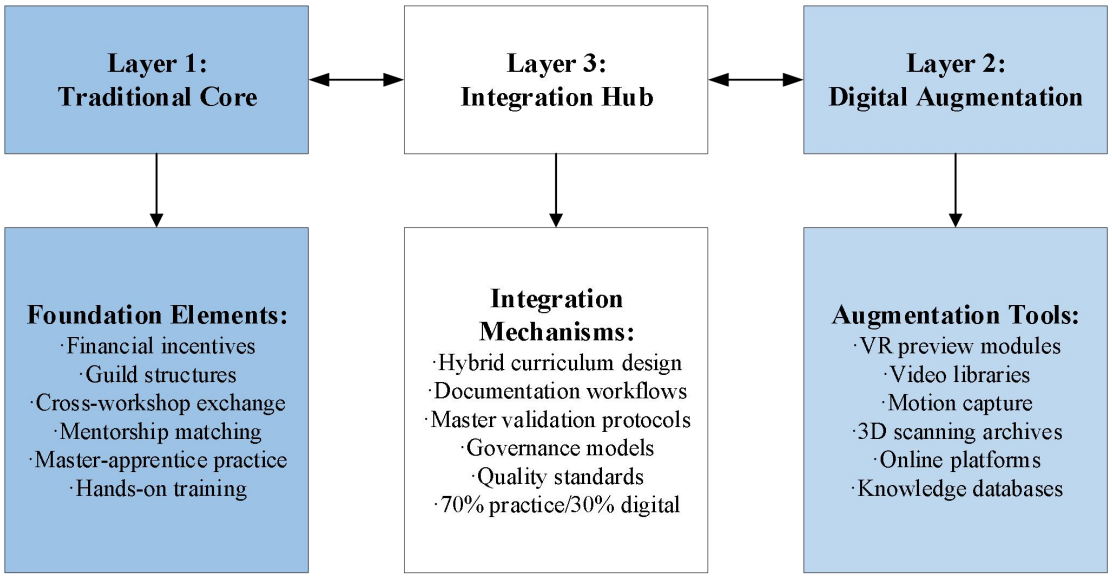
This suggests natural division of labor. Keep traditional apprenticeship as foundation since only direct practice develops embodied mastery. Integrate digital tools judiciously where they have real benefits without inhibiting hands-on learning. Digital media also have the capacity to provide scaffolding that will enable the learner to comprehend concepts earlier—a tutorial video will allow the trainee to acquire the techniques abstractly first before physically learning, constructing a mental model that paves the way for physical learning (Hadjimichael et al., 2024). The model opens for community-based approach framing practitioners themselves as agents facilitating the utilization of the tools.

4.2. Three-Layer Framework Architecture

The architecture has three intersecting levels that work together to accelerate knowledge transmission while embracing originality in culture. **Figure 2** illustrates the composition of the design of our proposed architecture such that the three levels work together in constructing a complete system of knowledge transmission.

Figure 2

Three-Layer Integrated Framework Architecture



Layer 1: Enhanced Traditional Core

Old master-student teaching remains the major cornerstone but needs strengthening. Financial help makes working apprenticeships a possibility—with

wages to masters for lost work time spent teaching and money help towards overcoming obstacles deterring young people entering careers in the crafts.

Guild groups keep quality high, setting training rules and proving skill levels. Cross-workshop exchange events create sideways knowledge sharing that adds to top-down teaching. Matching systems help future apprentices find right masters in an organized way.

Layer 2: Strategic Digital Augmentation

Digital aids are supplements but not replacements. Preview guides also enable students to pre-understand concepts prior to hands-on activities. Virtual Reality applications also depict angles of joint movements for easier first attempts. But these undoubtedly prepare for the real attempt.

Libraries of video also afford second viewing of demos for apprentices during solo practice. Work videotaping also retains knowledge stored as a result of training—the apprentices videotape technique while reinforcing knowledge and building a body of records. Internet spaces also afford knowledge sharing beyond their own shops. Master rule: seventy percent work done by hands, thirty percent using the computer.

Layer 3: Integration Mechanisms

This layer makes everything work together smoothly. Mixed training plan uses both methods—early steps use digital previews to introduce ideas, later stages focus on solo practice with digital help.

Steps in recording mean training—apprentices are taught recording techniques instilling comprehension while making records. Master checking protocols guarantee quality—masters check records for accuracy. Community organizations' leadership models guarantee control over the manner it's done so it's for the good of craftsmen.

4.3. Implementation Roadmap

Implementation takes an incremental approach and attends to various needs. Recording priority focuses on masters most at risk — elderly masters with rare skills. A method of intensive documentation keeps techniques from fading away. Trial Phase: Testing the approach in selected workshops. Small groups practice combined training, make their first statistical models, and watch the results.

Growth Phase: The spreading of working methods to increasingly more communities. The plan is incorporated into trade schools. Monetary systems are

self-supporting and require less external funding. Regional centers provide assistance and maintain rigorous quality standards. Other dying crafts with similar woes can borrow from this plan. Step-wise approach and timing for each step is summarized in **Table 2**.

Table 2

Implementation Phases and Expected Outcomes

Phase	Priority Activities	Expected Outcomes	Duration
Emergency Documentation	Record elderly masters	Core knowledge preserved	Initial period
Pilot Integration	Test in select workshops	Refined framework model	Medium term
Scaling	Expand to broader community	Sustainable ecosystem	Long term

4.4. Stakeholder Roles

It relies upon communal ecosystem with explicit roles. Master craftsmen remain the primary repositories of knowledge, inspectors, and teachers. They set all the aspects of the framework—all determining whose knowledge gets transmitted, how digital technologies are implemented, whose standards are appropriate for mastery. Apprentices are learners and document assistants, building additional understanding by active participation in recording.

Heritage institutions offer coordination, funding, and platform administration by facilitating connections between stakeholders. Technology providers offer equipment and technical assistance but are operated under practitioner direction. Government entities offer policy assistance by way of business funding and quality specifications. Academic researchers add evaluation and optimization. All offer necessary capabilities but where practitioners are central in determining how framework benefits their needs.

5. Pilot Implementation and Results

5.1. Case Study Design

To test framework applicability, we implemented it in a typical Cantonese furniture-production shop in Guangzhou. The shop had a single master craftsman and

three apprentices of mixed experience levels, affording us the potential to observe the joint approach under true conditions.

We also contrasted a control workshop in which the traditional methods alone were utilized. Both had similarly congruent characteristics—a similar master experience and apprentice background. Data included periodic assessment of skills, learning journals, interviews, and volume of documentation measures.

5.2. Implementation Process

Apprentices worked primarily under master supervision, progressing from practice cuts to joint-making to full pieces. Digital tools were integrated strategically: video demos introduced concepts before hands-on practice, and apprentices documented techniques while learning, creating records as a byproduct of training.

5.3. Results and Findings

The differences can be seen from the results. In the learning of complex joint ideas, it takes apprentices a much shorter time to master them. Tenons and mortises are skills: the apprentices reached them in less training time than the comparison group. For those utilizing digital tools, memory improved. Apprentices had better skills after breaks in practice. The records were very large—a lot of video, digital models, and photos were marked.

Apprentices indicated that video previews helped them learn techniques better so that their time for practice was useful. But they insisted that watching could never replace actually doing it. Master's attitude also changed—a doubter initially but admiring the videotaped tradition. He noted that the apprentices learned things sooner but needed the same amount of work by hands. Key takeaway: digital technologies helped but couldn't replace actual practice (Ji et al., 2023).

6. Conclusion

This research charted genealogical patterns that revealed centralized transmission models where knowledge centers around master craftsmen (Bortolotto, 2025). It was found that traditional apprenticeship is highly competent in transferring tacit, bodily

skills but has scalability constraints and risk of knowledge loss. Digital technologies enshrine explicit knowledge indefinitely but are incapable of retaining haptic feedback critical for mastery (Skublewska-Paszkowska et al., 2022). Our harmonized framework remedies these by refining traditional apprenticeship while using digital technologies in strategic auxiliary functions.

Pilot implementation confirmed such complementarity—digital sources accompanied but did not supplant embodied practice so that apprentices could learn concepts effectively while masters appreciated documented transmission. The model provides real-world advice for preservation of heritage. Policy planners need to finance both traditional rewards and digital infrastructure concurrently. Heritage institutions need to emphasize emergency documentation of aged masters while constructing hybrid training modules.

The model transfers to other endangered crafts where embodied knowledge requires hands-on learning yet benefits from digital supplementation. Success requires thoughtfully integrating tradition and modernity. This study focused on single craft tradition with limited pilot duration. Future work should explore sustainable financing and cross-cultural applications.

Conflict of interest: The authors declare no conflict of interest.

Funding: Guangdong Provincial Philosophy and Social Sciences Planning Project “Contemporary Value Reshaping: The Design Methodology for the Revitalization of Intangible Cultural Heritage of Foshan Woodcarving” (Project Number: GD25YYS48).

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