Digital Education: The Inheritance and Development of Chinese Shu Embroidery Culture

Ying Liu and Sastra Laoakka*

Faculty of Fine Applied Arts and Cultural Science Mahasarakham University
Corresponding author: Sastra Laoakka, E-mail: hugna.studio@gmail.com

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ABSTRACT

Sichuan embroidery, as one of China's traditional intangible cultural heritages, is renowned worldwide for its exquisite craftsmanship, profound cultural connotations, and unique artistic value. However, in the face of the impacts of modernization and globalization, the inheritance and development of Sichuan embroidery are facing numerous challenges. This article focuses on the digital preservation and innovation of Shu embroidery patterns, exploring the development model of Shu embroidery, a cultural heritage of Sichuan, by introducing artificial intelligence knowledge graphs and AIGC (Generative AI) technology. This paper focuses on Shu embroidery patterns as the core of the study and constructs the ontology of the Shu embroidery knowledge graph. It systematized the multidimensional information of Shu embroidery patterns, including cultural connotations, historical background, thematic meanings, embroidery techniques, and color structures, forming a structured digital resource. On this basis, by combining knowledge graphs with AIGC technology, a text-to-image pattern creation method was developed, achieving innovative design and efficient generation of Shu embroidery patterns. Research results indicate that knowledge graphs and AIGC technology play a significant role in the digital protection and innovation of Shu embroidery patterns. They not only achieve the modernization and inheritance of traditional culture but also provide new ideas for the industrial development of Shu embroidery art. This study holds important theoretical value and practical significance for the digital protection, intelligent innovation, and global dissemination of intangible cultural heritage.

Key words: Shu Embroidery Patterns, Intangible Cultural Heritage, Knowledge Graph, Visualization, AIGC

INTRODUCTION

Introduce the Problem

Our ancestors expressed their fervent desire for a happy and prosperous life and wealth through these intuitively perceptible perfect forms. Chengdu, the capital of Sichuan Province in China, is the largest origin of Shu embroidery. The embroidery patterns from this region represent the highest level of Shu embroidery and shine brightly on the international stage. Although modern society's attention to Shu embroidery has increased, it still faces challenges in the protection and inheritance of its patterns. How to systematically and standardly research and organize Shu embroidery patterns is a pressing issue for both the academic and industrial sectors. This study addresses the following research questions:

1. What is the historical origin of traditional Shu embroidery patterns?
2. What is the current state and the issues of traditional Shu embroidery patterns?
3. What model is needed for the development of the traditional patterns of Shu embroidery?

By applying knowledge graph technology to the study of Chinese Shu embroidery patterns, it not only systematically organizes and analyzes traditional pattern data but also provides strong support for the protection and innovation of traditional crafts. This research not only holds significant academic value but also has broad practical application prospects, playing an important role in promoting the inheritance and innovation of traditional culture and driving the development of related industries.

Explore Importance of the Problem

This study combines artificial intelligence technology with cultural heritage, utilizing knowledge graph technology. First, it is necessary to classify and display the complex knowledge elements of Shu embroidery patterns through the construction of an ontology at the entity level. Secondly, it requires leveraging the logical relationships between historical events related to Shu embroidery patterns. This atlas can connect the knowledge of Shu embroidery patterns, facilitating the interconnection, co-construction, and

sharing of knowledge. It also helps inheritors and related researchers better understand and learn the techniques of Shu embroidery, laying a solid foundation for the protection, inheritance, and development of the traditional techniques of Shu embroidery patterns as intangible cultural heritage (Archibald, 2006). Additionally, it provides convenience for the subsequent learning and research of inheritors and related scholars.

Domestic Related Applications

The domestic application of Shu embroidery patterns is developing from traditional craftsmanship to modern design, digital art and other diversified directions (HE, 2023). With the advancement of science and technology and the expansion of the market, Shu embroidery can not only be inherited as a cultural heritage (Zhang, 2018), but also glow with new commercial value and artistic charm in the new era. In the future, combined with artificial intelligence technology and international promotion (Zhao, 2023), Shu embroidery is expected to become one of the important representatives of China's cultural soft power. For detailed information see Table 1.

Relevant Research Theories

The knowledge graph model of Chinese Shu embroidery patterns is an important advancement that combines traditional craftsmanship with modern information technology（Liu, 2005), aiming to systematically organize, deeply analyze, and effectively disseminate the rich cultural heritage of Shu embroidery.

In terms of knowledge graphs, as early as 2012, Google introduced the term "knowledge graph" and stated that it could be widely applied in various fields such as finance, national security, and intangible cultural heritage. Essentially, it is a relationship graph composed of nodes (entities) and edges (relationships between entities).From the perspective of logical architecture, it can be divided into entity layer knowledge graphs and data layer knowledge graphs. Typically, ontologies are used to construct the entity layer, and graph databases are used to store the data. In terms of foundational technical research on knowledge graphs, Deshpande and others continuously update the Wikipedia dataset to construct, maintain, and apply knowledge graphs. Meanwhile, Yago and his team have been consistently following up on domain knowledge graph and ontology construction. Wang and others pointed out the issues of quality and category derivation in the source data, while another scholar, Lin, proposed that there are also corresponding problems with knowledge representation methods. In addition, Wang Zhongyi used analytical knowledge representation methods to construct a knowledge representation model. During the construction process, Liu Qiao utilized the analytical framework to identify key technical challenges and innovatively adopted a top-down analytical approach.

So far, the storage of knowledge graphs remains a classic topic. Scholars often use RDF triples to achieve their storage goals (Hu, 1997). Li Yue and others have compared large-scale RDF triple conversion and storage tools from multiple perspectives, including technical principles, performance characteristics, and application scenarios. Angles, among others, directly map their databases based on the work of predecessors, altering their attributes and converting them into graph databases. Compared to RDF triples, graph databases can describe nodes and attributes. The most common storage system currently is the Neo4j graph database, which has built-in Cypher query language and supports various efficient graph algorithms. Subsequently, a series of scholars have carried out new innovations around the Neo4j graph database. For example, Xu Jian used it to build a 5G protocol knowledge base, while Gao Chenxiang and others used it as a foundation to expand into regional government Weibo services. Then applied it to the field of social networks, using data sources that included Twitter and various open web pages, and constructed a knowledge graph for the social network domain using Neo4j.

The Study of Pattern Culture

Our country is a great nation of art with thousands of years of cultural tradition(Deng, 1984). Decorative patterns appeared with the birth of humanity and have a long history and magnificent achievements in our country. Our traditional decorative patterns are ever-changing and brilliantly colorful. Due to the different substrates they are attached to, there are pottery patterns, bronze patterns, textile patterns, jade patterns, and so on; due to the different decorative contents, they can be divided into animal patterns, human patterns, plant patterns, life scene patterns, etc.; the factors determining the pattern decoration on an object are numerous. Examining the history of Chinese patterns, one can still find traces of it. This trajectory is almost like a record of human growth and social development(Sun, 1987).

Chinese patterns also enjoy a prestigious reputation internationally. For example, the "Chinese Patterns" collector's edition (Figure 1), through high-level printing technology, restores the texture of traditional crafts such as blue-and-white porcelain, cloisonné, filigree enamel, and famille rose porcelain. This book not only provides enthusiasts with a rich visual experience but also offers researchers valuable historical materials. The dissemination and influence of Chinese patterns have also extended overseas(Wang, 2006).

In summary, Chinese patterns are not only a manifestation of art but also a carrier of history and culture. Through them, one can gain a deep understanding of the Chinese way of life, aesthetic concepts, and the profound heritage of Chinese culture.

METHOD

This study employs a mixed research method to examine Chinese Shu embroidery: the development model of Sichuan cultural heritage. Researchers collected data from relevant literature and research papers. Field investigation methods, including surveys, observations, interviews, and focus group discussions, were used to gather data and information. The data were analyzed using research concepts, theories,

Table 1. The application of Shu embroidery

Fields of application	Specific applications	Cases and development status
Clothing & Fashion	High-end custom clothing, cheongsam, accessories	Designer brands integrate Shu embroidery elements into high-end ready-to-wear, such as Shu brocade cheongsam, embroidered Hanfu, etc., Well-known domestic brands, such as "The Legend of Gaia" and "Zhuang Ji", use Shu embroidery skills in clothing design and enter the international market.
Home der	Wall decorations, screens, throw pillows, carpets	Shu embroidery decorative paintings, embroidery screens and other products are widely used in Chinese home furnishings, hotels and clubs and other space design. Many custom home furnishing brands combine the traditional patterns of Shu embroidery to launch personalized home furnishing products.
Stagecraft	Traditional theatrical, film and television costumes	Shu embroidery is used in theatrical costumes (such as Sichuan opera, Peking opera) and film and television dramas (such as "Shu Jin People"). Many high-end theater costumes use Shu embroidery techniques to enhance the visual arts.
Cultural and creative products	Bookmarks, silk scarves, notebooks, phone cases	Cultural institutions such as the Palace Museum and Sanxingdui Museum have launched cultural and creative products with Shu embroidery elements. Shu embroidery combines modern technology, such as 3D printing, laser engraving, etc., to achieve miniaturized and convenient cultural and creative products.
Digital art and AI creation	Knowledge Graph, AIGC Art Design	Through artificial intelligence (AIGC) technology, a database of Shu embroidery patterns is built based on the knowledge graph to achieve intelligent design. AI-assisted generation of personalized Shu embroidery patterns, which are applied to emerging markets such as NFT art and digital collections.
Architectural decoration	Hotels, cultural centers, commercial spaces	High-end hotels (such as the Diaoyutai Boutique Hotel in Chengdu) use Shu embroidered screens and wall decorations. Cultural spaces such as museums and exhibition halls use Shu embroidery elements to enhance the cultural atmosphere of the space.
Education & Training	Intangible cultural heritage, online courses	Major colleges and universities (such as Chengdu Textile College) offer courses related to Shu embroidery and carry out training for intangible cultural heritage inheritors. Online platforms (such as NetEase Cloud Classroom, Bilibili) have launched Shu embroidery skills teaching courses to promote learners' exchanges.

Note: The author sort out it based on literature.

Figure 1. Traditional Chinese patterns

Table 2. Research schedule

Number	Content	Year, Month
1	Collect information from research and determine the pattern protection plan.	2023.6
2	Pattern collection.	2023.10
3	Classification, organization, and storage of Shu embroidery patterns.	2024.2
4	Constructing the Shu embroidery pattern ontology and conducting visual display of the process.	2024.3
5	Improve the system design plan and schedule.	2024.6
6	Conclusion and submit the results.	2024.9

Data source: By Ying Liu, 2024

Table 3. Relevant researchers

Number	Name	Photo	Content
1	National-level Shu embroidery inheritor: Hao Shuping		The first batch of representative inheritors of the national-level intangible cultural heritage project Shu embroidery, a Chinese arts and crafts master, enjoying special government allowances from the State Council.
2	National-level Shu embroidery inheritor: Meng Dezhi		The general manager of Chengdu Mengyuan Shu Embroidery Crafts Co., Ltd., and the director of Chengdu Chanlin Shu Embroidery Research Institute, has been engaged in the creation and research of Shu embroidery techniques for over 30 years.
3	Provincial-level inheritor of Shu embroidery: Peng Shiping		Master of Arts and Crafts in Sichuan Province, born in 1961 into a family of Shu embroidery, has been engaged in the study of Shu embroidery techniques for over thirty years, and has created hundreds of exquisite pieces of Shu embroidery.

Data source:ByYing Liu,2024

literature, and related studies, and descriptive analysis was employed to analyze the data according to the research objectives.

Research Timeline

1. Preliminary preparation: By analyzing literature, we will outline the historical development, pattern characteristics, and cultural connotations of Shu embroidery, laying a theoretical foundation for field investigation.
2. Data Collection: Record the characteristics and connotations of Shu embroidery patterns during field investigations, and gain in-depth insights into the inheritors' views on pattern preservation through interviews.
3. Data organization and analysis: Classify, organize, and analyze the collected image data, interview records, and

historical documents to summarize the cultural characteristics and pattern meanings of Shu embroidery.
4. Model Construction: Based on the theory of protecting the cultural connotations and patterns of Shu embroidery, combined with research data, establish a protection model for the inheritance and innovation of Shu embroidery culture.
5. Writing the report: Finally, systematically organize the research findings into a paper and propose specific suggestions for the protection and inheritance of Shu embroidery culture (Table 2).

Research Field

The birthplace of Shu embroidery, Anjing Town, is located in the heart of the Chengdu Plain, situated in a humid

subtropical monsoon climate zone. The mild climate and moderate humidity provide excellent conditions for the development of sericulture. On this land, the production of high-quality silk has laid the foundation for the raw materials of Shu embroidery, allowing the craft to continue to thrive. In addition, the abundant water resources in Anjing Town are also beneficial for dye production, ensuring the vividness and durability of Shu embroidery colors. Choosing Anjing Town for the study of Shu embroidery helps in understanding the complete process from material collection to craft production, providing a detailed case for the localization research of Shu embroidery. Through the investigation of the Shu embroidery workshop in Anjing Town, one can trace the evolution of Shu embroidery techniques from the Han Dynasty to the present, deeply analyzing its artistic value and historical heritage. By means of on-site interviews and field surveys, one can more directly engage with the old artisans of Shu embroidery, finding the unique artistic style of Shu embroidery in their craftsmanship, thereby forming a more empirical historical perspective9Cui & Liang, 2008).

Research Population

According to the research objectives, purposive sampling was used to select three groups of people as respondents for the field study. They are key informants, temporary informants, and general informants. The following criteria and selected personnel will be introduced (Table 3).

Research tools

The research tools used in this thesis are primarily based on interviews and observations conducted on the foundation of data collection and factual observation. This method focuses on process and structural analysis, striving to obtain target field survey data and conduct qualitative research and interpretation of the subjects. To gather research data, the researchers designed questionnaires and tailored interview and observation formats according to different research subjects.

Research steps

1. Field Investigation: Conduct on-site visits in places like Anjing Town in Sichuan, the birthplace of Shu embroidery, to collect first-hand information and observe the current state of local craft inheritance.
2. Survey: The questionnaire is designed around the cultural understanding, pattern characteristics and connotations, inheritance status, and modernization development needs of Shu embroidery, helping to analyze different groups' understanding, support, and the promotion prospects of Shu embroidery culture in modern society.
3. Interview method: By interviewing inheritors of Shu embroidery, local cultural scholars, and related practitioners, understand the characteristics of Shu embroidery patterns and their development needs.
4. Digital Photography: Using high-definition camera equipment to record Shu embroidery works and their

Figure 2. Representative work of Shu embroidery: Giant Panda Source: By Ying Liu, 2024

production process for subsequent image analysis and data archiving.
5. Literature Review: Consult literature and government documents related to Shu embroidery culture, Shu embroidery patterns, and history to establish a theoretical foundation.

RESULTS

The Historical Origins, Artistic Value, and Cultural Summary of Shu Embroidery

This study systematically reviews the historical origins of Shu embroidery, revealing its evolution from a folk art form in the Bashu region to a court tribute, reaching its peak during the Song and Yuan dynasties. Sichuan embroidery is renowned for its exquisite stitching techniques, vibrant colors, and rich cultural connotations (Zhang, 2005). The research delves deeply into the totemic beliefs, ritual culture, and social symbolism embedded in the patterns of Sichuan embroidery, uncovering the artistic value and cultural heritage of Sichuan embroidery as a traditional craft. As shown in Figure 2, the pattern design of Shu embroidery not only reflects the profound heritage of traditional Chinese aesthetics but also showcases the unique cultural traits and contemporary characteristics of the Bashu region (Zhao, 2005).

The Inheritance and Preservation of Shu Embroidery

Sichuan embroidery faces severe challenges in the modernization process, including the aging of inheritors, the impact of marketization, and cultural disconnection (Li, 2007). Through research on the current state of Sichuan embroidery inheritance, the paper summarizes the experiences of government support policies, inheritor training models, and intangible cultural heritage protection mechanisms. Specifically proposed digital-based protection strategies, including the establishment of a Shu embroidery pattern database, the development of educational courses, and the utilization of diverse communication channels. These measures not only continue the craft traditions of Shu embroidery but

also provide a modern platform for the younger generation to understand and learn about Shu embroidery, effectively alleviating the crisis of the inheritance chain breaking.

The Role of Artificial Intelligence Knowledge Graph Technology in Promoting the Development of Shu Embroidery Patterns

This study innovatively applies artificial intelligence knowledge graph technology to the research and development of Shu embroidery patterns. Using the knowledge graph as the core framework, it systematically models the semantic features, cultural connotations, and craftsmanship techniques of Shu embroidery patterns, thereby achieving intelligent classification, retrieval, and cultural interpretation functions for Shu embroidery patterns. By constructing a pattern knowledge graph and a design assistance system, the paper explores the practical application of artificial intelligence in innovative pattern design, providing modern designers with sources of creative inspiration. At the same time, knowledge graph technology has enabled the cultural cross-border dissemination of traditional Shu embroidery in a digital context, offering new ideas for the protection and innovative development of intangible cultural heritage.

This paper starts from the historical origins and artistic value of Shu embroidery, focusing on the practice of its inheritance and protection. At the same time, it integrates artificial intelligence technology to empower the innovative development of Shu embroidery, providing a new methodology for the integration of traditional crafts and modern technology (Han, 2002). The research results not only point the way for the future development of Shu embroidery but also inject new technology-driven momentum into the field of intangible cultural heritage protection.

DISCUSSION

Construction of the Knowledge Graph for Shu Embroidery Patterns

As a new way of knowledge representation, knowledge graphs can represent entities and their attributes and relationships through a graph structure of nodes and edges. In the process of inheriting Shu embroidery, the digitization, classification, and systematic management of Shu embroidery patterns are one of the key challenges (Zhong, 2002). By constructing a knowledge graph of Shu embroidery patterns, researchers, designers, and cultural workers can better understand and organize the traditional content and innovative paths of Shu embroidery patterns, providing systematic data support for subsequent creation and preservation.

As the core component of Shu embroidery, Shu embroidery patterns possess rich symbolic meanings, cultural backgrounds, and historical value. Each pattern is not merely a combination of designs but also embodies specific cultural symbols or aesthetic concepts. For example, the use of elements such as dragons and phoenixes, flowers and birds in Shu embroidery holds significant symbolic meaning, representing traditional cultural values such as auspiciousness,

prosperity, and happiness. By constructing a knowledge graph of Shu embroidery patterns, each pattern can be linked to its cultural background, historical origins, colors used, and production techniques, forming a systematic knowledge network. This network not only aids researchers in understanding the history and artistic value of Shu embroidery but also provides digital tools for the preservation work.

In the process of constructing knowledge graphs, the application of artificial intelligence technologies, especially natural language processing (NLP), computer vision, and deep learning, has greatly enhanced the efficiency of automated data processing. Through image recognition technology, the patterns in Shu embroidery works can be automatically extracted and classified, and matched with descriptions in literature, thereby constructing a knowledge graph that includes pattern attributes, evolutionary relationships, artistic features, and other content. Furthermore, based on big data analysis and machine learning algorithms, the construction of knowledge graphs can not only automatically classify patterns but also identify the intrinsic connections between them, revealing multidimensional information about their cultural, artistic, and social backgrounds.

This constructed knowledge graph of Shu embroidery patterns can be used in multiple fields. Firstly, in cultural studies, researchers can use the graph to understand the historical origins and cultural connotations of different patterns, conducting in-depth interdisciplinary research. Secondly, in terms of inheritance and protection, knowledge graphs can help digitize and preserve the classic patterns of Shu embroidery, and through a database management model, ensure the long-term preservation and sharing of these traditional cultural symbols. Finally, in terms of creative design, designers can use knowledge graphs to explore variations and innovations of patterns, find sources of inspiration, and apply these patterns to modern design, thereby creating innovative works that possess both traditional charm and modern sensibility.

Generating Creative Ideas Based on Artificial Intelligence Knowledge Graph Data

The patterns of Shu embroidery are a reflection of its artistic characteristics, with each pattern possessing unique forms, colors, and symbolic meanings. Traditional Shu embroidery patterns come in an extremely rich variety and expression techniques, such as flowers, animals, landscapes, etc., showcasing strong regional characteristics and cultural symbolism. How to systematize and digitize these patterns, and provide data support for their creative generation, is the primary task for the creative development of Shu embroidery.

Knowledge graph technology, through the graph structure of nodes and edges, can structurally express various information about Shu embroidery patterns. This information includes the patterns' forms, historical background, cultural symbolism, materials and techniques, etc. It can be processed and analyzed using artificial intelligence algorithms to form a structured data network. Through the study of a large number of Shu embroidery patterns and their related cultural backgrounds, AI can understand and extract the

intrinsic characteristics and aesthetic values of each pattern, and based on this, generate creative works.

With the support of the Shuxiu pattern knowledge graph, AIGC technology can automatically classify, analyze, and generate different types of Shuxiu patterns. For example, based on specific historical periods or cultural backgrounds, AI can generate patterns with particular styles and symbolic meanings.At the same time, the use of knowledge graphs can effectively prevent the generated patterns from deviating from the cultural and artistic foundations of traditional Shu embroidery, maintaining the unique charm of Shu embroidery.

Artificial intelligence, especially AIGC technology, has played an important role in the inheritance and innovation of Shu embroidery. Through the construction of a knowledge graph of Shu embroidery patterns, AIGC can effectively generate creative ideas, promoting the transformation of Shu embroidery from a traditional craft to a modern, international art form. Its powerful data processing capabilities and innovative generation mechanisms not only promote the artistic creation of Shu embroidery but also provide new technical means for its protection and inheritance. With the continuous development of artificial intelligence technology, AIGC will play an increasingly important role in the inheritance and innovation of Shu embroidery and other traditional cultural heritages.

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