

Public Learning: Constructivist Education of the Chinese Abacus Museum

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How to cite this paper: Lin, Y.-H. (2024). Public Learning: Constructivist Education of the Chinese Abacus Museum. *Chinese Studies, 13,* 257-267. https://doi.org/10.4236/chnstd.2024.134016

Received: April 3, 2024 Accepted: September 17, 2024 Published: September 20, 2024

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Abstract

This paper aims to identify how constructivist education contributes to cultural preservation and educational promotion, particularly its influence on preserving Zhusuan culture. Grounded in the theory of constructivism, this study employed field research to examine the world's largest abacus museum and assess the current status of museum education. The findings of this study indicate that the Chinese Abacus Museum (CAM) serves various roles in preserving and promoting intangible cultural heritage, focusing primarily on preservation, public orientation, and social education. These components are closely related, forming a comprehensive educational system. This interconnection and collaboration enable the constructivist education at the CAM to comprehensively and effectively fulfill its educational and cultural preservation mission.

Keywords

Intangible Cultural Heritage of Humanity, Chinese Abacus Museum, Preservation and Promotion, Theory of Constructivism, Museum Education

1. Introduction

The Chinese Abacus Museum (CAM), presently recognized as the world's largest museum dedicated to Zhusuan (mathematical calculation using the abacus), is situated within the Haohe Scenic Area, a nationally acclaimed 5-A tourist attraction in Nantong, Jiangsu Province. It officially opened on December 19, 2004. Jia-Zheng Sun, the then Minister of Culture of the People's Republic of China, emphasized that the CAM would "play a vital role in preserving and researching the history of Zhusuan, as well as carrying forward and continuing Zhusuan culture." With respect to the CAM's initial exhibition hall layout upon its establishment, the first floor was divided into two themes: "Essentials of History" and "Selected Topics," while the second floor was dedicated to showcasing the abacus artifacts, including specialized, general, crafted, folk, foreign, and revolutionary abacuses. In the "Cultural Overview" section, themed exhibitions explored the connection between Zhusuan and literature, painting, music, dance, drama, film & TV, riddles, proverbs, and stories, highlighting its deep integration into public artistic expression. The "Essentials of History" section primarily provided insights into the history of Zhusuan, presenting a distinctive and elegant narrative of its evolution spanning from the Han dynasty to modern times, starting from emergence, formation, development, maturity, and popularization to revival. Museums are considered sanctuaries for the protection and continuation of human civilization. Utilizing cultural relics as a vehicle, museums facilitate the exchange and mutual learning of civilizations. Visitors cultivate their understanding of relics, culture, and civilization through their museum visits and educational journeys.

This study focuses on how the China Abacus Museum (CAM) achieves the dual goals of cultural heritage preservation and public education by designing and implementing educational activities based on a theoretical framework and practice. The goal is to assess the practical effects of constructivist education on cultural preservation and educational promotion, especially in the sustainable preservation and development of Zhusuan culture.

Guided by the theory of constructivism, this paper employed field research to probe into the relationship between the cultural features of the CAM and the evolution of Zhusuan from three perspectives: preservation, public orientation, and social education. The ultimate goal is to explore museum education's cultural positioning and value.

2. Educational Construction of Museums

In accordance with the general requirements outlined in the Guidelines on Promoting the Reform and Development of Museums (National Administration of Cultural Heritage (2021) No. 16), museums should "meet people's expectations for a better life." Furthermore, the guidelines emphasized that in terms of "solidifying development foundations and improving service efficiency," museums should "boost protective capabilities," "fulfill educational functions," "advance research, education, dissemination, and preservation of Chinese civilization," "optimize communication services," "deepen museum-community collaboration," "enhance international cooperation," and "carry forward universal values inherent in Chinese culture." In terms of "innovating institutional mechanisms and unleashing development vitality," the guidelines highlight the crucial role of museums in "encouraging public engagement" and "facilitating the integration of museums with other sectors, including education, science and technology, tourism, commerce, media, and design." Heiny (1998) emphasized the necessity of learning in museum settings in the book *Learning in the Museum*, which is based on the theory of constructivism. In his work, Heiny (1998) emphasized that creating conducive learning environments within museums, with visitors (the public) at the forefront, facilitates tangible and intangible interaction and communication between visitors and exhibits, making it easier for visitors to shape their understanding of the outside world and helping them develop personal perceptions. Museums' cultural significance mainly lies in the following aspects, namely knowledge, emotions, and ethics, alongside the specific values that accompany these three aspects (Su, 2012). Building upon Dong-Hai Su's framework of three cultural features of museums, Dong-Lei He explored the positioning and value of museum education, asserting that museums serve as hubs for knowledge generation and sharing. They engage in communication during knowledge generation (Su, 2012; He, 2022), characterized by its role in assisting visitors in constructing their own knowledge frameworks-a communication model based on "knowledge construction." The exhibition hall planning, design, and layout of the CAM revolve around preserving Chinese culture and promoting Zhusuan culture. By fostering knowledge generation and sharing, the CAM facilitates visitors' acquisition of cultural knowledge and the construction of their own systems of understanding.

The constructivist education approach employed by the CAM helps visitors gain a deeper understanding of the history and culture of Zhusuan and master this traditional skill through interactive experiences. The theory of constructivism has laid a solid theoretical foundation for this approach. In *The Construction of Reality in the Child*, Jean Piaget (1954) explored how children actively construct cognitive structures about the world through interactions with their surroundings. His theory emphasizes learners' active roles in exploration and manipulation, which is suitable for helping museum visitors effectively construct Zhusuan-related knowledge through the hands-on operation of abacuses and interactive exhibitions (Piaget, 1954).

Lev Vygotsky (1978) introduced the concept of "Zone of Proximal Development (ZPD)" in *Mind in Society*. This concept underscores the importance of social interaction in cognitive development. According to Vygotsky, learners can achieve higher cognitive levels through interaction and cooperative learning with experienced individuals. This theory is particularly applicable to museum education, where guides and instructors can help visitors enhance their Zhusuan-related skills and knowledge (Vygotsky, 1978).

Bruner (1966) proposed the theory of discovery learning in his book *Toward a Theory of Instruction*, which advocates for learning through exploration and discovery. His "Spiral Curriculum" design concept emphasizes active and autonomous learning, guiding the museum in designing interactive exhibitions and hands-on activities. This approach sparks visitors' interest in exploration and learning (Bruner, 1966).

Jonassen (1999) developed principles for designing constructivist learning environments in his article "Designing Constructivist Learning Environments," including authentic tasks, contextualized learning, and community practice. He stressed the importance of real-world contexts to enhance understanding and application. The CAM can enhance visitors' learning experience and outcomes by showcasing the applications of Zhusuan in real life and organizing community practice activities, such as Zhusuan-related competitions and workshops (Jonassen, 1999).

Guided by constructivist theory, which integrates the theories of Piaget, Vygotsky, Bruner, and Jonassen, the CAM can design educational exhibitions and activities. This approach can spark visitors' interest in learning and deepen their understanding and application of Zhusuan-related knowledge. Furthermore, applying constructivist theory helps the museum achieve the dual goals of education and cultural preservation, allowing visitors to experience the charm of Zhusuan and pass on this valuable cultural heritage through interactive experiences.

3. Jointly Developing a Comprehensive Educational System 3.1. Preservation

On December 4, 2013 (local time), during the Eighth Session of the General Assembly of the Intergovernmental Committee for the Safeguarding of Intangible Cultural Heritage of the United Nations Educational, Scientific and Cultural Organization (UNESCO) held in Baku, the capital of Azerbaijan, "Chinese Zhusuan" received approval for inclusion on the Representative List of the Intangible Cultural Heritage of Humanity. The official certificate recognized the "Chinese Zhusuan knowledge and practices of mathematical calculation through the abacus." According to the Editorial Office of the Chinese Zhusuan Cultural Atlas (2015), Chinese Zhusuan involves arithmetic calculations performed through finger manipulation of beads on an abacus. It represents a time-honored method of calculation, embodying not only the cultural identity of the Chinese people but also serving as a practical tool with diverse socio-cultural functions, contributing a unique knowledge system to the world. Including Chinese Zhusuan on the Representative List of the Intangible Cultural Heritage of Humanity is conducive to increasing the visibility of intangible cultural heritage, fostering respect for human creativity, and serving as an adaptable exemplar to contemporary needs.

ICH protection is a global initiative spearheaded by UNESCO. Participants are required to fulfill their obligations to protect and promote cultural heritage, ensuring that items included on the *Representative List of the Intangible Cultural Heritage of Humanity* are well-protected. When the Chinese Abacus and Mental Arithmetic Association applied for inclusion, a nine-minute video titled "*Application Documentary for Chinese Zhusuan*" was submitted to underscore the association's commitment to preserving Chinese Zhusuan and metal arithmetic cultures and ICH items. In the video, the association made the following promises: "(1) Refine the mechanism for heritage preservation and strengthen the training of inheritors; (2) Establish dedicated centers for protecting and carrying forward Zhusuan culture in areas rich in heritage; (3) Provide Zhusuan and mental arithmetic textbooks to researchers; (4) Sort out and preserve traditional abacus craftsmanship; (5) Organize seminars, exhibitions, and competitions at home and

abroad; (6) Disseminate more information about Zhusuan." To preserve Chinese Zhusuan culture and protect its status as an intangible cultural heritage, China has implemented six measures: refining the preservation mechanism, establishing preservation bases, providing reading materials, preserving the relevant craft, or-ganizing activities, and disseminating information. The completion and opening of the CAM in 2004 effectively fulfilled these commitments, predating the successful inclusion application by nine years in 2013. This demonstrates that relevant authorities have already recognized the pressing need to safeguard Zhusuan culture and promote relevant cultural education.

On December 19, 2004, the CAM officially opened its doors. In May 2009, it was recognized as one of the first national third-grade museums. However, as of June 2, 2021, it temporarily closed for a significant renovation and upgrade. Finally, on December 21, 2021, the CAM reopened to the public. The researchers of this study conducted field research at the museum in Nantong on August 11, 2022. Three exhibition halls are designed inside the museum: the Zhusuan History Hall, the Select Abacuses Hall, and the Red Sandalwood Abacuses Hall. The Zhusuan History Hall immerses visitors in a quaint ambiance, showcasing simple yet profound artifacts that unveil the rich cultural heritage of Zhusuan. Meanwhile, the Select Abacuses Hall and the Red Sandalwood Abacuses Hall feature a dazzling array of meticulously crafted red sandalwood abacuses with unique structures, exemplifying these timeless tools' exquisite craftsmanship and practical utility. Adjacent to the CAM stands the Nantong Children's Zhusuan and Mental Arithmetic School, which serves as a training base for young minds under the Chinese Abacus and Mental Arithmetic Association. The school is equipped with state-ofthe-art multimedia teaching facilities, training rooms, and a competition hall capable of accommodating 200 participants. Together, these two institutions fully demonstrate the association's commitment to "establish dedicated centers for protecting and carrying forward Zhusuan culture." The artifacts housed within the CAM exemplify the museum's commitment to preserving and promoting tangible and intangible cultural heritage, fostering deeper public understanding and appreciation of culture and civilization.

3.2. Public Orientation

As a mediator for communication between exhibits and visitors, interpretative planners require not only profound cultural literacy and knowledge but also the ability to summarize and apply cultural interpretation strategies in practice to facilitate communication with visitors (Zhao & Wang, 2022). Spanning an area of 30 mu, with a building area reaching 6,000 square meters, the CAM houses over 10,000 pieces of Zhusuan-related artifacts and historical materials. Of particular note is its interactive hall, equipped with a multimedia system that allows visitors to physically engage with abacuses, creating an inviting atmosphere that encourages exploration and interaction with the exhibits. The museum's hall dedicated to tracing the evolution of Zhusuan offers a captivating overview of the extensive

history of Chinese Zhusuan in a comprehensible manner, primarily showcasing authentic abacus-related artifacts accompanied by images. Additionally, multimedia elements such as sound, light effects, and 3D animations are incorporated to recreate an immersive educational and entertainment environment. This enables visitors to journey through historical epochs alongside the evolution of Chinese Zhusuan, providing an enriching experience in a historical context.

Zhusuan, conducted using an abacus, serves as a tangible vehicle of Zhusuan culture. On the CAM's second floor, various abacus artifacts take center stage. From specialized and general abacuses to crafted, folk, foreign, and revolutionary varieties, visitors are presented with a diverse array that broadens their perspectives. Each abacus, ranging from the world's smallest to the largest, is accompanied by a unique exhibition atmosphere, providing visitors with an exquisite space suitable for housing artifact collection and engaging in public learning. As a public service institution, the CAM offers visitors an intellectually and emotionally stimulating learning environment where diverse cultural and historical emotions resonate and intertwine.

Arithmetic has held a revered position as one of the "Six Arts" in ancient China and was integrated into childhood education as early as the spring and autumn periods and the Warring States period. Textbooks for enlightenment during the pre-Qin and Han dynasties to the Tang dynasty featured the "Nine Times Table." Unearthed cultural relics further confirm the widespread use of the "Nine Times Table" since ancient times. The arithmetic method of Chinese Zhusuan relies on mnemonic devices that engage visual, auditory, and tactile senses to swiftly perform calculations. Its practicality stems from the inclusion of "mathematics" in the "Six Arts" in ancient China and the "Nine Times Table" in Chinese mathematics. At the CAM, a diverse collection of commonplace items offers insights into the integration of abacuses into people's daily lives, including accounting abacuses, decorative abacus ornaments, crafted abacuses, red sandalwood abacuses regarded as exquisite works of art in daily life, and Taiji Bagua abacuses. Such displays underscore the abacus's utility in daily life.

The establishment of the CAM signifies a renaissance and revitalization of Zhusuan culture (Lin, 2022). This cultural renaissance, driven by the CAM, resonates with Yang's (Yang, 2011) notion of "a shift toward the revitalization and reconstruction of folklore." Museums inherently serve as platforms for cultural communication. By shifting from a focus on artifacts to a people-centered approach, museums have garnered significant momentum by offering services to the public and delivering meaningful and valuable cultural insights grounded in reality and woven into everyday life. This embodies the essence of communication (Zhang, 2016).

The term "Zhusuan" first appeared in the Eastern Han dynasty in Yueh Xu's work *Shushu Jiyi* (Xu & Zhen, n.d.), which means records of mathematical arts. According to the book, the wooden board is divided into three sections, with the top and bottom sections designed for movable counting beads and the middle

section used for positioning. Each position holds five beads, with the top bead representing five and the bottom four beads representing one each. The book elaborates on various calculators in ancient China, including "Jisuan, Taiyi, Liangyi, Sancai, Wuxing, Bagua, Jiugong, Yunsuan, Liaozhi, Chengshu, Batou, Guisuan, Zhusuan, and Jisuan." Among these methods, only the final "Jisuan" refers to mental arithmetic, while the rest involve calculating tools. Among the 13 calculators listed, Zhusuan, which employs an abacus as the calculating tool, has remained in use for over 2000 years, enduring the Eastern Han dynasty to its inclusion in the world-class ICH by UNESCO in 2013.

Following UNESCO's recognition of Chinese Zhusuan on the *Representative List of the Intangible Cultural Heritage of Humanity*, there was a global surge in interest in learning this ancient skill, prompting China and the international community to reassess the significance of this traditional culture. The development trajectory of Chinese Zhusuan reflects the evolution of its cultural heritage, transitioning from one of the "Six Arts" to being recognized by UNESCO for ICH. However, this evolution was not predetermined; rather, it adapted to the changing needs of each era (Lin & Meng, 2023). The collection of abacus artifacts in the CAM symbolizes the museum's endeavors to preserve and promote Zhusuan culture. Its shift from mere exhibition space to a provider of public services, integrated into everyday life, advocates for cultural participation among people that has deeply influenced the public, touching people's hearts.

3.3. Social Education

China has a rich tradition of arithmetic education, as evidenced by discoveries such as the Zhu Tao from the Western Zhou dynasty. Initially used for basic counting purposes, the "Chinese Zhusuan" has evolved into a fundamental arithmetic skill. In particular, the "quinary decimal system" rule covers a wide range of numerical operations. Archaeological findings from the pre-Qin and Han dynasties further highlight the prevalence of the "Nine Times Table" in ancient China, which is closely linked to the ancient Chinese "nine times" concept. Consequently, the Nine Times Table was widely integrated into childhood education across China, even extending to remote regions like Dunhuang during the Tang dynasty, where arithmetic was compulsory in the imperial examination. During the Ming dynasty, merchants relied heavily on the abacus amidst flourishing commerce and economy, making Zhusuan an essential skill with mnemonic devices passed down through generations within families. In the Qing dynasty, Zhusuan was formally incorporated into school textbooks. In contemporary times, to adapt to current trends and accommodate different social and cultural contexts, Zhusuan was integrated into school mathematics curricula. Additionally, in response to the increasing global awareness of safeguarding ICH, Zhusuan was recognized as "ICH." Thus, it is evident that Chinese Zhusuan has exhibited various development trajectories and applications across different historical, social, and cultural contexts.

As a service institution committed to social education, the CAM has shifted its focus towards the public and current trends, which is evident in the design of its exhibition halls, ranging from the history of Zhusuan to folklore. This transition aims to deepen visitors' understanding of artifacts and culture. In the museum context, information about artifacts is communicated through various exhibits and interpretative materials. Unlike traditional classroom learning, museum education offers visitors greater autonomy, empowering them to determine the content of their study, the learning time, learning requirements, and motives. As a result, visitors can construct their own knowledge and understanding of the artifacts and culture presented in the museum in personalized ways based on their interests, preferences, and feelings.

Swiss educator J. Piaget was a pioneer in introducing the constructivism theory. He delved into children's cognitive development through internal and external factors. According to Piaget, as children interact with their surroundings, they gradually construct their understanding of the outside world, thus enhancing their cognitive structures. Building upon Piaget's theoretical foundation, subsequent educators, including J. Dewey, L.S. Vygotsky, J. Bruner, et al., further elaborated the constructivist framework through a comparative analysis of learning experiences in museums and schools. Heiny emphasized that the intricate dynamics between visitors and museums are best understood from a constructivist perspective. He argued that learning in a museum setting can be regarded as a form of constructivist education. Museums not only facilitate deeper public exploration of Chinese civilization and promote education in this regard but also play a crucial role in preserving and advancing Chinese culture while fostering new cultural trends among people.

According to He (2022), "Museums play a lasting role in shaping individuals' outlook on life, values, and worldviews in temporal terms." From a spatial perspective, museums embody cultural aspects involving knowledge, emotions, and ethics. As visitors engage in a learning journey during their museum visits, they absorb knowledge from the surroundings, gradually constructing their own cognitive development journeys and overall perception of culture. He emphasized that "Implementing museum education will provide a platform for lifelong learning for the public." (Fan, 2024). Museums, as accessible public spaces, offer emotional, attitude-related, and values-related education to the public, serving as vital cultural hubs for social education. Through dynamic engagement in socially educational activities, museums assist the public in constructing their cultural and civilizational awareness through immersive learning experiences.

The constructivist education at the CAM is categorized into preservation, public orientation, and social education. These components are closely related, forming a comprehensive educational system.

Interdependence: Preservation, public orientation, and social education are interdependent and essential. Specifically, preservation provides a content foundation, public orientation facilitates popularization, and social education deepens and applies relevant knowledge.

Mutual promotion: Effective public orientation and social education can, in turn, enhance preservation efforts. By increasing public interest and a sense of identity in Zhusuan culture, social awareness and support for the protection of this cultural heritage are strengthened.

Unified goal: Preservation, public orientation, and social education collectively aim to preserve and advance Zhusuan culture. This ensures its continued relevance in modern society and achieves the dual objectives of intergenerational cultural transmission and social education.

This interconnection and collaboration enable the constructivist education at the CAM to comprehensively and effectively fulfill its educational and cultural preservation mission.

4. Research Findings and Conclusions

4.1. Research Findings

Chinese Zhusuan, which entails mathematical calculation through the use of the abacus, has its roots in the Shang and Zhou dynasties, gained prominence during the Tang and Song dynasties, and reached its peak during the Yuan and Ming dynasties. The constructivist education at the CAM effectively preserves and educates about Zhusuan culture through the close integration and collaboration of preservation, public orientation, and social education.

Significance of preservation: Preservation plays a crucial role in the CAM's education. By preserving and maintaining Zhusuan-related tools, documents, and historical materials, the CAM ensures the integrity of this traditional technique and its associated culture. This preservation effort provides a solid material and cultural foundation for public orientation and social education, which are essential for the successful execution of subsequent educational activities.

Effects of public orientation: Through exhibitions, interactive activities, and multimedia displays, Zhusuan-related knowledge is widely disseminated. This outreach transitions Zhusuan culture from specialized knowledge to broader public awareness and interest. Such dissemination not only makes Zhusuan culture more accessible and understandable to the public but also lays a foundation for social education.

Transformation through social education: Social education further enhances the impact of public orientation. Through school programs, community activities, and practical workshops, social education promotes mathematical literacy and a sense of cultural identity among individuals and society. Learners not only gain an understanding of Zhusuan culture but also acquire the skills to apply and preserve this art, thereby extending the educational impact of Zhusuan culture.

Moreover, this study suggests that the original collections of the Chinese Abacus Museum were geared toward preserving tangible and intangible cultural heritage. However, over time, the Chinese Abacus Museum has shifted its focus to enhancing public engagement by offering public services and integrating with people's daily lives. Furthermore, the Chinese Abacus Museum undertakes the responsibility of social education by establishing a learning environment within the museum that assists the public in constructing their understanding of culture and civilization. Preservation, public orientation, and social education are interdependent. Preservation provides the content foundation, public orientation facilitates broader popularization, and social education deepens and applies the relevant knowledge. Collectively, they form a comprehensive constructivist education system at the CAM. Moreover, successful public orientation and social education reciprocally promote preservation efforts by enhancing public interest and sense of identity with Zhusuan culture, thereby increasing social awareness and support for its protection.

4.2. Conclusion

In conclusion, the constructivist education at the CAM, through the synergy of these three elements, achieves the dual goals of intergenerational transmission of Zhusuan culture and social education. This comprehensive educational system stimulates visitors' interest in learning and promotes a better understanding and practical application of Zhusuan-related knowledge, ensuring the continued role of Zhusuan culture in modern society. The CAM exemplified constructivist education for the public through its cultural positioning and values, covering three aspects: 1) The museum's original collections demonstrate its commitment to the protection and continuation of tangible and intangible cultural heritage; 2) Transitioning towards enhancing public engagement, the museum provides public services and integrates it into people's daily lives; 3) As a hub for social education, the museum the public construct their respective understanding of culture and civilization through learning in museum settings. The CAM has significantly enriched people's understanding of Zhusuan-related cultural relics and civilization, helped visitors construct their cultural awareness, promoted the dissemination of Zhusuan culture, advanced relevant education, and preserved Chinese culture. Moreover, it has fulfilled the general requirements outlined in the Guidelines on Promoting the Reform and Development of Museums by "meeting people's expectation for a better life" and "facilitating the integration of ICH into the new trend among the public toward a better life."

Acknowledgements

The study was supported by a grant from a major project of philosophy and social sciences research in Hubei Province, China (21ZD130).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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