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A Child-Oriented Theoretical Framework for Designing Tibetan Bangdian Children's Science Picture Books

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Abstract This article develops a child-oriented theoretical framework for the design of Tibetan Bangdian children's science picture books, addressing both the lack of child perspective and the formal monotony that currently characterize ethnic-cultural publications for young readers. Rather than presenting empirical findings, the study undertakes a conceptual construction grounded in developmental psychology and multimodal learning theory. By systematically integrating Piaget's Cognitive Development Stage Theory, Vygotsky's Zone of Proximal Development, and Gardner's Theory of Multiple Intelligences, the article proposes a Developmental, Scaffolding, and Multi-Channel Integrated Design Model tailored to the cognitive, emotional, and perceptual characteristics of children.Building upon this model, the article articulates a comprehensive design framework and operational pathway for producing children's science picture books on Tibetan Bangdian culture. Anchored in a developmental dimension, the framework aligns the complexity and abstraction of cultural content with children's cognitive stages. From a scaffolding dimension, it employs embedded questioning, guided characters, and layered narrative cues to support cognitive advancement within the child's Zone of Proximal Development. From a multi-channel dimension, it utilizes diversified aesthetic strategies and interactive elements to convert the abstract cultural knowledge of Bangdian—including its pattern codes, color symbolism, weaving techniques, and socio-cultural functions—into multisensory experiences accessible to children with varied intellectual strengths.By translating the profound cultural connotations of Tibetan Bangdian into narrative, visual, and material forms attuned to children's psychological development, the proposed framework offers both theoretical grounding and a practical creative paradigm for the early childhood education of Bangdian and other forms of intangible cultural heritage. It aims to contribute to the accurate transmission of cultural knowledge while fostering cognitive growth, thereby supporting the cultivation of a new generation of cultural identifiers and innovative inheritors.

Keywords Digital Preservation of Intangible Cultural Heritage; Tibetan Bangdian Culture; Children's Picture Book Design

1. Research Background

1.1 Growing Emphasis on Children's Popular Science and Aesthetic Education

Against the macro-backdrop of comprehensively advancing quality-oriented education and the fundamental task of "Fostering Virtue through Education," children's popular science and aesthetic education, as a crucial pathway for enhancing comprehensive literacy, is receiving increasing attention from society, families, and the educational

sector. Today, the connotation of traditional science education has expanded from conventional natural science knowledge to encompass a broad field including humanities, history, and artistic aesthetics. The "Opinions on Comprehensively Strengthening and Improving School Aesthetic Education in the New Era," issued by the General Office of the State Council in 2020, emphasizes "educating people through aesthetics, transforming people through aesthetics, and cultivating fundamentals through aesthetics, integrating aesthetic education into the entire process of talent cultivation across all types and levels of schools." As a vital component of the "simultaneous development of the five educations," the value of aesthetic education lies in stimulating children's creative potential and shaping their sound character through aesthetic experiences, thereby laying a solid foundation for their future development. Children's picture books, often regarded as a child's "first book of life," serve as an ideal medium for science initiation and aesthetic education due to their characteristic combination of images and text, intuitiveness, and vividness. The essence of aesthetic education is perceptual education (Dewey,2005). The "Guidelines for the Learning and Development of Children Aged 3-6" stress the importance of guiding young children to "form a basic sense of identity and belonging." Through the perception and experience of aesthetic elements such as form, colour, rhythm, and harmony, children's perceptual experiences can be systematically enriched, their emotions refined, and their minds nurtured[1]. Outstanding artistic works can, like "moistening things softly and silently," help children establish positive values and noble emotional orientations (Fan,2023).

1.2 Development Challenges Facing Tibetan Bangdian Culture

Tibetan Bangdian, as an essential component of traditional Tibetan women's attire, possesses not only a long historical lineage and practical value but also carries rich cultural significance and aesthetic characteristics, reflecting the unique life wisdom and aesthetic inclinations formed by the Tibetan people in their high-altitude environment. However, with the accelerated advancement of modernization, its protection and inheritance face severe challenges. Firstly, market demand continues to shrink. The proliferation of modern clothing has significantly reduced the practical contexts for wearing Bangdian, with its use now largely confined to festive occasions and elderly groups within Tibetan areas, leading to a notable decline in daily wear. Secondly, production and inheritance are in crisis (Gardner, 2011). The diminishing interest in traditional crafts among the younger generation, coupled with an aging demographic structure, directly leads to a crisis in the inheritance of traditional weaving techniques. Concurrently, continuously rising costs of raw materials and an imbalance in market value further constrain the sustainable development of traditional craftsmanship. Furthermore, cultural distinctiveness faces dilution. Innovative designs aimed at catering to market trends often deviate excessively from tradition, resulting in the gradual weakening of Bangdian's unique cultural symbols and artisanal essence. These challenges collectively hinder the transmission of Bangdian's cultural value, urgently necessitating systematic preservation measures and innovative transformation to revitalize this intangible cultural heritage gem (He, 2019). The report of the 20th National Congress of the Communist Party of China outlined overall arrangements and deployments for "Implementing the National Cultural Digitalization Strategy," proposing to "enhance the protection of cultural relics and cultural heritage," thereby

continuously strengthening the top-level design for cultural digital transformation at the macro level. Promoting the creative transformation and innovative development of intangible cultural heritage represented by Tibetan Bangdian culture, particularly its dissemination and popularization among youth groups, is an inevitable requirement for achieving cultural inheritance and aligning with national strategies.

2. Research Content and Significance

This study systematically integrates the cognitive development theories of Piaget, Vygotsky, and Gardner to construct a Developmental, Scaffolding, Multi-Channel Integrated Design Model applicable to picture books on Tibetan intangible cultural heritage. It aims to enrich and expand the application of child-oriented design theory within the realm of intangible cultural heritage inheritance and innovation, thereby providing a referential theoretical framework and methodological support for creative works on similar themes. By yielding a set of concrete and actionable design strategies for Tibetan Bangdian children's popular science picture books, and through an in-depth exploration of the developmental lineage and cultural characteristics of Tibetan Bangdian culture, this research explores its vivid expression within children's literature. It is hoped that this will provide publishing institutions and creators with clear creative guidelines, foster the production of high-quality cultural picture books, and offer innovative pathways for the inheritance and educational dissemination of ethnic minority intangible cultural heritage (Jiang, 2024).

Furthermore, adopting a "Learning Through Play" approach, it seeks to plant the seed of ethnic cultural identity in children's hearts, stimulate their spirit of exploration, and cultivate their understanding and respect for intangible cultural heritage, while simultaneously leveraging the elements of Tibetan Bangdian culture to promote children's cognitive development. The overarching goal of transforming intangible cultural heritage (Lai,2014), such as Tibetan Bangdian, through picture books that align with children's cognitive and aesthetic patterns is not directly to cultivate skill inheritors, but to nurture a new generation who understand, appreciate, and disseminate outstanding traditional Chinese culture. Through the medium of picture books as a form of aesthetic education, children can connect with the ancient wisdom, exquisite craftsmanship, and aesthetic spirit inherent in intangible cultural heritage (Liao, 2019). This process enables them to construct a solid sense of cultural identity and confidence from within, laying an indispensable humanistic foundation for the future creative transformation and innovative development of intangible cultural heritage.

3. Theoretical Basis and Current Situation Analysis

3.1 Current Status of Children's Cultural Popular Science Picture Books

Children's cultural popular science picture books are a specific publishing genre that systematically conveys scientific knowledge and cultural connotations through the integration of images and text, based on children's cognitive development patterns. Their core characteristics include scientific content, age-appropriate expression, artistic visuals, and interactive engagement. Within the current context of promoting outstanding traditional Chinese culture, cultural popular science picture books have become a vital bridge connecting children with traditional culture. These books utilize vivid illustrations and

concise, understandable language to purposefully and subtly convey knowledge and information to children, combining storytelling and heuristic content to attract children's exploration and learning.

An overview of the current market reveals diversified, interactive, and systematic development trends in children's cultural popular science picture books. Based on their content, they can be categorized into: those broadening knowledge reserves (popular science knowledge), those cultivating literary literacy (classical literature), those fostering traditional cultural literacy (humanities and history), and those developing good living habits (emotional development). Thematically, choices have expanded from traditional festivals and folklore to broader fields such as traditional crafts, ethnic epics, and ancient technology. In terms of presentation, they have evolved from simple image-text narratives to multi-dimensional experiences incorporating AR technology, pop-up mechanisms, sound interaction, and more.

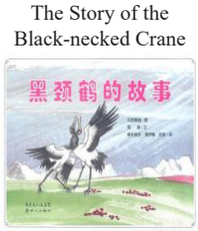
In recent years, driven by policies such as the "Opinions on Implementing the Project for the Inheritance and Development of Outstanding Traditional Chinese Culture," the market for traditional culture-themed children's picture books has shown vigorous growth. Existing traditional culture picture books increasingly feature diverse themes, covering multiple dimensions, including folktales, folk customs, and traditional arts. Classification methods demonstrate a trend emphasizing both cultural symbols and modern educational value. Based on the findings of various research scholars, different categories overlap yet have their own focus (as shown in Table 1). Jia Dan's classification emphasizes thematic breadth, Li Jing's stresses content hierarchy, and the classification from Dangdang.com prioritizes the modern transformation and educational value of culture. Overall, in terms of visual design, many works integrate traditional ink painting techniques, ethnic totem elements, and innovative image-text layouts, highlighting distinct Eastern aesthetic qualities. In terms of physical format, there is an emphasis on combining traditional craftsmanship with modern interactive design, enhancing cultural communication effectiveness through material innovation and gamified design.

Table 1. Summary of Children's Picture Book Classification Methods (Source: Author)

Classification Dimension	Jia Dan	Li Jing	Dangdang.com
Folktales	Folktale Themes	Traditional Stories (Folktales)	Culture & Arts (Stories & Rhymes)
Myths & Legends	Folktale Themes	Traditional Stories (Myths)	Culture & Arts (Stories & Rhymes)
Historical Stories	Adapted Themes	Traditional Stories (Historical Stories)	Culture & Arts (Stories & Rhymes)
Literary Stories	Adapted Themes	Traditional Stories (Literary Stories)	Culture & Arts (Literary Classics)
Festivals & Customs	Real-life Themes	Traditional Stories (Folktales)	Folk Customs (Seasonal Festivals, Folkways)
Regional Culture	Real-life Themes	Popular Science (Regional Culture)	Folk Customs (Regional Characteristics)
Traditional Arts		Traditional Arts (Painting Techniques & Handicrafts)	Culture & Arts (Opera & Painting)
Opera Culture		Traditional Arts (Opera Performance)	Culture & Arts (Opera & Painting)
Technological Achievements		Popular Science (Biographies of Famous Figures)	Science & Technology Achievements
Ideology & Concepts			Ideology & Concepts

Focusing on the educational dissemination of intangible cultural heritage, including Tibetan culture, related picture book creation demonstrates unique cultural value and developmental characteristics. Such picture books often deeply integrate ethnic aesthetic symbols while also emphasizing the modern translation of oral traditions, reconstructing epics, legends, and folktales through discourse systems that align with contemporary children's aesthetics (as shown in Table 2). The Barley Seed, a collaboration between Langdun Dezhen and Ciren Langjie, is an exemplary work. Based on a Tibetan folktale and employing a painting style integrating Thangka artistic features, this picture book vividly conveys the profound themes of courage, sacrifice, and cultural inheritance through the heroic narrative of Prince Achu's quest for the seed, achieving a perfect unity of ethnic character and child-friendliness. Additionally, Malu Zhuoma, adapted from a true story on the Tibetan plateau, tells the story of a Tibetan boy, Dunyue, rescuing and releasing a young deer, reflecting the warmth of harmonious coexistence between humans and animals. The Story of the Black-necked Crane, part of the Popular Science Series on China's Rare Species, is set in the ecological context of the Narangsang Wetland in the southern part of the Nianbaoyuze Mountains on the Qinghai-Tibet Plateau. It employs a creative approach blending scientific documentation and cartoon personification, meticulously recording the real process of the black-necked cranes' summer habitation and reproduction to showcase their unique behaviours and habits. Through the touching storyline of a pair of cranes unable to migrate due to injury and ultimately passing away, it deeply conveys the core themes of ecological protection and life care, provoking readers' profound reflection on biodiversity conservation (Liu, 2010).

Table 2. Summary of Representative Tibetan Cultural Picture Books (Source: Author)

	Publication Information	Main Features
Malu Zhuoma 	Published in 2024 by Beijing Juvenile & Children's Publishing House Author:Baima Nazhen, Wang Guang	Vividly reflects Tibet's "ecological priority, green development" strategy; awarded the 20th Wenjin Book Award.
The Barley Seed 	Published in 2022 by The Ethnic Publishing House Author:Langdun Dezhen, Ciren Langjie	Selected for the Chinese Classic Folktale Animation Creation and Publication Project in 2021
The Story of the Black-necked Crane 	Published in 2012 by New Century Publishing House Author:Zhaxi Sang'e, Zhou Wei	Selected for the State Administration of Press, Publication, Radio, Film and Television's "2013 List of 100 Outstanding Books Recommended for National Youth"

However, behind the market prosperity, significant limitations persist. Most works face several core dilemmas: Firstly, an adult-oriented tendency remains prominent. Content design often overemphasizes the completeness of knowledge systems and focuses on instilling moral lessons, lacking childlike fun and neglecting children's cognitive development patterns. Secondly, issues of formal monotony and a lack of innovation are widespread, failing to transform profound cultural connotations into language and forms that children can perceive, interact with, and understand. Thirdly, cultural depth and rigour are sometimes sacrificed for the sake of interest. Some works habitually use formulaic bright colours and stereotypical character designs. Visual expression often remains at the level of simple illustrative presentation, failing to effectively handle the intertextual relationship between images and text. Additionally, there are obvious problems, such as insufficiently systematic narrative structures and weak application of ethnic minority cultures. To break through these limitations, attention must be refocused on children themselves, establishing a genuinely child-oriented design perspective. This requires creators to deeply study the psychological characteristics and cognitive patterns of children across different age groups, fully respecting children's subjective status in all aspects, including content selection, narrative methods, and visual presentation. Simultaneously, research on the adaptation of ethnic minority cultures, especially intangible cultural heritage, into picture books needs strengthening, exploring more suitable expressions of traditional culture for contemporary children, thereby achieving a win-win situation for both cultural inheritance and child development.

3.2 Child-Oriented Cognitive Theories of Children's Reading

The concept of the "Child-Oriented" theory originates from educational theory. In child-oriented education, children are no longer passive recipients of knowledge or mere subjects to be moulded; instead, they become active, proactive, and creative agents in the educational process[2]. As John Dewey stated, "The child is the sun, around which all the educational appliances revolve; the child is the center, about which they are organized"[3]. This revolutionary perspective has profoundly influenced the field of children's content creation, establishing a foundational principle that centers on children's psychological characteristics, cognitive development levels, emotional needs, and interest preferences. In the realm of children's reading, the application of this concept signifies an essential shift in the role of picture books: they evolve from being mere unidirectional tools for knowledge transmission into interactive "dialogic partners" that engage deeply with children and promote their mental growth. Cognitive theories related to the development of children's reading ability have primarily evolved through Piaget's Cognitive Development Stage Theory, Vygotsky's Zone of Proximal Development, and Gardner's Theory of Multiple Intelligences. This progression marks the academic community's deepening understanding of the nature of children's reading—shifting from viewing reading merely as the emergence of literacy skills towards understanding it as a multifaceted enlightenment activity that promotes cognitive development[4]. During this shift in understanding, scholars gradually recognized that for children, reading is not only the acquisition of language but also a comprehensive growth experience that facilitates thinking development, emotional nurturing, and social cognition through multiple cognitive channels.

The deepening and development of this concept have been strongly supported by modern cognitive

theories. Swiss psychologist Piaget delineated stages of cognitive development in children based on age, aiming to reveal the patterns of children's thinking and knowledge acquisition and to provide scientific guidance for education. The specific stages can be divided into the Sensorimotor Stage (0-2 years), the Preoperational Stage (2-7 years), the Concrete Operational Stage (7-11 years), and the Formal Operational Stage (11 years to adulthood). Children's cognitive development follows a pattern of stage-like progression, starting from initially relying on sensory and motor actions to explore the environment, gradually transitioning to thought dominated by concrete imagery, then developing higher-order cognitive abilities like symbolic understanding and logical reasoning, and finally forming systematic abstract thinking abilities. Concurrently, their cognitive and emotional development are synchronous and jointly drive intellectual growth. Specifically, children in the Preoperational Stage exhibit characteristics such as animism, egocentrism, and intuitive thinking. They rely on concrete images and cannot perform abstract logical operations. In contrast, children in the Concrete Operational Stage acquire abilities like conservation and reversibility, enabling them to perform logical thinking supported by concrete objects, but they still cannot handle purely abstract hypotheses (Shen, 2021).

Vygotsky's "Zone of Proximal Development" theory emphasizes the crucial role of social interaction in the learning process, pointing the way for designing reading scaffolds that promote cognitive development. The "Zone of Proximal Development" is the distance between a child's actual developmental level and their potential developmental level, highlighting the key role of social interaction and "scaffolding" guidance in learning[5]. "Scaffolding" refers to the temporary support provided by a more competent other during the learning process. As the learner's ability increases, the scaffolding is gradually removed. Vygotsky also emphasized social interaction, proposing that higher mental functions first form through social interaction between people before being internalized as individual internal mental activities. He posited that learning is essentially a social and culturally mediated process. Gardner's Theory of Multiple Intelligences challenged the unitary view of intelligence, proposing that humans possess at least eight relatively independent intelligences: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, and naturalist[6]. Intelligence is the ability to solve problems and create products within a specific context. He also delineated stages of children's aesthetic cognitive development: the Period of Infantile Perception, the Period of Symbolic Cognition, the Period of Peak Literalism, the Period of the End of Literalism and the Beginning of Aesthetic Sensibility, and the Period of Crisis in Aesthetic Involvement[6]. Among these, the Period of Symbolic Cognition (ages 3-7) is a critical stage for children's aesthetic development, during which children begin to understand the meanings of various symbolic systems like images, sounds, and numbers, and demonstrate rich associative abilities[7].In summary, Piaget's theory scientifically distinguishes the cognitive structures and ability boundaries of children at different ages; Vygotsky's theory promotes cognitive development at these boundaries through social interaction and scaffolding; and Gardner's theory, starting from the premise that children possess diverse intellectual strengths, guides children to learn and express themselves through different pathways.

3.3 Tibetan Bangdian Culture

The term "Bangdian" is a transliteration from

Tibetan, referring to the apron worn by Tibetan women below the waist to protect the abdomen. It is widely used in traditional garment components such as aprons, waistcoats, satchels, and as trim on Tibetan robes, and in recent years has been progressively integrated into modern decorative design, demonstrating a high degree of unity between practicality and artistry. The basic form of the Bangdian consists of three striped rectangular pieces of pulu (Tibetan woollen fabric) of equal width, stitched together with their patterns offset (As is shown in Figure 1). Its length is adjusted between the knee and the Tibetan boot, depending on the wearer's physique and aesthetic preference. Wearing a Bangdian not only reflects Tibetan women's aesthetic taste but also signifies their role identity within the family structure and cultural traditions. The diversity in Bangdian classification methods reflects its deep integration with the natural environment and cultural practices. In terms of texture, they are divided into silk and woollen Bangdian; the former, characterized by elegant colours and delicate patterns, is common in cities like Lhasa, while the latter, featuring strong colours and made from dyed wool, is widely used in farming and pastoral areas (Suolang, 2010). Material variations include Xie Ma, Nang Bu, and silk thread. Regional colour preferences exist: urban women often prefer shorter, elegant Bangdian in plain black, blue, or grey stripes, while those in farming and pastoral areas favour styles combining colored and plain stripes. Colored-stripe Bangdian include contrasting and analogous colour schemes. The "Cha Qing" type, often used for festivals, employs contrasting colours for strong visual impact, whereas analogous-colour Bangdian offer unified hues suitable for daily wear or specific groups, such as the yellow "Se Cha" worn by nuns.

Figure 1. The Tibetan Bangdian showcasing its distinctive striped patterns and vibrant colors (Source: Internet)

Research perspectives on Tibetan Bangdian culture are numerous. Scholars like Fan Shuangjie[8] and Suolang Cuomu[9] focus on folklore studies of Bangdian customs; Wang Lili[10] and He Jialing[11] approach it from an artistic perspective, studying its colours and aesthetics; while Deji Zhuoga[12] and You Jia[13] investigate paths for the development of the handicraft industry and the contemporary inheritance, development, and innovative transformation of Bangdian from an economic standpoint. Overall, however, applied research in digital dissemination and children's picture book creation remains relatively limited. Studying Tibetan Bangdian culture aids subsequent picture book content design by facilitating the extraction of elements to more comprehensively showcase Bangdian's cultural value and connotation, transmitting its cultural essence and ethnic appearance to child readers.

The Gyaidexul area of Gongga County, Shannan City, Tibet, is particularly renowned for its Bangdian weaving craftsmanship, earning the moniker the Hometown of Bangdian. Known throughout Tibet for its high-quality raw materials,

exquisite craftsmanship, and fine texture, the Bangdian produced here is listed as a representative project in China's National Intangible Cultural Heritage inventory. Gyaidexul Bangdian's fame stems from superior natural conditions and a long-accumulated tradition of hand-weaving, representing a concentrated embodiment of traditional Tibetan textile art and ethnic cultural spirit. Raw materials are mostly sourced from local valley Tibetan sheep wool, particularly wool from the neck and abdomen, collected in spring, prized for its softness and fine fibres. The wool undergoes complex processes, including washing with local yellow earth, beating, sun-drying, carding, and spinning, resulting in high-quality yarn with even strands and a fluffy hand-feel. Dyeing primarily uses natural plant dyes from madder, rhubarb, buckwheat, walnut skin, etc., combined with a small amount of imported dyes, forming a stable and rich colour system. The dyeing process requires repeated grinding, heating, and stirring to ensure colour fastness and bright lustre. Gyaidexul dyers could even achieve natural transitions between seven colours within a single dye pot through controlled layering, demonstrating an extremely high traditional craft level. From material selection and spinning to dyeing, Bangdian is a paradigm of the high integration of traditional Tibetan craftsmanship and cultural spirit, showcasing profound ethnic cultural charm and intangible cultural heritage value.

From a functional perspective, Bangdian possesses multiple values encompassing practical, cultural, social, and aesthetic aspects. Regarding practical function, Bangdian was initially used to cover the heavy hem of Tibetan robes, preventing soiling or wear during labour. Its sturdy fabric also serves as a temporary wrap, seat cushion, rain cape, or handkerchief, demonstrating high adaptability and versatility in daily life. Culturally, Bangdian is deeply embedded in the religious rituals and festive life of Tibetan society, used not only as monks' cloaks in Buddhist ceremonies but also as betrothal gifts symbolizing maternal love and blessings in weddings, revealing its spiritual and ritual symbolism. Furthermore, Bangdian is an indispensable core costume in traditional Tibetan cultural performances, further highlighting its importance as a cultural symbol. On a social level, Bangdian carries symbolic meanings related to nature worship and moral guidance, becoming a cultural symbol that regulates social behaviour and maintains ethnic identity. Aesthetically, Bangdian patterns are predominantly composed of wide and thin stripes, expressing ethnic vitality and cultural confidence through high-contrast colour combinations. Their characteristic use of brilliant, multicoloured hues reflects the Tibetan people's reverence and love for nature, as well as their optimistic, open-minded, enthusiastic, and uninhibited attitude towards life.

From a historical development standpoint, the origins of Tibetan Bangdian can be traced back to early textile prototypes on the Tibetan Plateau. Archaeological discoveries, such as spindle whorls unearthed at the Karuo cultural site dating back over 4,000 years, indicate early Tibetan ancestors possessed preliminary spinning capabilities. By the 11th century, pulu was widely popular as a primary textile in the Gyantse area, and the prototype of Bangdian developed from this. Depictions of horizontal stripe fabrics in murals provide further evidence of their historical evolution. During the Tubo period, the Tibetan textile industry significantly improved with the introduction of weaving techniques from inland China and Nepal through marriages arranged by Songtsen Gampo and trade. By the mid-15th century, the Gyaidexul

area had gradually developed high-quality products like the "Xie Ma Bangdian," which became one of the most representative items of women's clothing in U-Tsang. Entering the 17th century, with the 5th Dalai Lama's establishment of a handicraft exhibition and review fair in Lhasa, the craft standardization and scaled production of Gyaidexul Bangdian began to take shape, further expanding its social influence. Until the mid-20th century, Bangdian production relied primarily on manual skills. With the development of mechanized textile production, traditional craftsmanship gradually declined, making the protection and inheritance of related skills increasingly prominent. Currently, the inheritance and development of Bangdian require not only policy support but also innovative design and digital dissemination to stimulate its cultural vitality and promote the contemporary expression and sustainable development of intangible cultural heritage resources.

4. Framework Construction Integrating Cognitive Theory and Picture Book Design

4.1 Analysis of Cognitive Characteristics in Children's Reading

4.1.1 Stage-Specific Cognitive Abilities and Limitations

Piaget's Cognitive Development Stage Theory reveals the sequential and stage-specific nature of children's cognitive development. For preschool and early school-age children, their thinking primarily resides in the Preoperational Stage (approximately 2-7 years) and the Concrete Operational Stage (approximately 7-11 years). Children in the Preoperational Stage exhibit animism and egocentrism, attributing life to inanimate objects while struggling to see things from others' perspectives. Their thinking is also intuitive, relying on appearances rather than logic. Consequently, in picture book design, theme selection should prioritize concrete, visual, and intuitive subjects, avoiding abstract and complex didacticism. Character design should employ personification techniques, which align better with children's cognitive patterns and effectively evoke empathy. Furthermore, a linear and simple narrative structure is easier for children to understand and remember. Children in the Concrete Operational Stage gradually acquire concepts like conservation, reversible thinking, and some logical reasoning abilities, but they still depend on concrete objects and practical experiences. Picture book content design for this group can introduce simple cause-and-effect relationships and symbolic meanings. Interactively, simple classification, sequencing, and puzzle-solving tasks can be incorporated.

4.1.2 Learning Potential in Social Interaction

Vygotsky's "Zone of Proximal Development" theory transcends Piaget's static description of individual developmental stages by emphasizing the central driving role of social interaction in children's cognitive development. The "Zone of Proximal Development" refers to the gap between a child's actual developmental level, as determined by independent problem solving, and their potential developmental level, as determined through problem solving under adult guidance or in collaboration with more capable peers. Based on this, picture book design should not function as a passive transmitter of information but rather as an interactive platform and social mediator. The content should not remain solely within the realm of what the child already knows; it must incorporate challenges slightly above their current level that are understandable with guidance. The design needs to embed guiding mechanisms—such as questions, prompts, and demonstrations within the text and

images—to accompany the reading process and help children bridge cognitive gaps.

4.1.3 Diverse Intelligent Structures and Preferences

Howard Gardner's Theory of Multiple Intelligences challenges the traditional unitary view of intelligence, positing that individuals possess at least eight relatively independent intelligences. Each child has a unique intellectual profile and preferred learning channels. This implies that if popular science reading materials remain traditional and overly reliant on linguistic and logical-mathematical intelligences, they may neglect children's other intellectual strengths, thereby hindering their reading comprehension and knowledge acquisition. Therefore, an outstanding children's picture book should provide opportunities for mobilizing and expressing multiple intelligences. It should not merely be a text reflecting linguistic intelligence; it should also cultivate visual-spatial perception through exquisite illustrations and clever compositions, connect reading with physical activity through designs like flaps, tactile materials, or action imitation, stimulate musical perception through rhyming text, rhythmic language, or accompanying audio/video, and evoke emotional resonance and self-reflection through storytelling.

4.2 Construction of the Integrated Application Model

Based on the three major cognitive theories of Piaget, Vygotsky, and Gardner, a comprehensive child-oriented concept is constructed from three dimensions: developmental foundation, guiding mechanism, and implementation path. Piaget's theory functions like a cognitive map, pinpointing the "current position" of child readers at a specific age. It reveals the age-specific characteristics and patterns of cognitive development, helping to understand their modes of thinking and level of receptivity. This ensures the age-appropriateness and acceptability of reading content, providing a baseline reference for grading content difficulty, narrative structure, and modes of expression in picture books. Vygotsky's Zone of Proximal Development theory emphasizes the crucial role of social interaction in the learning process. This theory guarantees the developmental nature of the reading process. It can guide this study in designing interactive questions, guiding characters, and progressive challenges within picture books to facilitate leaps in children's cognitive development, helping them move from their "current position" towards the "target zone," thereby ensuring the guiding function of the picture book. Gardner's theory, in turn, realizes the multiplicity of the reading experience. Picture book design can transcend traditional linguistic and logical channels by employing diverse artistic expressions, interactive designs, and extension activities. This provides varied learning paths and modes of expression for children with different intellectual strengths, ensuring the universality and potential for personalization of the picture book. This model constitutes a child-centred, closed-loop design process: from understanding the child's position, to promoting their development, and finally to serving each unique child. It perfectly interprets the core concept of being "child-oriented." This theoretical framework provides solid scholarly support for the design of Tibetan Bangdian popular science picture books, guiding the creation of cultural enlightenment materials that both respect children's cognitive patterns and effectively promote their holistic development.

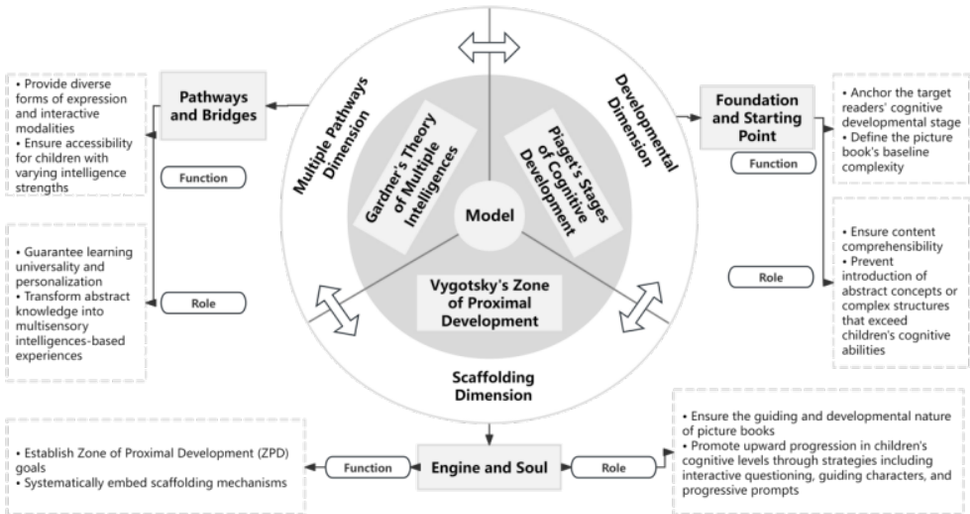


Figure 2. The Developmental, Scaffolding, Multi-Channel Integrated Design Model (Source: Author)

5. Core Element Design Strategies for Child-Oriented Tibetan Bangdian Picture Books

The picture book design strategies, based on the Developmental, Scaffolding, Multi-Channel Integrated Design Model, deconstruct and reshape the key elements of picture book creation. This section systematically elaborates the design strategies for Tibetan Bangdian children's popular science picture books from five aspects: story conception and character setting, textual expression and linguistic rhythm, artistic aesthetics and visual presentation, the relationship between illustration and text, and physical format and dissemination methods. This ensures the picture books both adhere to children's cognitive development patterns and vividly and effectively convey the essence of Bangdian culture.

5.1 Story Conception and Character Setting Strategies

5.1.1 Narrative Construction Based on Cognitive Development Stages

Stories and characters serve as the bridge for children to enter the picture book world. Designs based on the integrated model must simultaneously satisfy cognitive age-appropriateness, developmental guidance, and entry-point diversity. For readers aged 3-6 in the Preoperational Stage, the narrative structure can adopt a "linear adventure-based" framework. This aligns with this stage's children's understanding of sequence, concrete imagery, and goal-directed actions. For example, designing Little Drolma's Rainbow Apron could revolve around the story of Drolma, a little girl from the Bangdian hometown of Gyaidexul. To weave a beautiful Bangdian, she embarks on a journey to collect colours from nature, guided by her grandmother. The structure follows a linear sequence of "arising desire, sequential exploration, completion," where each segment corresponds to the exploration of a specific Bangdian color: finding madder for the red of celebrations, using walnut skin for the brown of the earth, learning about the strong blue-green contrast in the "Cha Qing" technique, and understanding the specific use of the yellow "Se Cha." Core knowledge, such as wool processing steps (e.g., washing with yellow earth, spinning) and plant dyeing, is integrated into the adventure process. The clear, single-outcome story design suits this stage's children's comprehension of sequence, concrete images, and purposeful actions, transforming abstract textile techniques into

concrete tasks of collecting items and exploring nature, which resonates with their reliance on concrete imagery.

For children aged 7-10 in the Concrete Operational Stage, the picture book narrative needs to introduce a "logical puzzle-solving" narrative mode. It should cleverly integrate cultural aspects, such as the logic of pattern composition, socio-cultural rules, and historical origins, into the picture book narrative, catering to this stage's children's budding logical thinking, sense of rules, and interest in cause-and-effect relationships. A logical structure of "problem discovery, rule exploration, problem resolution" can be used. For instance, designing the story Guardian of the Bangdian Code might begin with the fading of the eternal swastika pattern on Grandma's treasured antique Bangdian due to age, requiring restoration. The young protagonist must find the method to restore the Bangdian by understanding the compositional rules of Bangdian patterns, recognizing their social functions (where different colours and styles represent different regions and identities), and comprehending cultural taboos, symbolism, and weaving techniques—much like deciphering a code carrying ethnic memory. This type of narrative logic aligns with the emerging logical thinking and rule consciousness of children in this stage, stimulating them to apply their concrete operational abilities through setting up puzzles.

5.1.2 Scaffolding Function of the Guide Character

The design of a guide character within the picture book story can become the narrative embodiment of Vygotsky's "scaffolding." By externalizing the thought process, the guide character drives the plot forward, providing timely and appropriate support within the child's Zone of Proximal Development. For example, one could design a kind elderly artisan or a guardian mythical creature that knows the secrets of Bangdian—such as a snow lion or antelope, characteristic plateau animals—interacting with children on a cognitive level through the story design. For instance, when the young protagonist doesn't understand why cumbersome natural dyes are used, the guide might say, "Child, machine-printed colours are like a sudden gust of wind—they come fast and leave fast. But the red from our local Millettia root dye contains the warmth of the sun and the deep affection of the land. It can accompany you for a very long time, just like the friendship between us Tibetan people." When explaining the offset stitching of the three pulu pieces, the guide might prompt, "Look, these three colored strips, aren't they like Mother, Father, and you? Although each is different, only when closely stitched together do they form a complete and beautiful Bangdian?" Furthermore, the guide's language can be directly designed as embedded questions within the text, such as "Guess why can Gyaidexul Bangdian be dyed with seven colours as smoothly transitioning as a rainbow?" to introduce the sophisticated layered dye control technique. This can be complemented by textual designs like challenge-issuing commands, hint-providing dialogues, and summarizing narration to enhance interactivity.

5.1.3 Character Setting Aligned with Multiple Intelligences

Guided by the Theory of Multiple Intelligences, picture book characters, beyond the protagonist and guide, can include companion characters with different specialties, subtly demonstrating diverse intelligences through varied design. For instance, one could design a little artist skilled in observation and map-drawing to guide children in developing spatial intelligence; an expert character familiar with various plants, animals, and minerals to promote naturalist intelligence; a companion

good at observing and deducing the arrangement rules of patterns to help readers understand the geometric logic of the three pulu pieces; and an artisan companion who is agile in obtaining raw materials and skilled in weaving to lead children in developing bodily-kinesthetic intelligence. Solving challenges in the story progression requires different characters to utilize their unique strengths, illustrating that addressing a genuine, culturally relevant problem necessitates the combination of multiple intelligences. This hints to readers the diversity of problem-solving paths and encourages children to recognize and apply their own dominant intelligences.

5.2 Textual Expression and Linguistic Rhythm Strategies

5.2.1 Language Expression Aligned with Stage Characteristics

Piaget's theory indicates that children in the Preoperational and Concrete Operational stages tend to prefer concrete and figurative language. In textual design, vocabulary selection should use specific verbs and nouns to clarify the names of specialized objects and procedural steps within Bangdian culture. For instance, explicitly use Bangdian craft terms like "Bangdian," "pulu," and "shuttle," and employ concrete, precise action verbs such as "stir," "weave," and "comb" to reduce readers' misinterpretation of cultural knowledge and craft details (Deji, 2023). Furthermore, extensively using metaphors and personification can stimulate children's reading interest. Vivid descriptions can enhance children's immersion and spark their imagination, for example, "as soft as a lamb's fleece" or "[it] widened its eyes in fear at the sight." Sentence structures should primarily consist of short sentences. For complex concepts, a three-step descriptive method can be adopted, explaining what it is, what it is like, and how it feels. For example: "This is the swastika pattern". It spins endlessly like the sun. It represents the Tibetan people's wish for eternal happiness."

5.2.2 Embedded Questioning and Interactive Dialogue

The design of Vygotsky's "scaffolding" at the textual level requires transforming passive reading into active thinking, creating a "Zone of Proximal Development." In terms of questioning techniques, questions from the guide character can be directly integrated into the narrative text. These can include Predictive Questions, as "If I want to weave a Bangdian as a blessing for a wedding, should I choose the brighter 'Cha Qing' colors or the more elegant analogous colors?", Observational Questions, as "In this Bangdian, how many different shades of red can you count?", Emphatic Questions, as "If you were a weaver in Gyaidexul, how would you feel seeing the Bangdian you wove being joyfully worn by people during the Ongkor Festival?" Such scaffolded dialogues and embedded questions directly converse with the reader within the narrative, forming a rhythm of "narrate, pause, question, continue."

5.2.3 Rhythmic Language and Textual Development of Musical Intelligence

Based on Gardner's theory regarding the development of children's musical intelligence, picture book design can utilize rhythm and rhyme to aid children's memory and increase reading pleasure. Fully leveraging the sonic appeal of language, descriptive passages can consciously use reduplicated words, onomatopoeia, and rhyming short phrases. For example, when describing Bangdian dyeing, use "Gently stir, slowly stew, the bright Bangdian glistens anew"; when depicting the weaving process, use "Feet press down, hands pass through, the shuttle flies like a cloud-swift anew" – rhythmic phrases that mimic the cadence of the

work. Additionally, turning core knowledge points, such as craft mnemonics, into catchy nursery rhymes can reinforce knowledge retention. For instance, create a colour nursery rhyme: "Madder red, bright and bold, brings joyous blessings, a sight to behold; Walnut brown, deep and grand, earth's warm blessings spread across the land."

5.3 Artistic Aesthetics and Visual Expression Strategies

5.3.1 Visual Deconstruction and Simplification of Complex Imagery

The developmental principle in Piaget's theory, where children progress from perceiving wholes to analyzing parts, guides picture book design to avoid cognitive overload. Knowledge presentation should avoid directly displaying the complete, complex picture. Instead, methods like partial magnification and step-by-step analysis should be employed. For instance, when designing a picture book, multiple parts of the knowledge can be explained one by one. One could first show a scene of a complete, magnificent Gyaidexul Bangdian worn by a Tibetan woman. Then, through exploded diagrams, deconstruct it into the three pieces of pulu, then focus on basic pattern units like the cross pattern and the swastika pattern, and finally use schematic diagrams to explain how they are woven together. For presenting abstract knowledge, comparative illustrations can showcase abstract functions. For example, juxtapose illustrations showing the Bangdian's practical function of protecting against dirt during labour, its social functions as a wedding betrothal gift and monk's attire, and its aesthetic function as festive wear, thereby visually presenting its multi-functionality. For demonstrating the dynamic knowledge of craft processes, key steps—such as washing wool with yellow earth and spinning, the layered dye control process, and the multi-step collaborative weaving—can be clearly shown through step-by-step diagrams or sequential illustrations. This transforms intangible, orally and manually transmitted skills into visible, understandable visual sequences (Wang, 2023).

5.3.2 Visual Guidance and Creating a Discovery-Based Learning Environment

Clues in picture book design are the visualization of Vygotsky's "scaffolding." This means using visual elements to guide observation, cultivate children's spatial intelligence and observational skills, and enable them to accomplish more complex cognitive tasks within a game-based framework. When designing visual focal points and observation paths, visual "signposts" like arrows, halos, or special borders can be added to guide children's gaze towards key information points in the image. For example, design visual games like "Find the Pattern Rule" or "Help Little Drolma Match the Bangdian," where children make choices based on different scenarios or different identities. This guides children to observe the symmetrical structure, repeating patterns, and colour contrasts of Bangdian designs through play. Embedding a gamified visual exploration mechanism can interestingly guide children to follow clues and explore knowledge. For instance, design lift-the-flap elements to reveal secrets: lifting a "plot of land" pattern reveals the vegetation used for making pigments; opening the "door of the Bangdian workshop" shows dye materials and vats to illustrate the dyeing process; or use pull-tab mechanisms to simulate the action of operating the treadle loom.

5.3.3 Visual Stimulation of Multiple Intelligences

Multiple intelligences can be engaged through: colour and composition to develop spatial intelligence; imitation of tools and actions to develop bodily-kinesthetic intelligence; and connections between nature and culture to develop

naturalist and interpersonal intelligences. For cultural popular science picture books, spatial intelligence is key to transforming abstract cultural connotations into perceivable visual forms. This can involve using clear colour palettes and regional comparison charts to show the intense colours of Bangdian from farming/pastoral areas versus the elegant colours of urban Bangdian, or using schematic diagrams to analyze the stitching structure and the underlying skeletal lines of pattern composition. Furthermore, by clearly depicting craft actions, children can be guided to imitate gestures and postures, allowing them to experience bodily coordination and the craft process, thereby stimulating bodily-kinesthetic intelligence. Close-up depictions of natural elements can stimulate naturalist intelligence (You, 2023). For example, meticulously illustrate the plants and mineral raw materials that appear in the Bangdian-making process, possibly including their growth environments, to restore the real scene. Depicting scenes like the Ongkor Festival or weddings, showing Tibetan women of different ages and regions happily wearing various Bangdian, demonstrates its function as a social identity marker and sense of group belonging.

5.4 Strategies for the Relationship Between Illustration and Text

5.4.1 Complementary Roles and Collaborative Narration

Illustrations and text cooperate to advance the picture book's plot logically and enhance its atmosphere. Their complementarity reflects the differing logic of information distribution between the abstract and the concrete. The text is responsible for logical progression and cultural explanation, such as supplementing knowledge within cultural scenes: "At weddings, the Bangdian symbolizes the mother's love and blessings for her daughter." The illustrations, meanwhile, handle atmosphere creation and concrete depiction: the image shows the warm moment at the wedding where the mother hands a new Bangdian to her daughter as a betrothal gift. Furthermore, the collaboration between text and image must balance functional cooperation between logical advancement and atmospheric rendering. For instance, the text might pose a challenge: "Next, we need to find the plant that can produce the most colorfast and vibrant red." Simultaneously, the illustration provides a clue, depicting madder plants growing on the hillsides of Gyaidexul.

5.4.2 Configuration of Text-Image Weight from a Developmental Perspective

For picture books targeting younger children in the Preoperational Stage, the design should be image-dominant with text playing a supporting role. The pictures carry the bulk of the narrative, while the text provides brief explanations and interspersed rhymes. Children should be able to understand the story primarily by 'reading' the images. For older children in the Concrete Operational Stage, picture books can achieve a more balanced integration of text and image, where they mutually deepen understanding. The text can appropriately increase explanations of topics like the "social functions of Bangdian," the "symbolic system of patterns," the "uniqueness of Gyaidexul craftsmanship," and the "current state of intangible cultural heritage inheritance." Illustrations, in turn, can more precisely depict knowledge such as the structure of the loom, the logic of pattern composition, and historical comparisons.

5.4.3 Synergistic Design of Text and Image for Multi-Channel Perception

Text and image can work together to stimulate sensory experiences beyond the visual, serving various intelligences like Gardner's bodily-kinesthetic intelligence, and creating an immersive

reading experience. For example, when depicting the heavy texture of Bangdian pulu, the text can guide: "Imagine touching this Bangdian with your hand; it feels warm, like the natural warmth of wool itself." When illustrating a weaving scene, it can be paired with a textual description: "One can almost hear the whoosh of the shuttle passing through, the rhythmic 'clack' of the loom, and the ancient melody hummed by Grandma."

5.5 Strategies for Physical Format and Dissemination Methods

5.5.1 Gamified Interactive Format Design

Piaget's theory indicates that children in the Preoperational Stage perceive the world through action. Interactive format design transforms reading into a game dominated by bodily-kinesthetic intelligence, making the picture book align with children's cognitive style. This can involve shaping the book itself into die-cut forms like auspicious clouds or Tibetan robes, or designing manipulative interactive books to increase playful engagement. For instance, using peek-through holes that allow children to glimpse part of the next page can create suspense. Lift-the-flaps and pull-tabs can be integrated with experiential narratives like craft processes—for example, designing a mechanism where lifting a flap reveals a mineral transforming into pigment on cloth, or pulling a slider completes a drawing step. Utilizing different materials and assembly methods can help children learn new knowledge through direct experience, such as using varied UV textures to simulate the roughness of pulu or the smoothness of silk, or including pattern cards for children to assemble themselves, helping them understand the principle of offset stitching for the three pulu pieces.

5.5.2 Parent-Child Reading Guide and Scaffolding Extension

Parent-child shared reading extends Vygotsky's social interaction theory from within the book to the actual parent-child relationship, empowering adults to become more effective "guides." Providing a "Reading Guide Handbook" alongside the children's picture book can instruct parents on companion reading. This guide should clarify the core knowledge points of the popular science book and the corresponding "Zone of Proximal Development" goals, indicate embedded questioning points within the book and their intended guidance direction, and suggest extended discussion topics and parent-child activities. The handbook can offer simple craft activity plans, such as "simulated weaving" with colored paper strips, guiding children to collect petals and leaves for simple plant rubbing, or introducing related legends like the "Four Harmonious Friends," encouraging family discussions on topics like "How can we live harmoniously with family, friends, and nature?" and providing other extracurricular knowledge extensions.

5.5.3 Derivative Products and Activities Based on Multiple Intelligences

Producing supporting merchandise and culturally creative products expands the picture book from a single reading material into an ecosystem that meets children's personalized learning and expression needs. This allows every reader to find an entry point that resonates with their own intellectual strengths, thereby truly achieving the deep dissemination of the "child-oriented" concept. Cultural derivatives could include simplified Bangdian-element puzzles and colouring books to develop spatial and logical intelligence, while safe mineral pigment identification sample boxes or Bangdian-themed craft kits can develop children's bodily-kinesthetic and naturalist intelligences. Additionally, accompanying audio stories can stimulate musical

and linguistic intelligence. Utilizing Augmented Reality (AR) technology can create immersive learning environments—for example, using an app to scan the picture book to view 3D animations of a traditional loom's working principle or to "try on" virtual Bangdian from different regions and for different occasions, allowing for an intuitive cultural experience. This enables children to deeply understand the past, present, and future of this intangible cultural heritage through immersive, gamified experiences.

6. Conclusion

From narrative structure to visual translation, from textual interaction to physical form, the design strategies for Tibetan Bangdian children's popular science picture books, grounded in a child-oriented approach, aim to start from the child's "Zone of Proximal Development." Through diversified intelligent channels, they seek to achieve the effective transmission of cultural connotation and the active promotion of cognitive abilities. The strategic framework proposed in this study holds broad potential for application and further development. Firstly, as a methodology, it can be extended to the development of children's enlightenment materials for other intangible cultural heritage projects. Whether dealing with the textile techniques of other ethnic groups, ceramic crafts, or folk dramas, its core logic—respecting cognitive development stages, building learning scaffolds, and opening multiple perceptual channels—holds universal guiding significance. Secondly, deep integration with digital technology is an inevitable trend. Based on this framework, further exploration is possible into how to use Augmented Reality (AR) to allow children to virtually participate in the entire intangible cultural heritage experience, or how interactive storytelling can let children decide the narrative direction, thereby fostering a deeper understanding of Bangdian's functions across different social contexts. This would make the "scaffolding" more intelligent and the "channels" more immersive. Finally, this framework encourages a dynamic co-creation model. In future picture book practice, children, parents, educators, and even Bangdian inheritors could be invited to participate in the creation and testing process. This ensures the picture books are not only theory-based but also rooted in genuine needs and feedback, allowing for continuous optimization. However, this research also has its inherent limitations. Primarily, it provides a theoretical framework and strategic conception. Its ultimate effectiveness and appeal urgently require validation through subsequent practice. This involves observing children's reading behaviours through rigorous user testing and collecting empirical data by interviewing parents and children about their shared reading experiences, thereby refining and improving the strategies. Secondly, while the study emphasizes multiple intelligences, at the practical level, achieving a skillful balance among various intelligent channels within a single picture book without appearing cluttered or chaotic still requires creators to possess superior integrative design and artistic expression abilities. The journey from theoretical construction to the creation of an outstanding picture book that deeply touches children's hearts remains long and requires further exploration. It is hoped that the strategies proposed in this study can serve as a valuable starting point, inspiring and guiding future creators to jointly produce excellent reading materials for children that both uphold cultural authenticity and brim with childlike wonder, thereby imprinting Tibetan intangible cultural heritage onto the spiritual world of the next generation.

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