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Research on the Design and Educational Application of AR Hubei Intangible Cultural Heritage Picture Books from the Perspective of Cultural Identity: Taking the "Tianmen Sugar Sculpture" AR Picture Book as an Example

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Abstract: The purpose of this study is to explore the application effect of AR technology in intangible cultural heritage (ICH) education by taking the children's augmented reality (AR) picture book "Tianmen Sugar Sculpture" as an example, focusing on analyzing how to enhance children's cognition and cultural identity of traditional culture through vivid interactive experience. The study used experimental and interview methods to evaluate picture books from five aspects: font design, reading fluency, comprehension level, design style preference, and cultural identity influence. The experimental results show that the font design of the picture book is suitable for children's reading, and most children can understand the content smoothly during the reading process. Although some children lack the memory of sugar and plastic details, overall, the picture book has successfully stimulated children's interest in Tianmen Sugar Plastics, and effectively convey relevant non -heritage knowledge. Children displayed strong enthusiasm for the cultural essence of sugar sculpture. The research results show that the design of AR non -heritage picture books not only meet children's aesthetic and cognitive needs but also promote cultural identity of children, has positive educational application value, and provides new ways and reference for the digital communication of the future non -heritage.

Keywords: Non-heritage Picture, Intercultural Identity; Educational Applications; Augmented Reality

1. Introduction

In the context of globalization, the communication of intangible cultural heritage (ICH) faces significant challenges, particularly in fostering awareness and interest among younger generations. Hubei has rich non - heritage resources, but how to effectively pass these cultural elements to children and enhance their cultural identity is still an urgent problem. The development of augmented reality (AR) technology offers an innovative pathway for cultural communication. By integrating virtual and real-world experiences, AR technology provides more engaging and interactive methods to help children deeply understand and appreciate Hubei's ICH. This study addresses the core question: how can the educational function of Hubei ICH picture books be enhanced through the innovative application of AR technology to strengthen children's cultural identity, fostering a sense of pride and connection to their local Intangible cultural heritage through interaction and experience.

1.1 Cultural Identity Related Theories

Cultural identity is an individual or group's sense of recognition and belonging to its culture, and the basis for cultural heritage and development [1]. Related theories show that cultural identity involves not only the construction of self -awareness, but also differentiated cognition with others. The benign identity of culture can promote the formation of individual social attributes, and it is conducive to the comprehensive development of individuals [2]. ERIKSON (1968) believes that the formation of cultural identity is the most important part of individual socialization. Especially at the stage of children's growth, the shape of cultural identity will affect their self -awareness, social behavior, and emotional development. In

children's education, cultural identity is shaped by the interplay of various factors, including family, school, and societal influences. Cultural carriers, such as books and picture books, play a vital role in this process.

In recent years, researchers have gradually realized that cultural identity is not only achieved through language and knowledge, but also deepen the understanding of emotional identity, symbols and symbolic systems. As a medium that combines visual and linguistic elements, picture books enable children to engage with cultural symbols through the integration of text and imagery, fostering their cultural identity in a meaningful way. Consequently, effectively incorporating cultural identity education into children's learning has become a significant topic in academic research.

1.2 The Current State of Intangible Cultural Heritage Education and Communication in Hubei

As a culturally rich region in China, Hubei is home to a wealth of intangible cultural heritage (ICH) resources, including Chu opera, paper-cutting, sugar sculptures, and woodblock New Year paintings. Hubei's ICH embodies profound historical and local characteristics, and its educational transmission is undergoing gradual changes. Traditional ICH education has primarily relied on institutions such as schools and museums, using methods like exhibitions and handicraft instruction to pass on cultural knowledge. However, with societal changes—especially the waning public attention to traditional culture—these conventional approaches face significant challenges. Understanding the principles of cultural transmission and uncovering the deeper meanings of ICH have become central to advancing its preservation and education in the modern era [3].

In recent years, Hubei's intangible cultural heritage (ICH) education has started to explore more innovative communication methods. As a new medium for cultural dissemination, ICH-themed books have garnered increasing attention. Through the combination of visuals and text, these books present Hubei's traditional cultural content in a vivid and easily accessible format for children. In particular, when it comes to folk art, ICH picture books have become a crucial vehicle for transmitting

and popularizing local culture.

Despite its progress, Hubei's intangible cultural heritage (ICH) education faces several challenges. First, the content of ICH education is often abstract, making it difficult to engage children effectively. Designing creative formats that appeal to young learners remains a significant hurdle. To address this, picture book creation must incorporate representative Chinese cultural symbols to highlight local characteristics and artistic styles, while reflecting the essence of Chinese culture in a way that resonates with children [4]. Second, although some ICH-themed picture books have been produced, there remains a lack of systematic educational resources, particularly in the innovation of teaching materials and tools. Finally, integrating local cultural characteristics with modern educational approaches to meet the needs of contemporary children is an urgent issue for advancing Hubei's ICH education.

1.3 AR-Enhanced Intangible Cultural Heritage Picture Book Design and Its Impact on Cultural Identity

With the rapid development of augmented reality (AR) technology, traditional picture book design has increasingly shifted toward digitalization and interactivity. AR technology offers children an immersive learning experience by transforming traditional two-dimensional illustrations and text into interactive, three-dimensional content. This allows children to engage with intangible cultural heritage (ICH) in a more intuitive way. In AR-based ICH picture books, children can interact with three-dimensional models by touching or scanning specific images, and explore traditional festivals, folk art, and skills through a blend of the real and virtual worlds. This dynamic approach enhances their understanding of ICH and fosters a stronger cultural identity.

By employing scientific and technological methods, and utilizing reading approaches such as "scenario interaction" and "two-way interaction," AR technology effectively generates the aesthetic tension unique to intangible cultural heritage (ICH) picture books [5]. This stimulates the vitality of ICH books and enhances their readability and the overall reading experience for children. Studies have shown that the introduction of

AR technology can significantly improve the interactivity and engagement of picture books. In children's education, AR can spark interest and increase participation, thereby strengthening their understanding of cultural content. However, the design of AR-based ICH books faces several challenges. First, effectively integrating the deeper cultural meanings of ICH with AR technology presents a major design challenge. The innovative expression of ICH content must preserve its cultural authenticity while aligning with children's cognitive development and aesthetic needs. Second, the popularity of AR ICH picture books remains limited, with many educational institutions and families not fully utilizing AR technology for ICH education. While some successful AR-based ICH book cases exist, the overall market is still in its early stages, and further integration of technology and content is needed.

2. The Role of Cultural Identity in the Design of Hubei's Intangible Cultural Heritage Picture Books

2.1 The Exploration and Design of Hubei's Intangible Cultural Heritage Elements in Picture Books

Hubei Province has abundant intangible cultural heritage resources, instead of the inheritance of not heritage is not only an important task of cultural protection, but also a key way to cultivate children's cultural identity and national pride. Therefore, it is an important way to realize the non -heritage elements in Hubei and transform into the content of the picture book.
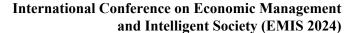
In the design of picture books, we must first choose representative non -heritage elements. For example, Hubei traditional folk art, such as flower drums, paper - cutting, Hubei Huangmei opera, etc., all have distinctive regional characteristics and profound cultural heritage. These non - heritage elements can not only show the local cultural characteristics of Hubei, but also attract children's interest through visible pictures and vivid stories. In picture book creation, you can present the diversity of non -heritage through illustrations, storylines, character settings and other means. For example, the Dragon Boat

Festival and Dragon Boat Culture in Hubei can be displayed through rich pictures and narrative techniques, so that children can be easily understand Hubei's traditional customs in the process of reading.

Additionally, the creative expression of intangible cultural heritage (ICH) elements is crucial. In order to make it easier for children to understand and accept, designers need to re -conceive modern art on the basis of respect for traditional culture. Building design practices with non -heritage art elements, based on the influence of art and culture, establish psychological, thought, and feelings based on the influence of art and culture [6]. For example, Hubei paper-cutting art can be adapted to meet children's aesthetic preferences by simplifying it and employing modern visual styles. Similarly, traditional folk stories and opera elements can be made more entertaining and educational through cartoon-style expressions. This approach helps ensure that ICH is deeply rooted in children's hearts.

2.2 Empowering Non-Heritage Picture Book Design through AR Technology

The application of Augmented Reality (AR) technology in education and cultural communication is increasingly widespread, particularly in the dissemination of intangible cultural heritage. AR provides a novel means of engagement by enhancing the traditional picture book experience. AR picture books use technology to transcend the limitations of paper, enriching sensory interaction within real-world scenarios and creating an immersive, participatory reading experience [7]. In the design of non-heritage picture books, the integration of AR technology enables traditional cultural content to be presented in a vivid, interactive format. This allows children to directly engage with the illustrations and storylines, fostering a deeper cultural identity through an immersive experience.

In AR non -heritage, children can scan the drawing on the book page through the smart device to see the characters or scenes in the picture "live". For example, by scanning an image of the Hubei Dragon Boat Race, children can witness a virtual dragon boat race on the water, hear the sounds of gongs

and drums, and even participate by controlling the dragon boat in a competition. In this way, AR technology not only increases the interaction of picture books, but also allows children to feel the unique charm and cultural connotation of Hubei traditional festivals during the participation process.

Additionally, AR technology enriches the relationship between text and images in picture books. While traditional picture books are two-dimensional, AR picture books enable readers to experience multi-dimensional cultural elements through 3D images, animations, and sound. For example, when scanning paper-cut art patterns, children can watch virtual paper-cut characters gradually assemble into complete designs, and even experience the paper-cutting process. Digital technology enhances non-heritage books by presenting them with a unique, visually comprehensive, three-dimensional, multi-layered, and interactive format. The distinctive visual and interactive features of digital picture books can effectively engage the younger generation [8]. This type of interaction and immersion significantly enhances the educational value of non-heritage books, allowing children to not only visually explore non-heritage but also deepen their understanding of traditional art through hands-on experience.

2.3 Cultural Identity Shaping and Embodiment

AR-powered non-heritage books serve not only as tools for cultural preservation but also as vital mediums for enhancing children's cultural identity. Through interactive engagement with traditional culture in AR non-heritage picture books, children can emotionally connect with local cultural elements, gradually developing a deeper sense of cultural identity.

First of all, AR technology helps children understand and experience Hubei traditional cultural elements through vivid expression. Traditional non -heritage is often more abstract, and it is difficult for children to perceive and understand. Through AR technology, elements such as traditional festivals, folk stories, handicrafts, etc. have become lifelike, and children have gained a

more close to cultural experience in interaction. For example, Hubei's flower drum opera not only presented in AR picture books through animation, but also through the interaction of virtual characters and the addition of live music to make children perceive the diversity and charm of culture in a dynamic environment. This interactive cultural experience not only deepens children's understanding of Hubei's traditional arts but also fosters their interest and connection with local culture.

Secondly, AR non-heritage picture books break the limitations of traditional "book knowledge," offering children more opportunities for self-directed learning and exploration. By scanning and touching, children actively engage in cultural learning and become participants in the story, rather than passive recipients. This sense of participation boosts children's self-confidence while stimulating their curiosity and desire to explore local culture. For example, through AR technology, children can explore Hubei's folk art, experience the vibrancy of the culture, and strengthen their cultural identity through interactive engagement.

Finally, AR non-heritage picture books allow children to experience the emotional power of culture through immersive, multi-sensory design. By integrating elements such as images, sounds, and animations, non-heritage culture is transformed from an abstract symbol into a "living" culture that children can touch and feel. This profound cultural experience not only strengthens children's awareness of local culture but also deepens their emotional connection, fostering the development of cultural identity. Through participation and interaction, children not only grasp the essence of the culture but also experience its unique charm, thereby cultivating a sense of identity and pride in their cultural heritage.

3. Educational Application Practice of AR Hubei Intangible Cultural Heritage Picture Books

3.1 Education Application Goals and Needs Analysis

In today's globalized and information-driven

society, children's cultural identity faces significant challenges, particularly due to the influence of foreign cultures and the gradual erosion of local traditions. In rapidly developing urban areas and the digital age, many children are becoming increasingly disengaged from traditional culture, resulting in a weakened sense of cultural identity. This issue is especially evident when it comes to intangible cultural heritage (ICH), as most children rely on traditional, monotonous teaching methods that fail to capture their interest or foster emotional engagement. Consequently, improving children's recognition of local culture through innovative educational approaches has become a critical focus in contemporary educational practices.

The educational application goal of AR non - heritage picture book is to solve this practical problem. Its main goal is to through the empowerment of AR technology to break the limitations of the traditional education model, and to convey Hubei intangible cultural heritage in a more vivid and interactive manner. With AR, non-heritage content becomes dynamic and engaging, moving beyond static text and images to showcase stories, arts, and customs through virtual-reality interactions. AR-enhanced picture books integrate various narrative elements, including images, videos, and audio, offering a multi-sensory reading experience [9]. Through this innovative approach, AR non-heritage picture books capture children's visual and auditory attention while fostering emotional resonance [10]. This helps children understand Hubei's intangible cultural heritage, gradually developing a sense of cultural identity and pride.

Furthermore, current non-heritage education faces challenges such as a lack of teaching resources, limited content, and reliance on traditional teaching methods. This issue is particularly pronounced in remote areas, where access to cultural identity education is more restricted. AR-based non-heritage picture books can overcome regional limitations, offering equal cultural learning opportunities to children both nationwide and globally. Through new technologies, children can engage with traditional culture, fostering the widespread dissemination and equal access to cultural education.

3.2 The Application Model of AR-based Hubei Intangible Cultural Heritage Picture Books

The application model of AR Hubei Intangible cultural heritage picture books demonstrates both diversity and flexibility, primarily reflected in their use across cultural settings such as classrooms, family environments, and museums. By employing non-heritage picture books as a medium and AR technology as a supporting tool, these models connect schools, families, and communities to create a cohesive and dynamic reading ecosystem. In classroom teaching, AR-enhanced non-heritage picture books provides students with an immersive learning environment through augmented reality technology. Through augmented reality, students can experience virtual scenes and characters that vividly portray traditional cultural elements by scanning specific pages. For instance, while studying Hubei's traditional festivals, students can use AR to visualize dynamic scenes such as Dragon Boat Festival celebrations, temple fairs, and related cultural activities. They can even hear festive music, immersing themselves in the atmosphere of the event. This interactive and visually engaging approach transforms students from passive recipients of knowledge into active cultural explorers, significantly enhancing their learning interest and participation.

In family education, AR non-heritage picture books create opportunities for parents and children to read and learn together. By utilizing AR technology to scan illustrations in the books, families can access virtual content that explores Hubei's intangible cultural heritage, fostering shared understanding and learning. This process allows parents to deepen their own knowledge of traditional culture while engaging with their children, reinforcing cultural identity through meaningful parent-child interactions. For instance, parents and children can collaboratively participate in virtual paper-cutting art creation or watch a virtual performance of Hubei Flower Drum Opera. These shared experiences enhance their perception and appreciation of intangible cultural heritage. This interactive reading approach not only strengthens family cultural education but also nurtures children's cultural confidence in their everyday lives.

In museums and cultural venues, AR-based intangible cultural heritage picture books offer an innovative approach to cultural

dissemination. By scanning exhibits or display boards, children can experience virtual interpretations of traditional culture. For instance, at a traditional art exhibition in the Hubei Museum, children can use AR technology to scan paper-cuttings, pottery, or other displayed artworks and observe virtual demonstrations of their creation process or the re-enactment of folk stories. This interactive display method enhances the engagement and enjoyment of the exhibits while presenting cultural heritage in a more vivid and accessible way. The integration of virtual and real elements allows children to better understand and appreciate the charm of traditional culture during their visits.

3.3 Implementation and Effectiveness Evaluation of Educational Applications

This study uses the children's augmented reality (AR) picture book Tianmen Sugar Sculpture as an example to examine the educational impact of AR picture books, particularly in enhancing children's cultural identity and learning interest. The content of the picture book includes the historical legends, production process, and representative artworks of Tianmen sugar sculpture. By scanning AR markers in the picture book, children can view three-dimensional sugar sculpture artworks. The AR interactive design of Tianmen Sugar Sculpture primarily utilizes Unity3D, VuforiaAR, and Playgrounds to achieve image tracking and content presentation. VuforiaAR offers advanced 2D and 3D image recognition capabilities, supporting custom image recognition, making it suitable for augmented reality development (Figure 1. AR picture book effect). Unity3D, a robust multi-platform game development tool,

provides a convenient environment for creating real-time 3D animation and graphic visualization. For mobile users, Unity3D is employed to develop Android applications, while Playgrounds ensures compatibility with Apple systems. In terms of material modeling, Cinema 4D is used for 3D modeling of sugar sculptures, employing a realistic style to accurately reproduce their shapes. For sound design, voice narration and lively background music are incorporated, enriching the interactive and engaging experience of the AR picture book. This combination of visual and auditory elements not only enhances the interactivity and appeal of AR picture books but also facilitates children's comprehension, sparks their learning interest, and transitions them from passive recipients to active learners, thereby fostering an enjoyable and educational reading environment.

Figure 1. AR Picture Book Effect

The study evaluated the educational effect of the AR intangible cultural heritage picture book through experimental tasks and interviews. The in-depth analysis was conducted from five aspects: the comfort of the picture book design, reading fluency, comprehension levels, overall design preferences, and the influence on the dissemination of intangible cultural heritage.

3.3.1 Experimental samples

Table 1. Basic Information of the Subjects

Serial number	Gender	Age	Grade	Have you read the non-legacy picture book?
V1	Female	10 years old	Grade 3	Yes
V2	Male	10 years old	Grade 3	No
V3	Female	10 years old	Grade 3	No
V4	Male	9 and a half years old	Grade 3	No
V5	Female	9 and a half years old	Grade 3	Yes
V6	Female	9 years old	Grade 3	No
V7	Female	9 years old	Grade 2	Yes
V8	Male	8 and a half years old	Grade 2	No
V9	Female	7 years old	Grade 1	No

The experiment included interviews to collect basic information about the

participants, such as gender, age, and prior experience with intangible cultural heritage

picture books (Table 1. Basic information of the subjects).

3.3.2 Experimental tasks

Task 1: To evaluate the comfort of the picture book's font size, observation and interviews were conducted to determine whether the font size was suitable for easy reading.

Task 2: To assess reading fluency, the observation method was used to examine whether children could read the picture book smoothly.

Task 3: To measure comprehension, children were asked simple questions during interviews to determine their understanding of the picture book's text and story content.

Task 4: To evaluate design preference, the interview method was used to gather children's overall impressions of the picture book design.

Task 5: To assess cultural identification, interviews were conducted to ask children about their interest in Tianmen Sugar Sculpture after reading the picture book.

3.3.3 Effect experiment results

The designed test adopted the observation and interview method to observe the length of time children spent reading picture books, their behavioral performance during the reading process, etc. (Table 2. Observation Record Sheet). According to the difficulty of picture book reading for children, they were divided into three levels: simple, moderate and difficult. To evaluate their understanding, children were asked questions related to the content of the picture book, allowing us to verify whether their narration was accurate and detailed. In the test of the overall design of the picture book, we evaluate the picture book through the children's subjective attitude. To test the effect of picture book, we tested the children's interest in Tianmen Sugar Sculpture after reading the picture book (Table 3. Interview record form), and further verified the reliability of the experimental results and the subjective feelings of the experimental subjects through interviews (Table 4. Interview record).

Table 2. Observation Record Sheet

Observation date: 2022.12.6 Observation location: Tianmen Experimental Primary School, Tianyuan

Gardening School			
Serial number	Reading time	Do you read books closely?	Is reading fluent?
V1	3m45s	No, normal reading distance	Yes
V2	3m35s	No, normal reading distance	Yes
V3	3m27s	No, normal reading distance	Yes
V4	4m03s	No, normal reading distance	Yes
V5	3m38s	No, normal reading distance	Yes
V6	3m44s	No, normal reading distance	Yes
V7	3m42s	No, normal reading distance	Yes
V8	3m52s	No, unknown words will be moved closer	Yes
V9	4m09s	No, unknown words will be moved closer	Yes

The experimental results indicate that the design of the children's augmented reality (AR) picture book "Tianmen Sugar Sculpture" has produced positive effects in several areas. Firstly, the font design of the picture book meets children's reading needs, with most children maintaining an appropriate reading distance and demonstrating good reading fluency. Secondly, although the children lacked understanding of details, they were able to understand the basic content of the picture book and describe the relevant knowledge of Tianmen sugar sculpture. The picture book's vibrant colors and innovative design align with children's aesthetic preferences, effectively capturing their attention. The character design also fosters emotional resonance. In addition, through reading picture books, children developed a strong interest in Tianmen sugar sculpture culture and demonstrated a strong sense of cultural identity. Overall, the picture book successfully enhances children's aesthetic abilities, creative thinking, and cultural identity by integrating traditional folk art with modern AR technology. These findings validate the effectiveness of the design and offer valuable insights for future intangible cultural heritage education.

Table 3. Interview Record Form

Serial number	Difficulty	Is it described correctly?	Is the detail clear?	Overall design evaluation	Cultural identity effect
V1	Moderate	Yes	Yes	Rich and interesting content	interested
V2	Simple	Yes	Yes	Nice pictures	interested
V3	Moderate	Yes	Yes	Can learn knowledge	interested
V4	Moderate	Yes	No	Nice color	interested
V5	Moderate	Yes	Yes	Like to turn the pages	interested
V6	Difficult	No	No	Can learn knowledge	interested
V7	Moderate	Yes	Yes	Rich and interesting content	interested
V8	Difficult	No	No	Nice pictures	generally
V9	Difficult	No	No	Nice color	interested

Observation date: 2022.12.6
Observation location: Tianmen Experimental Primary School, Tianyuan Gardening School

Table 4. Interview Record

[Picture book comprehension level]

Question: After reading the picture book, can you briefly describe the historical legend of sugar sculpture?

V1: I know! It's about a war. The bad guys released poisonous bees to bite the soldiers. Then someone made a human shape out of candy to attract the bees, so that the bees would not bite the soldiers.

V2: I remember there seemed to be two legends! One was about war and the other seemed to be the legend of Miss Sugar! During a war, a soldier was injured by a bee. A grandfather thought of a way to drive away the bees with a scarecrow with sugar, and then the war was won.

Question: After reading the picture book, what representative works of sugar sculpture do you know now?

V3: I think about it, and I remember there is something that looks like a lion, yes, yes, it's called "Gourd Lion", it looks very cute, and I remember it likes it very much!

V4: I think I saw it, but I can't seem to remember the name.

[Overall evaluation of the picture book]

Question: Do you like this picture book? Why?

V1: I like it. This picture book contains a lot of content, including traditional Chinese culture, which allows me to learn knowledge.

V2: This picture book is very nice. The characters and gadgets in it are very cute and the colors are beautiful.

V3: I like it. After reading this picture book, I learned some knowledge about Tianmen sugar sculpture, which is helpful to me.

V7: I like it because I know how maltose is made. And I like the feeling of turning pages.

V8: I like it because I like eating candy. The pictures inside are very nice.

Question: Do you like the AR effect in this picture book? Why?

V3: I like it. The effect seen on the tablet is different from that in the book. It feels magical.

V4: I like it. I can see the three-dimensional effect on my phone, there are voice explanations, and I can rotate it with my hands to watch it carefully. It's really interesting and gives me a good experience.

[Picture book communication effect]

Question: After reading the picture book, will you become interested in Tianmen sugar sculpture?

V1: After watching it, I became very interested in sugar sculpture. If I have the chance, I would like to make one myself and give it to my mother.

V2: After reading the picture book, I felt that sugar sculpture making was very interesting and I also wanted to learn it.

V4: Yes, I want to make sugar sculptures with my friends, it should be fun.

4. Conclusion

This study explores how to convey intangible cultural heritage through innovative digital technology and enhance children's cultural identity and learning interest via the design and application of the children's augmented reality (AR) picture book "Tianmen Sugar Sculpture." By integrating AR technology, the picture book brings the traditional art of sugar sculpture to life and enhances children's

understanding and emotional connection to intangible cultural heritage through interactive experiences. The experimental results show that the picture book design meets children's reading needs, stimulates their interest in learning and creativity, and also promotes their recognition of the traditional culture of Tianmen sugar sculpture.

This study demonstrates the potential of AR technology in children's education, particularly its application in the inheritance of intangible cultural heritage. Through visual, auditory, and interactive multi-sensory experiences, children not only acquire knowledge in an engaging learning process but also form an emotional connection with traditional culture. While this study has limitations in terms of detailed memory retention, it offers valuable insights and serves as a reference for the further development of AR picture books. In the future, we can further optimize content design on this basis to enhance the memory of cultural details, while expanding more intangible cultural heritage content to better meet children's learning needs and promote the innovative inheritance of intangible cultural heritage in education.

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