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Exploratory sequential design for creation of the Miao's traditional patterns mobile application

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ABSTRACT: This study aimed to define a data set for the design of an app that would show Miao's traditional patterns. At the preliminary stage, the study traced the socio-cultural transformation that the Miao people went through, and which was reflected in their traditional patterns. In the first stage of the study, an Internet survey was conducted on the international tourism platform among the population of all continents. The survey confirmed the existence of a public request for content related to Miao's traditional patterns. The survey also determined the required information sources and approaches to training. Further, the desired content was prepared and coordinated with the help of experts in the field of Miao cultural heritage. At the final stage, usability, design, and content issues for the future mobile application were discussed during an interview with experts in the field of digital representation of artefacts.

KEYWORDS: cultural heritage; digital artefacts; mobile application; transformation of traditional patterns; user interface.

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Título traducido: Diseño secuencial exploratorio para la creación de la aplicación móvil de patrones tradicionales de Miao.

RESUMEN: Este estudio tuvo como objetivo definir un conjunto de datos para el diseño de una aplicación para el aprendizaje de los patrones tradicionales de los Miao. En la etapa preliminar, el estudio trazó la transformación sociocultural por la que atravesó el pueblo Miao, y que se reflejó en sus patrones tradicionales. En la primera etapa del estudio, se realizó una encuesta por Internet en la plataforma de turismo internacional entre la población de todos los continentes. La encuesta confirmó la existencia de una solicitud pública de contenido relacionado con los patrones tradicionales de Miao. La encuesta también determinó las fuentes de información requeridas y los enfoques para la capacitación. Además, el contenido deseado fue preparado y coordinado con la ayuda de expertos en el campo del patrimonio cultural Miao. En la etapa final, se discutieron temas de usabilidad, diseño y contenido para la futura aplicación móvil durante una entrevista con expertos en el campo de la representación digital de artefactos.

PALABRAS CLAVE: patrimonio cultural; artefactos digitales; aplicación móvil; transformación de patrones tradicionales; interfaz de usuario.

INTRODUCTION

The development of technology plays an important role in the sustainable development and promotion of cultural identity (Li, 2022). Numerous modern projects, state and interstate initiatives are aimed at preserving traditional practices and giving new life to cultural heritage through the use of innovative technologies and new media. Virtual museum tours, live broadcast rooms, online communities, and specialized groups on social networks contribute to the protection and promotion of traditional craft methods (Jin, 2016; Nalcioğlu, 2021; Xie and Zhu, 2015). At the same time, the importance of user experience is emphasized, which is determined by ease of use, entertainment, and effectiveness for training (Argyriou *et al.,* 2020). It is reported that existing digital platforms for cultural heritage predominantly offer specialized or overly complex user interactions (Sweetnam *et al.,* 2012), lacking the requisite flexibility to cater to diverse socio-demographic user categories (Zahidi *et al.,* 2014). Additionally, many contemporary studies are oriented towards expert insights rather than encompassing public perspectives (Meyerson *et al.,* 2012). However, the success of any application, software, or website hinges on the comprehension and fulfilment of user needs (Konstantakis *et al.,* 2018; Tarasewich, 2003; Zamri, 2022). This underscores the significance of scholarly investigations focused on user interface design, guided by both expert opinions within the domain and the broader public opinion. Notably, a deficiency is evident within the research of this nature.

Technological progress has provided various groups of users with the possibility to study CH (Cultural Heritage) and obtain related knowledge. Owing to 4G technologies, exhibition museums have been modernized: the exhibits of the CH are combined with projection and animation creating an atmosphere of light and shadow, panoramic images, and technologies of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). The introduction of 5G technology has brought forth not just the highest data transfer speeds, reduced costs, and lower energy consumption but also improved system throughput and the capability to connect with larger equipment. Due to 5G, visual interaction technologies have become possible to integrate into eXtended Reality (XR) (Chu *et al.,* 2019). In the 5G era, there are new opportunities for the improvement of web applications, mobile applications, and desktop applications.

The National Museum of China offers its visitors panoramic images, VR experience exhibition zones, and immersed exhibition zones. Bringing a virtual reality device with them, visitors can plunge into the environment where Vincent Van Gogh created his paintings (Hu and Pan, 2020). The Palace Museum has a digital exhibition hall, where a high-precision panoramic 3D model of the Palace Museum is presented in combination with high-definition video and interactive demonstrations. Viewers have the opportunity to explore spatial locations and historical periods of the Imperial Palace, take a walk "over" the Forbidden City, and visit the digital interaction zone of Palace Museum Collections.

LITERATURE REVIEW

Technological innovations enable the realization of productive scenarios for accessing historical and cultural experiences without the necessity of physical site visitation (Dutra, 2020). Two predominant approaches emerge in this context: the utilization of virtual/augmented reality (Argyriou *et al.,* 2020; Fu *et al.,* 2020; Ozdemir, 2021; Saalfeld *et al.,* 2021) and mobile applications (Boiano *et al.,* 2012; Filippini-Fantoni *et al.,* 2011; Ruiz-Calleja *et al.,* 2023) are widely regarded as the most prominent.

The work by Fu *et al.* (2020). focused on using VR to generate specific knowledge and situational experience of digital mural protection. In a digital tour of the cave, users are invited to immerse themselves in the process of the Dunhuang frescoes restoration (Fu *et al.,* 2020). In the preliminary phase of their research, Fu *et al.* (2020) endeavour to bridge the knowledge gap between domain-specific experts in cultural heritage and the general public, employing a survey-based approach. Based on the outcomes of the implemented experience, researchers (Fu *et al.,* 2020) report an improvement in user interaction and awareness of CH protection. The study by Argyriou *et al.* (2020) addresses the experience of using interactive digital storytelling in the XR presentation of cultural heritage, where XR refers to both virtual and combined environments and interactions. Argyriou *et al.* (2020) concluded that the technique used facilitates interactive digital interaction and can be considered one of the exciting methods of exploring cultural heritage.

The literature also reports on some disadvantages of virtual reality technologies for the CH representation. Firstly, it is difficult to provide CH content that is interesting for a regular user (Katifori *et al.,* 2018). Secondly, the VR experience can be challenging, especially in terms of objects, which do not have an actual story that users can follow (Crawford, 2013). In addition, the experience of using VR/AR/MR/XR for educational purposes indicates difficult design process, ergonomic issues, errors affecting the GPS (Chiang *et al.,* 2014), cognitive overload of a user (Alzahrani, 2020) and a relatively high cost of these technologies (Ozdemir, 2021).

The work by Boiano *et al.* (2012) describes the experience of creating a mobile application to promote Maltese cultural heritage. Boiano *et al.* (2012) summarize that the number of cultural applications will grow, they will be more interactive in terms of design and have more functions for collaborative work. At the same time, the quality of the content filling the mobile application remains important (Boiano *et al.,* 2012). The investigation conducted by Ruiz-Calleja *et al.* (2023) examined the utilization of the Casual Learn application among students at the secondary school level. Ruiz-Calleja *et al.* (2023) note the importance of the task publishing interface, the availability of an information panel, and

good compatibility of the application with the learning environment.

Dutra (2020) centred their investigation on scrutinizing applications that offer information about cultural segments in Germany. Drawing upon surveys, a comparative analysis was conducted between recommendations documented in the literature and industry-derived suggestions gleaned from market-available applications. Moreover, an examination of user interactions with urban spaces was undertaken. According to the findings of Dutra (2020), specialized applications concerning cultural segments can serve as instruments for propagating designer perspectives. Notably, 83.3% of respondents in Dutra's study indicated a preference for recommendations grounded in literature as opposed to industry-oriented suggestions. Furthermore, Dutra (2020) discerned that applications could be more aligned with developers' preferences and experiences rather than the genuine requirements of the cultural sector.

Conversely, Zamri (2022) underscores that users tend to place a higher emphasis on usability and the efficiency of task accomplishment rather than design conception, in contrast to the perspectives of developers. The user interface serves as a pivotal gauge of an application's capabilities, dependability, suitability, and utility for users (Tarasewich, 2003). The design of the user interface initiates an understanding of user needs (Zamri, 2022). Konstantakis *et al.* (2018) directed their attention towards theoretical scrutiny of user requirements, particularly the dynamics of interactions between users and applications within the realm of cultural heritage. According to Konstantakis *et al.* (2018), the cultural user experience is shaped by the interaction between various cultural entities and the user's cultural background. The authors Konstantakis *et al.* (2018) emphasize the necessity of collaboration among experts from interconnected fields to generate reusable content and ensure high-quality management, editing, and enhancement of cultural assets in a digital format.

Han *et al.* (2018) identified a gap in characterizing user experience within the context of augmented reality applications for urban tourism, particularly regarding cultural heritage. Subsequently, they introduced their user experience model tailored for tourist applications. The framework proposed by Han *et al.* (2018) is grounded in Hassenzahl's (2003) model of user experience. Through a thematic analysis, undertaken by Han *et al.* (2018), it was deduced that the user experience is shaped by the interplay between product characteristics (both pragmatic and hedonic) and tourists' perceptions and encounters.

Han *et al.* (2014) delved into the investigation of user perceptions, experiences, and interactions with community cultural heritage by employing a mobile application test. As revealed by the findings of Han *et al.* (2014), noteworthy landmarks capture users' distinct attention, and individuals with longer community residences express a greater willingness to contribute to its preservation.

Zahidi *et al.* (2014) directed their inquiry towards examining the influence of user experience on the contentment of non-specialized users engaging with digital collections of cultural heritage artefacts. The principal insights garnered by Zahidi *et al.* (2014) can be encapsulated by the notion that users highly value succinct content presented through an engaging layout and dynamic information delivery. However, it is noteworthy that convenience of use does not invariably guarantee overall user satisfaction.

CH gives a broad idea of the artistic, historical, cultural, economic, ethnographic, and technological aspects of the societies' lives (Ruiz-Calleja *et al.,* 2023). Secondary and higher education in many countries includes the study of CH (Ruiz-Calleja *et al.,* 2023; Sonkoly and Vahtikari, 2018). In addition to schoolchildren and students, adult groups of the population can also be the target audience for obtaining knowledge about CH since this knowledge expands horizons and cultural literacy, contributes to the critical analysis of past and present events, self-identification and preservation of artefacts (Greene *et al.,* 2014).

Henceforth, the literature review has revealed a substantial body of research endeavours oriented towards investigating diverse facets of user experience within finalized digital collections (De Luca *et al.,* 2023; Dutra, 2020; Han *et al.,* 2014; Sabukunze and Arakaza, 2021). Nevertheless, a limited number of studies (Fu *et al.,* 2020) undertake the pursuit of an optimal approach to designing specific digital collections of cultural heritage for the broader public, grounded in a preliminary examination of the exigencies of the target audience and attentive to expert evaluations. This study considers it necessary to provide an opportunity for the general public to learn the features of Miao's traditional patterns. This opportunity can be possible due to the development of cultural heritage digital application design for a multi-age and multi-national audience. Therefore, the purpose of this article is to define a data set for an application design for studying Miao's traditional patterns. The central inquiry driving this research is: what constitutes the most effective digital approach for engaging a wide audience in the exploration of cultural heritage?

MATERIALS AND METHODS

The present study is based on an exploratory sequential design (ESD) (Creswell, 2021). ESD implies the collection and analysis of qualitative data, creating a theoretical basis for the subsequent collection of quantitative data (Creswell, 2021). The qualitative data in this study were collected from literary sources. These sources were a basis for further online public surveys and interviews with experts. The sequence of the study stages is presented in Figure 1.

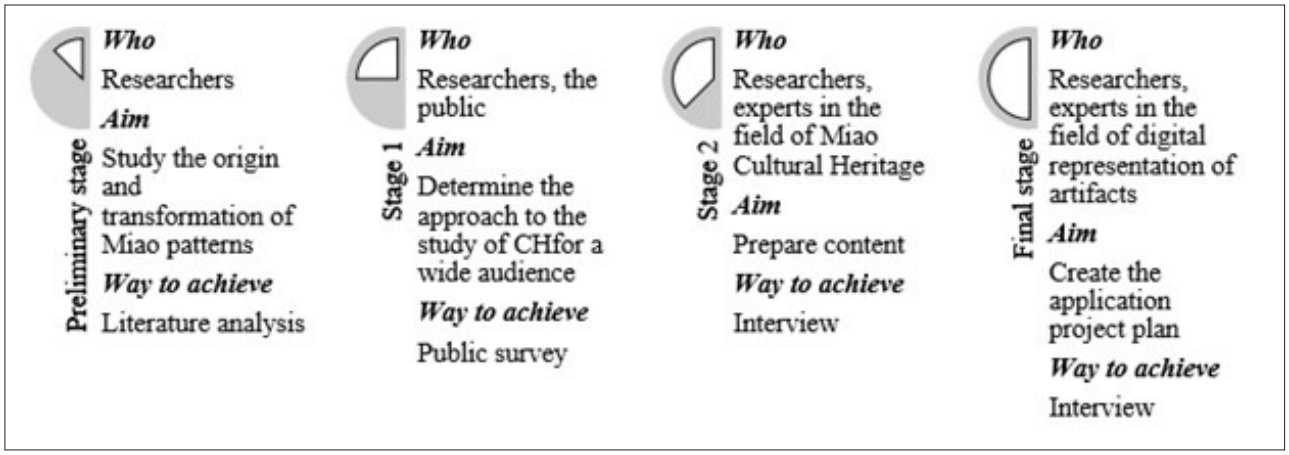

FIGURE 1. The sequence of the study stages.

The initial phase of the study encompassed the gathering and scrutiny of historical data about the inception, progression, and establishment of the Miao civilization, along with the evolution of their traditions, convictions, and ethical frameworks. This was done to study the origin and transformation of the Miao's traditional patterns. The summary of historical, ethnographic, and folklore data made it possible to trace the evolution of the traditional patterns, their symbolic identity, and diversity. The study covered not only the pattern on the fabric, but also on dishes, and other types of folk art.

In the first stage of the study, an Internet survey was conducted among the population. An invitation to participate in the study was posted on one of the popular international tourist platforms. Thus, 347 completed questionnaires were received. The survey was conducted in English. There were no special criteria for the selection of participants, but all participants in the survey had to be of legal age. The demographic data of the survey participants are presented in Table 1.

TABLE 1. The demographic data of survey participants.

Age	18-25	98 (28%)
	26-35	102 (29%)
	36-50	85 (25%)
	51-70	60 (17%)
	71+	2 (0.6%)
Sex	Male	132 (38 %)
	Female	215 (62 %)
Region	Asia	202 (58%)
	America	74 (21%)
	Europe	61 (18%)
	Africa	10 (3%)
Race/Ethnicity	White	98 (28%)
	Black	77 (22%)
	Latino	12 (3%)
	Asian	104 (30%)
	Mixed ethnicity	56 (16%)
Jobs	Students	74 (21%)
	Teachers	26 (8%)
	Office Staff	79 (23%)
	Retired	56 (16%)
	Other	112 (32%)
Total	347	100%

The questionnaire contained two sections of inquiries: (1) questions about public interest in the CH of the Miao people, willingness to learn about the Miao patterns, the preferred source of information about CH, preferences in teaching methods (Fu *et al.*, 2020), and (2) investigations into user interface preferences (following the elucidations presented by Zamri and Al Subhi (2015). The second segment comprised assertions, the significance of which respondents were required to assess on a scale ranging from 1 (strongly disagree) to 5 (strongly agree) points. These assertions were adopted from the work of Zamri and Al Subhi (2015), encompassing 10 constituent elements (Connectivity, Simplicity, Directional, Interactivity, User-friendliness, Comprehensiveness, Continuity, Personalisation, and Internal content), which collectively encapsulate four recommendations for user interface design: The Eight Golden Rules of UI [15], Additional Guideline for Mobile Interface Design [20], User Interface Design Principle [21], and Seven Usability Guideline for Website on Mobile Device [22]. Connectivity – the capacity to acquire information within a brief temporal interval. Simplicity – the utilization of straightforward and comprehensible constructs, conciseness, and an intuitively intelligible design. Directional – the sequential

nature of the information acquisition process. Informativeness – the capability to furnish requisite information. Interactivity – the simplicity and intelligibility of navigation. User-friendliness – an interface designed for user convenience. Comprehensiveness – an integrated assemblage of elements facilitating content transformation, thereby affording users the capacity to manipulate the application according to their requisites, capabilities, and understanding. Continuity – the sequence of interactions that ensures the perception and dissemination of information. Personalization – the provision for user control. Internal – the prevention of errors.

After passing the preliminary and first stages, the researchers chose a collection of digital artefacts, which they submitted for consideration to a group of experts. The data for the creation of the collection was taken from the Museum of Ethnic Cultures, Minzu University of China. The expert group consisted of 6 specialists, three in the field of Miao cultural heritage (a specialist in CH craft and two ethnographers who collected information in Miao's villages for many years) and three in the field of digital representation of artefacts (a university lecturer who conducted digital circuit exhibitions with the students, two software developers). It was one woman and three men. The average age of the experts was 42.6; the average work experience in their field was 8.8 years.

First of all, the researchers were interested in whether the particular artefact and the historical summary about it were suitable for creating an application for studying the Miao's traditional patterns. These issues were discussed with experts in the field of Miao cultural heritage (Stage 2). After the content for the application was prepared and agreed upon, the usability, design, and content issues of the mobile application were discussed between researchers and experts in the field of digital representation of artefacts (Stage 3). The main issues that were taken into consideration were as follows:

- What are the differences between a mobile app and a web-based site, which is better to choose for studying cultural heritage?
- Which platforms will the application support?
- How are maintenance and upgrades planned?
- What features will favourably distinguish the planned application for the study of cultural heritage?

RESULTS

Origin and transformation of the Miao's traditional patterns

Miao's history began about 5000 years ago (some data claim about 8000 years ago). The first mention of Miao is associated with the Chi Yu people. Its ancestors lived in the north, not far from modern Beijing. The war, famine, disease, high population density, and depletion of arable land forced the Miao people to relocate constantly, and this fact also left its mark on the transformation of the traditional pattern. Since 1949, Miao has been the official name for one of the 55 official minority groups recognized by the Government of the People's Republic of China). Now they live in the following main provinces: Guizhou (approximately 50% of the entire Miao population), Hunan (approximately 20% of the overall population), Yunnan (about 12% of the overall population), Chongqing County (about 5% of the overall population), Guangxi Autonomous Region (about 5% of the overall population), Hubei (about 2% of the overall population), Sichuan (about 2% of the overall population), Guangdong (about 2% of the overall population), Hainan (about 1% of the overall population). The Miao people have settled in the mountains and forests, away from other people.

In the period up to the 20th century, accounting for all the migrations of the Miao people, the necessary changes occurred in the economic, political, and social spheres, including the distribution of functional roles that individuals perform in society. During the 19th century, the Miao society underwent the dissolution of matriarchy, concomitant with the restructuring of social roles. Moreover, concurrent processes of mythological and religious evolution transpired within the societal framework. Over time, the Miao populace underwent a gradual detachment from complete alignment with the encompassing natural and communal realms. Specifically, the Miao community commenced recognizing a distinct dichotomy between humanity and nature, deeming the latter as an object of ownership. All these transformations were steadily affecting the development of spiritual and value orientations, social ideals, and moral norms (Fig. 2).

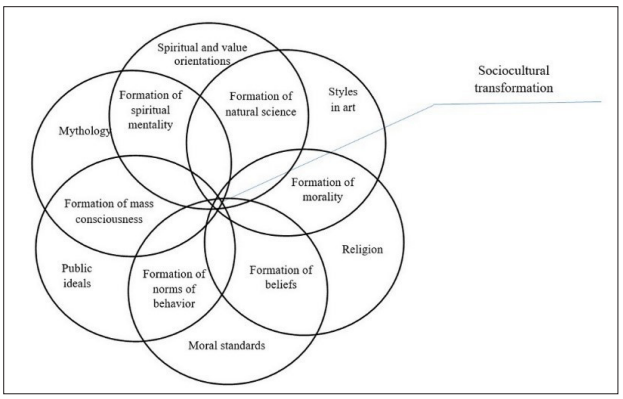

FIGURE 2. Formation of socio-cultural transformation (compiled by the author).

Technological development occurred relatively evenly at all stages of the Miao civilization formation. Sociocultural peculiarities have seriously affected the specifics of modernization. The only threat to the formation of socio-cultural identity may be the loss of historical memory. However, the Miao people managed to preserve

Table 2. The semantics of the main colours of the Miao people

Color	Symbolic meaning	Purpose	Traditions and beliefs
Red (South)	It symbolizes summer and fire. Personifies phoenix.	For rulers or rich people, and wedding ceremonies.	The main color for holidays, parties, celebrations, ceremonies.
White (West)	Symbolizes autumn and metal. It is also a symbolic meaning of terrorism and destruction.	Represents death and chaos.	Personifies tigers.
Black (North)	It symbolizes winter and water. It represents turtles and snakes.	It is associated with education. A suit for wise men.	It is perceived as a practical color for everyday clothes.
Yellow (Center)	It symbolizes summer and the earth; personifies butterflies.	A representation of national statehood.	A contradictory color. It is practically not used as the main one.
Green or Blue (East)	It symbolizes spring, trees and represents dragons.	It is associated with youth and vegetation; represents feminine power	Separates rich and poor. The colors are somewhat contradictory and green is never used as a main color.

their historical identity at all stages of their formation. In addition, sociocultural aspects laid the foundations for the colour perception and linguistic differences of the Miao people.

The Miao colour palette consists of five main colours (yellow, green and blue, red, black (or blue), and white). These colours are used as the main ones in the formation of the pattern. The Miao palette's main principles are presented in Table 2.

The Miao used their costumes to record history before the advent of writing. That is, Miao embroidery documents their history and culture. Various clothing models still retain rich meaning and are associated with legends, such as the origin of things, wars, and religious beliefs. At the same time, the embroidery technique and the content of drawings are diverse and differ in different settlements, depending on the history of origin, military transformations, religious expectations, and real life.

Stage 1. Results of the public survey

The majority of participants in the online survey reported an interest (68%) or a neutral attitude (21%) in studying Miao's CH, while only 11% admitted to a lack of interest. Ads/links/invitations in social networks (47%) and search engine queries made via smartphone (59%) were leading the sources of information about CH. Other responses included television news (37%), print media (33%), and live visits to cultural sites (32%). More than half (55%) of respondents reported their willingness to make efforts to learn the Miao's traditional patterns. About 14% of respondents were ready to make a live visit to Miao's cultural sites, but not to use digital solutions to compensate for the experience of visiting. The majority of respondents agreed to use a mobile application or website to study cultural heritage (73%). Although 14% did not agree to use remote technologies at all, there were 86% agreed and 73% were ready to use a mobile application for this. A large number of participants (68%) agreed to watch educational documentary videos; 49% reported interest in 3D images; 32% of respondents noted readiness to read printed materials; and 27% were ready to participate in the VR/AR/MR/XR experience.

The inclinations within the user interface were manifested as follows: the majority of participants underscored the significance of Simplicity (4.31), Informative (4.14), User-friendliness (4.06), and Comprehensiveness (4.01). Conversely, Directional (2.25) and Continuity (2.13) were found to be of lesser importance to the respondents.

Stage 2. Preparing content for the application

The experts in the field of Miao's cultural heritage have agreed on a collection of digital artifacts, selected by researchers and accompanying texts. The main sections for the future application were determined: totems, embroidery styles, brocade weaving, batik, and festivals.

Text for the introductory video:

> The Miao's national costumes preserve the traditional Chinese folk art of weaving, dyeing, embroidery and knitting. The combination of various technologies and methods of production results in the distinctive folk art of the Miao people. At the same time, Miao's fabric finishing technology is unique, represented by silk, which was subsequently transferred to the main fabric. The Miao's silk weaving usually includes embroidery, patterned embroidery, braiding patterns, batik (drawing patterns with wax on fabric) and other folk crafts. The Miao women need at least a year to make one piece of traditional clothing. Women draw inspiration from the Miao's traditional songs and legends. After finishing their work in the field, the Miao women gather to do needlework together. They share news, tell stories, sing songs, watch each other's work.

Totems. For the Miao people, animism and totem worship have become an inexhaustible source of inspiration for creating embroidery patterns that are considered "common" by the Miao philosophy. Consequently, people, animals, and plants represent "the World." Dragons, butterflies, bulls, and fish are the most representative totems in Miao's embroidery. Figures 3-5 show the selected text (a) and images (b-d) to create the Totems section: Figure 3 – dragon, Figure 4 – butterfly, Figure 5 – fish.

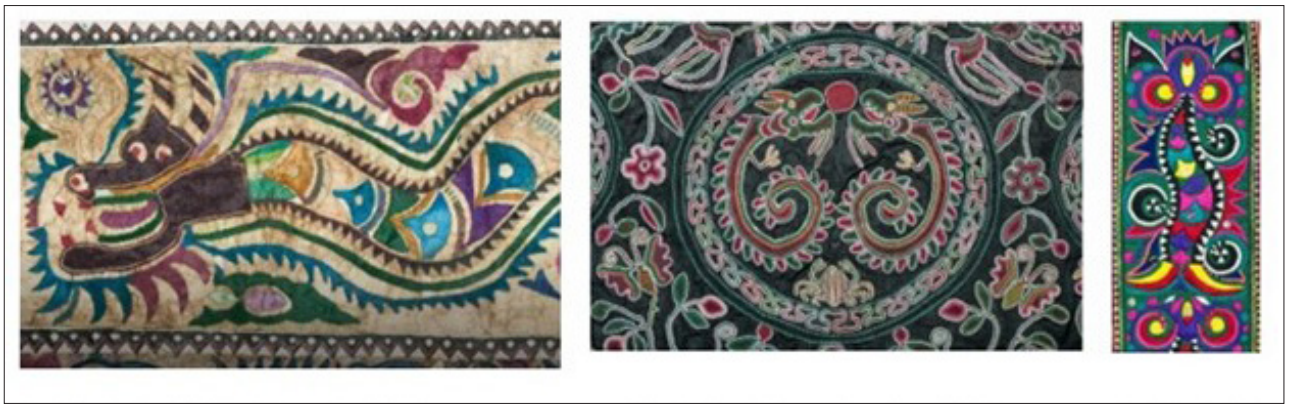

FIGURE 3. The Dragon Totem. Source: Museum of Ethnic Cultures.

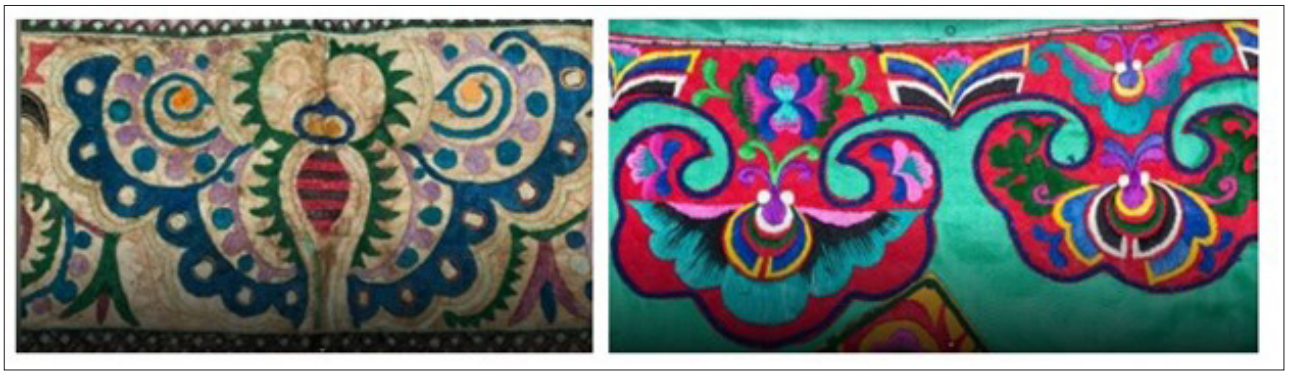

FIGURE 4. The Butterfly Totem. Source: Museum of Ethnic Cultures.

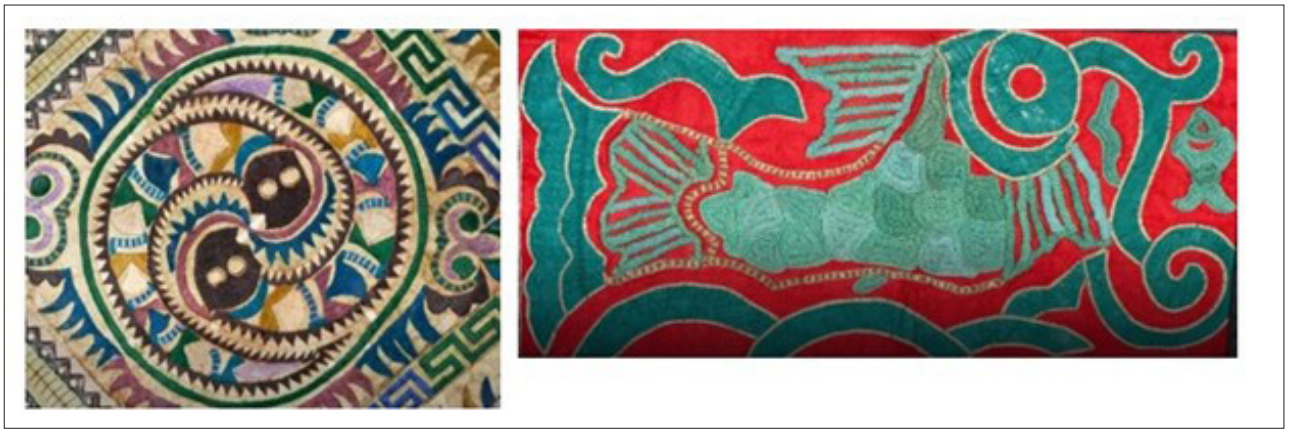

FIGURE 5. The Fish Totem. Source: Museum of Ethnic Cultures

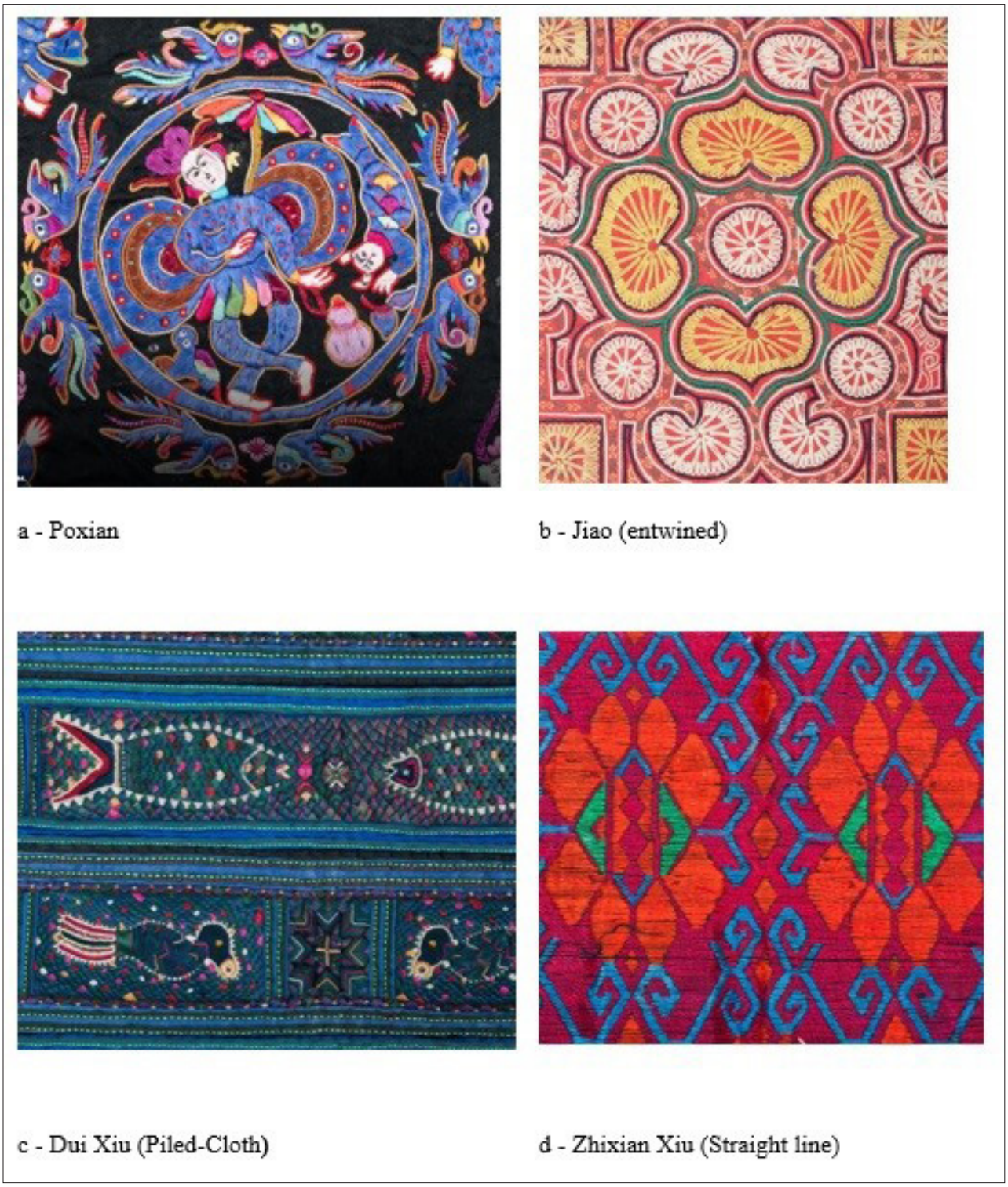

FIGURE 6. Styles of the Miao's needlework. Source: Museum of Ethnic Cultures.

The Poxian style embroidery (split thread) is used for special occasions – weddings, festivals. It takes 4-5 years of painstaking work to make. The pattern is embroidered with a flat stitch and edged with a tambour seam. The thread for needlework in the Poxian style is usually 1/8-1/12, sometimes even 1/16 of the standard thread.

FIGURE 7. The Poxian style description.

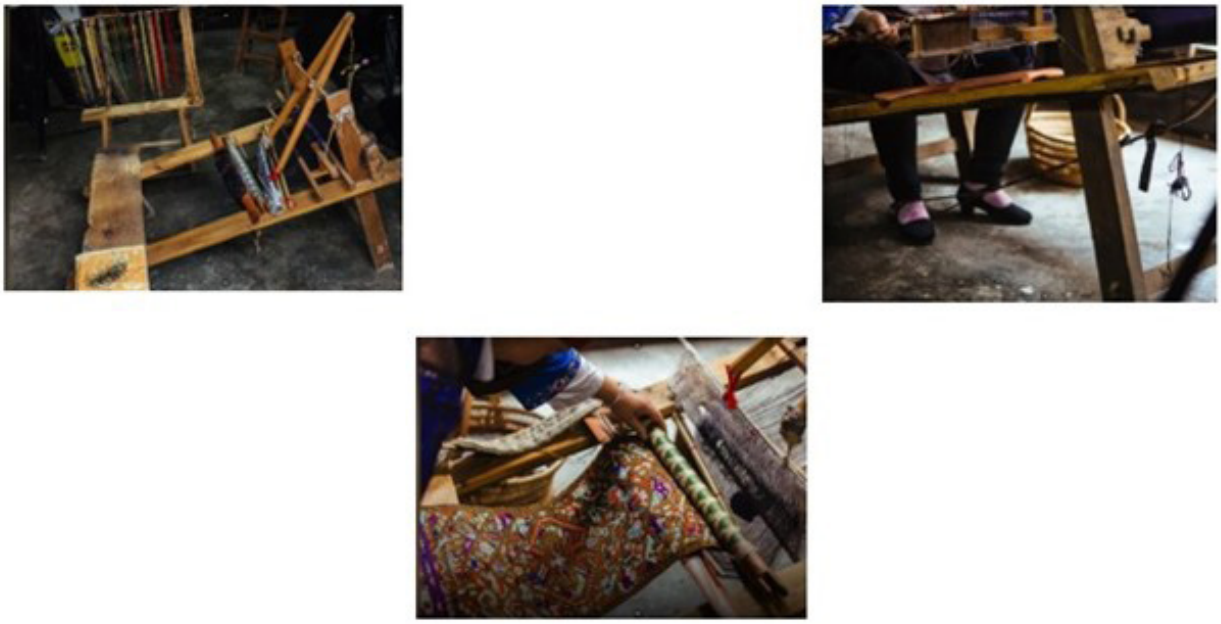

FIGURE 8. Brocade Weaving Machine. Source: Austin Kramer, Google Arts & Culture.

Styles of the Miao's needlework. This section introduces users to the most common styles of Miao's embroidery. Examples of images in different styles are presented in Figure 6.

Each style has a description, which is hidden under a spoiler (Figure 7).

Brocade weaving. This section offers a video series of sequential weaving steps based on Austin Kramer's photographs (Figure 8) accompanied by traditional Chinese music. The text for the video series is as follows: "Girls learn the art of weaving from their mothers from an early age. They start preparing a dowry from the age of 15. Embroidery and brocade are an important part of it. During festivals, women wear embroidered jackets and brocade aprons."

Festivals. It was agreed to make this section as simple as possible, in the format of photos from festivals supplemented with the names of the festivals.

Stage 3. The Application Project Plan

At this stage, the researchers teamed with a group of experts in the field of digital representation of artifacts. The experts discussed usability, design, and content issues for a future application. It was concluded that a website is the most economical option, requiring only regular content updates. It is easier to maintain, the required technology (PHP, (X) HTML, and CSS) is simpler and publicly accessible, and the website can be published more easily. Nevertheless, websites, even for mobile devices, lose out to applications in terms of usability. Applications exhibit enhanced efficacy in encompassing numerous essential functionalities requisite for the examination of cultural heritage, such as GPS positioning and camera integration. The choice of researchers and the group of experts was made towards a mobile application. Since Android and iOS (Apple mobile operating system) are the main platforms for smartphones, the experts recommended abandoning other platforms and developing an app for Android and iOS.

The experts agreed that it is necessary to shorten the text to the maximum since people usually do not read but view the application. In addition, using the application outdoors may be complicated due to the contrast. In this case, the text can be difficult to read at all. It is important to structure the text into small paragraphs and use tables, and lists.

The experts recommended using audio and video content, as they captivate users and can add an emotional background to cultural information. At the same time, the length of audio and video files is required to be as short as possible. Therefore, the file sizes are small and this reduces the size of the app itself. It is better to display location information (for example, about a festival) using an interactive map. Adding a hyperlink to a conventional Google Map could serve as a valuable remedy for users. Furthermore, facilitating a straightforward means for users to disseminate content through social media platforms is deemed advantageous.

An automatic update system was discussed as well. The system would regularly check and download content updates from the Internet without forcing users to download and reinstall the entire application. Testing the functionality of the application is required to be carried out at least once every six months.

In conclusion, it was decided to use some interactive techniques: pop-up questions to test the knowledge gained or an interactive function "Pick up a Miao outfit." The latter implies that artificial intelligence offers several clothing options, but asks to upload a selfie. In addition, gamification of some subsections may be an advantageous solution. For example, users need to assemble a puzzle showing the stages of weaving. It is also not superfluous to use scaling so that users can view every element in the smallest detail: lines of coloured thread woven between layers of twill to create a piece of brocade; drops of wax when creating batik; the expression of the characters' faces on embroidered battle scenes.

DISCUSSION

Interest in the Miao people has been increasing since the expansion of domestic tourism and its openness to the outside world. The active development of the tourism sector occurred in China in 1978. Nonetheless, it was only towards the close of the twentieth century that tourists initiated their visits to the Miao civilization. Due to the closeness and isolation of the Miao people from other populations, the study of their history and traditions was possible through symbols, religion, signs, and art. Xiao *et al.* (2018) and Yang (2019) explored the symbolism of the Miao culture, highlighting the design of souvenirs as the main component of the symbolism. Chun and Yang (2015) and Lili (2019) studied the Miao symbols in decorative dresses and clothing from the position of decoration.

It is observed that a principal quandary within the domain of conventional pattern analysis, encompassing that of the Miao ethnic group, resides in the underdevelopment of a theoretical underpinning for these investigations. This leads to a spread of knowledge and reduces the possibility of analysis and interpretation (Lili, 2019; Xiao *et al.,* 2018). In addition, the development of theoretical problems is crucial for sharing knowledge about the objects' specifics and developing historical studies of decorative art (which is a vast area of art heritage) (Yang, 2019). The present study attempted to fill this gap and provide a modern theoretical basis for the study of Miao's traditional patterns.

Although the scope of functions performed by patterns has decreased at this stage, this art form has not exhausted its possibilities for further development. In addition, in the context of the growing interest in the Miao culture, history, and values, it can be considered as a traditional decoration to the unique heritage of the future. Nevertheless, due to the relatively slow development of the Miao's traditional patterns, their names and semantics are preserved. Therefore, today the art of the Miao people has turned into a living artistic tradition. Thus, the research should be based on the experience of other peoples, cultural equality, perseverance, and the study of endangered elements. In this case, it is important to pay attention not to the traditional "preservation," but to its natural development.

This study aimed to define a dataset for further application design to study Miao's traditional patterns. To this end, the ESD approach was used, each next stage of the study was based on the results of the previous one. In the study by Ruiz-Calleja *et al.* (2023), and Fermoso *et al.* (2015), devoted to the application of CH, ESD was also used, where qualitative data were supplemented

with quantitative data obtained from several groups of informants. The informants in the work of Ruiz-Calleja *et al.* (2023) were teachers and students in different educational situations. Ruiz-Calleja *et al.* (2023) accepted as reliable those arguments and conclusions that were obtained from several data sources or different groups of informants. Fermoso *et al.* (2015), starting from the idea that open data published in an open format enriches their knowledge with other data on the web, offered the method to take advantage of semantic technologies such as ontologies or linked open data in collaborative e-learning. Fermoso *et al.* (2015) posited that semantic technologies can be powerful tools for information exchange and allow for generating knowledge for the integration of information about cultural heritage.

Fu *et al.* (2020) intended to bridge the gap between highly specialized experts and a wide audience and developed a set of design requirements for creating embodied knowledge and situational experience in virtual reality. An online survey and expert interviews showed the lack of effective promotion channels for CH. As in this study, the public was ready to learn more about CH, but the ways to gain the experience were insufficiently developed. Fu *et al.* (2020) presented a user-centric interactive virtual reality system that affords a digital exploration of a cavernous environment. This approach appears to demonstrate proficiency, particularly in the context of examining a designated cultural heritage site, namely the Dunhuang Mogao Grottoes, as evidenced in the study conducted by Fu *et al.* (2020). In addition, the participants of the preliminary survey conducted by Fu *et al.* (2020) confirmed their willingness to use VR technology. The public survey presented in our study showed that the overwhelming majority of participants agreed to use a mobile application or website to study cultural heritage (73%), whereas a significantly smaller number of participants (27%) were interested in the VR/AR/MR/XR experience. These results were decisive in the further design of the present study.

The study by Argyriou *et al.* (2020) was aimed at XR's presentation of the cultural heritage of Rethymno, Greece. It was reported that the gamified design provided participants with a high level of engagement during the study of the preserved fountains in the historical city of Rethymno (Argyriou *et al.,* 2020). The expert group in our study also recommended using games to improve participants' engagement in the learning process.

According to Hu and Pan (2020), associations between the user and digital content motivate the active study of CH and create a close "genetic link" between works of art and users. The Google Arts & Culture online platform contains images and videos of cultural artefacts from partner cultural organizations from around the world. Recently, the platform has added a new feature: "Is your portrait in a museum?" In this study, this idea was continued in the "Pick up a Miao outfit" function.

Limitations

This study did not include the testing of the mobile application. Moreover, the requirements for the design of the application were not described sufficiently and in detail. The development of an app was not planned before the start of the study, but its implementation was impossible without a clearly defined target audience. The absence of such guidelines is both an advantage and a disadvantage of this study. The advantage relates to an attempt to create a basis for learning traditional Miao patterns for a wide multinational audience with different income levels, knowledge, ages, and education. However, the application requires modifications to achieve more specific educational or tourist goals.

CONCLUSIONS

For the Miao people, one of the main ways to preserve and convey their history was a pattern. This study presented a set of data to learn the Miao's traditional patterns in digital form by a multi-age, multi-national audience. The dataset was curated through a synthesis of literature scrutiny and an online public survey under the guidance and coordination of the research and expert consortium. It is expected that it will serve as content for a mobile application or website with interactive features. The possible ways to increase the motivation and users' involvement are the gamification of some subsections, scaling function, outfit selection feature based on the user's photo, pop-up questions, hints, and small tests.

The minimum task that the research group set was achieved. The task was to select the content for the application and coordinate it with the expert group. Further research may focus on using the app for formal school education purposes by adapting its interface to motivate and engage participants. For example, a friendly robot in a Miao costume tells about the types of needlework and offers to take tests to consolidate knowledge. In addition, the application can be transformed into a digital tourist guide, in which a user can specify the city to see its historical objects, schedules, and fares, and choose routes on the map. Another idea that can be implemented based on the data presented in the article is modern interior design. Recently, there have been significant changes in indoor soft adornment design. These changes are related to national elements, which are considered carriers of modern decoration culture, giving interior space for living life, and forming different styles of interior decoration. Therefore, taking the Miao traditional design element as a starting point, the Miao traditional pattern in interior decoration design of innovative applications can be somewhat interpolated to the inheritance and protection of the Miao traditional pattern. At the same time, the proposed methodology is not limited to Miao's traditional pattern and is possible to be employed by any other CH sites.

DECLARATION OF COMPETING INTEREST

The authors of this article declare that they have no financial, professional or personal conflicts of interest that could have inappropriately influenced this work.

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AUTHORSHIP CONTRIBUTION STATEMENT

Shubei Qiao: conceptualization, writing – original draft, validation, visualization, supervision, project administration, formal analysis, data curation.

Yerbol Abdramanov: writing – review & editing, validation, software, resources, methodology, investigation, funding acquisition.

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