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Doctoral Dissertation

Study of Intangible Cultural Heritage Course on Mobile Application with Design Guideline and Game Elements

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Abstract

A fundamental issue facing the succession and development of Intangible Cultural Heritage (ICH) is how to make young people interested in and willing to inherit ICH. Education is an effective way for this purpose. The widespread use of smartphones and mobile applications has brought about innovative changes in ICH education. Mobile applications present ICH in an engaging and interactive way, helping enhance younger generation's interest in ICH. Thus, a reasonable course should be built to guide students in designing ICH mobile applications and to support their ICH learning.

Researchers have extensively studied on ICH learning on mobile applications. However, these studies have not explicitly proposed designing ICH mobile applications through an ICH design course or using game elements to design ICH mobile applications to support students' ICH learning.

The main objective of this dissertation is building a design course for ICH with mobile application to enhance students' learning and interest in ICH. To achieve this objective, this dissertation has set three sub-research objectives to: 1) explore an ICH design guideline for design students; 2) evaluate gamification elements for ICH mobile application; 3) demonstrate design practice of ICH mobile applications by combining ICH design guideline and game elements.

Sub-research objective 1 is to explore an ICH design guideline for design students. Students were guided to collect ICH cultural data, analyze ICH cultural information, and design ICH products according to the ICH design guideline. Results demonstrate the effectiveness of the ICH design guideline in ICH design courses, and the efficiency of interdisciplinary teams utilizing digital technologies beyond ordinary single-discipline teams under the ICH design guideline.

Sub-research objective 2 is to explore game elements for ICH mobile application. Students' scores for game elements were analyzed using a mixed model for linear analysis. Then the mobile application prototypes were divided into three clusters

through hierarchical cluster analysis based on expert evaluations. Interaction positively affected ICH mobile applications, while achievement had a negative effect. The findings on ICH mobile application prototypes indicate that interaction and storytelling promote young people's enthusiasm in ICH.

Sub-research objective 3 is to demonstrate the design practice of the ICH mobile application in an ICH design course by combining the ICH design guideline and gamification design. Based on experts' evaluations, the author conducted hierarchical cluster analysis on the prototypes and obtained three clusters. The ICH design guideline was effective for ICH mobile application prototyping. Combination of the game elements of interaction and storytelling yielded positive outcomes for ICH mobile application prototypes.

The primary contribution of this study lies in establishing an ICH design guideline based on Bronfenbrenner's EST. This guideline provides learning guidance on ICH knowledge for students through the design process. The author evaluated game elements, designed ICH mobile application prototypes, and used interaction and storytelling to support students' interest in ICH. The ICH design course will offer practical insights and effective tools for ICH educators to guide students and support their design processes. The assessment technique of the ICH prototypes will provide a basis for designing a gamification product or service for ICH.

Keywords: Intangible cultural heritage, design course, mobile applications, design guideline, gamification

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Chapter 1 Introduction

1.1 Research Background

1.1.1 Current status of Intangible cultural heritage (ICH) and issues with its inheritance among young people

ICH carries the history, culture and beliefs of a country or nation. It is a vivid expression of the characteristics of different nationalities, a witness to historical development, and a precious and important cultural resource. Preserving cultural heritage can maintain cultural diversity and strengthen cultural identity, national identity, and social cohesion (UNESCO Universal Declaration on Cultural Diversity, 2003; UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage, 2003). Unlike tangible cultural heritage, ICH (e.g., traditional skills, songs, dances, and rituals) is more difficult to preserve and transmit (Doulamis et al., 2017; Mortara et al., 2015; Ott et al., 2015; Song et al., 2019).

In particular, social transformation and urbanization have shifted from a traditional agricultural society to an industrialized and information-driven society, destroying the rural environment relied on by many ICH elements (e.g., folk songs, handicrafts, and festival customs). Changes in the social environment have led to changes in people's lifestyles, and ICH has become increasingly distant from people's lives (Zhang et al., 2023).

The development of modern technology has driven globalization and accelerated the spread of popular cultures, especially the rise of the digital entertainment industry that profoundly impacts modern lifestyles. It has led to a decline in young generation's interest in traditional cultures and a lack of awareness and motivation to protect and inherit ICH (Barghi et al., 2017; Li et al., 2021). ICH faces the risk of marginalization

or extinction due to a lack of successors.

Youngsters shall be involved in safeguarding ICH as the next generation is responsible for ICH preservation (Capecchi et al., 2024). Therefore, finding effective ways to attract younger generation's attention and increase their interest in ICH is an urgent and unresolved challenge.

1.1.2 ICH education is one effective way to promote ICH inheritance

In 2003, United Nations Educational, Scientific and Cultural Organization (UNESCO) promulgated *the Convention for Safeguarding of ICH*, which proposes the safeguarding and transmission of ICH through formal and non-formal education and positions education as the central discipline for safeguarding and management of tangible and ICH (UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage. 2003). Since then, the UNESCO Culture and Education Sectors have jointly launched the Living Heritage and Education Information Exchange (UNESCO ‘Living Heritage and UNESCO Information Exchange’, 2021), aimed at promoting living ICH through the synergistic development of ICH transmission and higher education. Hence, the knowledge, skills, and content of ICH shall be protected through education (Abdul Aziz, 2023; Cuenca, 2003; Wang, 2019; UNESCO ‘UNESCO Clearinghouse on Living Heritage and Education’. 2021) rather than freezing ICH in its pure and traditional form (Bouchenaki, 2003; UNESCO. ‘United Nations Educational, Scientific and Cultural Organisation Living Heritage and Education Information Exchange’, 2021; UNESCO Sustainable Development and Living Heritage). Education is one effective way to transmit and develop ICH in the contemporary society.

Integrating art and design education with the succession of ICH is considered more meaningful (Labrador, 2022). The succession and development of ICH involve interdisciplinary research across fine arts, design, folklore, communication, and history. In terms of art education, there are many convergence points between the ICH of traditional crafts in particular, and the major of visual communication design. For

example, the major of visual communication has course of ICH Patterns, ICH Brand Design, and ICH Cultural and Creative Product Design. The ICH Patterns course is about the transformation and reuse of traditional ICH elements. Students study ICH patterns, extract the symbols or graphics in the patterns, and redesign patterns using the symbols or graphics. The ICH Brand Design course is to design a modern image of ICH by combining traditional cultural preservation with modern branding strategies. The ICH Cultural Creative Product Design course is about the innovation and revitalization of ICH resources, where students use elements of ICH to design functional products. The principle of ICH design is to reconstruct and rebuild the ICH with a new language of art forms without changing the original living core of the ICH, to inject new vitality into ICH inheritance, and to make it a new cultural tradition.

1.1.3 Potential of mobile applications in ICH design education

However, encouraging students to learn ICH in ICH design education is a challenge, and researchers have been seeking methods to make the learning more enjoyable and engaging. The widespread adoption of smartphones and mobile applications has brought innovative changes to ICH education. These tools have broken down the barriers of time and space, and allow users to learn cultural heritage anytime and anywhere, significantly expanding the reach of ICH. They also present complex knowledge in an engaging and interactive way, which helps enhance awareness and interest, particularly among younger generations (Bidin and Abu 2013). Smartphones are very popular among students, and mobile applications are familiar to them, so learning ICH through mobile applications is an effective learning tool for students (Yidan et al., 2025).

Related studies on mobile learning for ICH education primarily focus on helping visitors' learn heritage knowledge through mobile applications (Bousbahi & Boreggah, 2018; Costabile et al. 2008; Lee et al., 2021; Lumpoon & Thiengburanathum, 2016; Zaibon et al., 2015), enabling students to learn heritage knowledge through mobile

applications in the classroom (Ruiz-Calleja et al., 2023), and exploring the potential of mobile applications to disseminate ICH among younger generations (Yidan et al., 2025).

However, these studies have some limitations, such as the use of images to present cultural heritage in the classroom to enhance cultural heritage learning, but no study has explored the gamified design for ICH mobile applications or how to establish learning guideline to guide students in ICH learning. Therefore, this dissertation aimed to develop a course that explores gamified elements in ICH mobile applications by creating an ICH guideline for design students, thereby promoting design students' ICH learning.

1.2 Research Objectives

The Main Research Objective (MRO) of this dissertation is building a design course for ICH with mobile application to enhance students' learning and interest in ICH. To achieve this goal, three sub-research objectives were set:

Sub-Research Objective 1 (SRO1): to explore an ICH guideline for design students;

Sub-Research Objective 2 (SRO2): to explore game elements for ICH mobile application;

Sub-Research Objective 3 (SRO3): to demonstrate design practice of ICH mobile application by combining ICH design guideline and game elements.

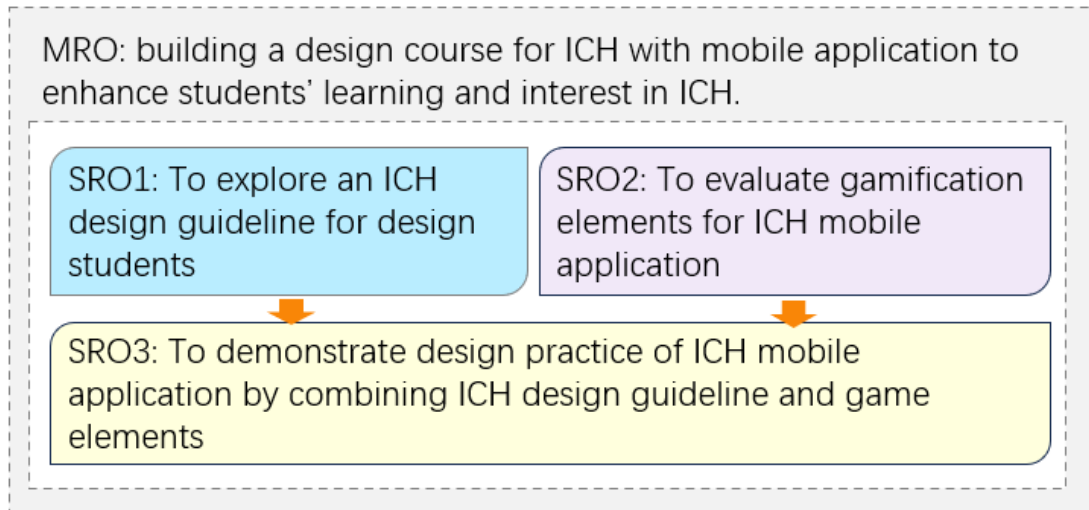


Figure 1.1 The relationship between three sub-research objectives

There is a relationship among the three sub-studies (Figure 1.1). Essentially, the realization of SRO1, SRO2 and SRO3 will achieve MRO. Figure 1.2 illustrates the relationship between the research question and the two sub-studies conducted in the research. Hence, Sub-research 1 was conducted to solve the SRO1 problem by constructing an ICH Ecological Systems based on Bronfenbrenner's ecological systems theory (EST) and an ICH design guideline based on it. It investigated how to use the ICH design guideline to instruct students to collect ICH cultural data, organize and analyze ICH cultural information, and design ICH products for ICH mobile applications. Therefore, the results of Sub-research 1 can answer SRO1 (Figure 1.2). For SRO2, Sub-research 2 focuses on investigating which game elements are important for ICH mobile applications and explores the possibility of using these game elements in the ICH mobile application prototype design. The results of Sub-research 2 could answer SRO2. Sub-research 3 presents the findings from Sub-research 1 and 2, and serves as a practical application and validation of the ICH Design Guideline and gamification design within the ICH Design course.

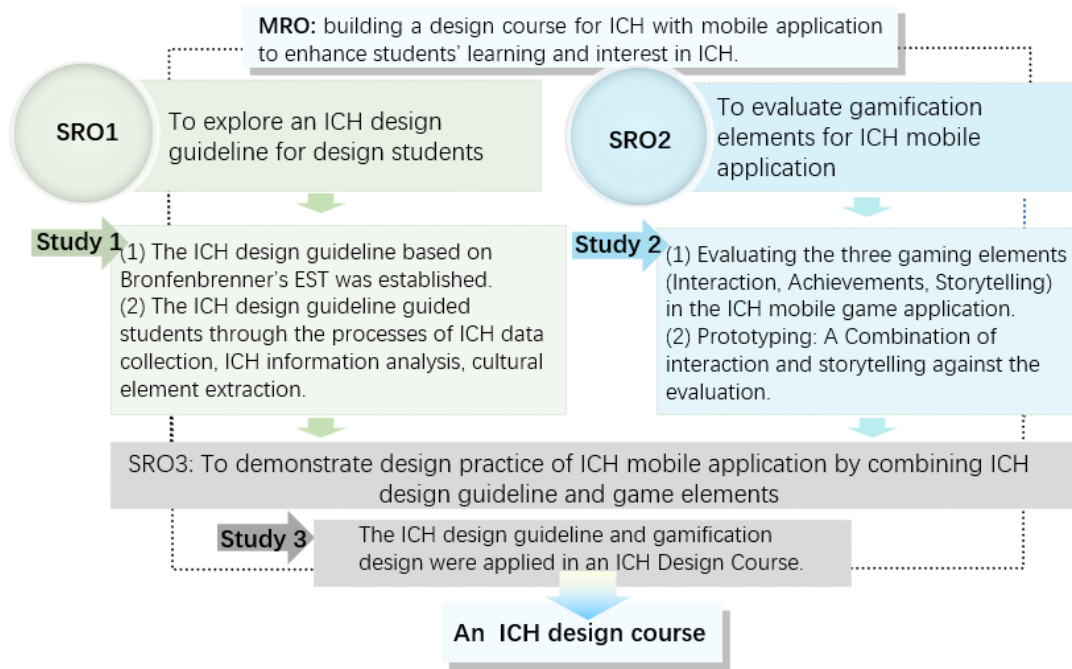


Figure 1.2 The relationship between research objectives and studies

1.3 Research Significance

This is particularly relevant that young people's lack interest, awareness, and understanding of ICH, so mobile applications can present complex knowledge in an engaging and interactive way, encouraging young people to learn ICH. Therefore, this study is aimed to build an ICH mobile application design course to support design students' ICH learning. The author explored an ICH design guideline to guide students in collecting ICH cultural data, analyzing ICH cultural information, and designing ICH products for ICH mobile applications. The author also explored game elements for ICH mobile applications to determine which game elements are crucial for ICH mobile applications, enabling to better design ICH mobile applications to support design students.

This study makes several important contributions to the literature. Although the importance of young people for ICH transmission has been recognized macroscopically both internationally and academically, UNESCO has organized several activities to highlight the importance of young people as the future protectors and transmitters of

ICH.

As far as the author is concerned, there is not enough research to increase young people's interest in ICH, especially design students. No guideline or tools are available in the literature on ICH to guide design students in collecting ICH cultural data, analyzing ICH cultural information, or learning ICH. The existing research on ICH education mobile applications focuses on utilizing mobile applications to enhance visitors' learning of heritage knowledge, using mobile applications to support students' learning activities within museums, and recreating cultural heritage through mobile applications, thereby supporting students' classroom learning of cultural heritage. Therefore, this study focuses on design students designing ICH mobile applications in ICH design courses through ICH design guideline and ICH gamification design, supporting students' ICH learning.

The ICH design guideline based on Bronfenbrenner's EST was established. This guideline provides students a learning framework for acquiring ICH knowledge through a structured design process. The approach evaluates game elements and designing prototypes for ICH mobile applications, and employs interactive and narrative techniques to stimulate students' interest in ICH. This research offers practical insights and effective tools for ICH educators to guide students and support their design processes. It provides a reference framework for educators to design and implement targeted professional development projects. The evaluation techniques for this ICH prototype will lay the groundwork for designing gamified ICH products or services.

1.4 Structure of this Dissertation

This dissertation consists of three parts with seven chapters. The first part consisting of Chapter 1 (Introduction) and Chapter 2 (Related works) is the background of the dissertation and related theories. The second part, which is the focus of this dissertation, consists of Chapter 3 to Chapter 5. This section introduces an ICH mobile application design course that includes ICH design guideline and ICH gamification

design. The third part consists of Chapter 6, which describes the conclusions of this dissertation, its contribution to knowledge science, and the outlook for future research. The details of each chapter are given below:

Chapter 1 (Introduction) presents an overview of this dissertation, including the background of this dissertation, the current situation of ICH design education, the problems faced, and the research significance.

Chapter 2 (Related works) presents the theoretical background of this dissertation. , and includes a literature review and definitions of certain terms.

Chapter 3 (Exploration of ICH Design Guideline in a Design Course) constructs the ICH Ecological Systems, and an ICH design guideline. Students were guided in collecting ICH cultural data and analyzing ICH cultural information by design guideline, and in designing ICH products for ICH mobile applications. The author also explored the efficiency of interdisciplinary teams using digital technology beyond ordinary single-discipline teams.

Chapter 4 (Investigation of Game Elements in ICH Mobile Applications) based on the ICH Ecological Systems in Sub-research 1 explored the importance of basic game elements in ICH mobile applications and analyzed the reasons for the differences. The author also explored the possibility of using these game elements in the prototype design of ICH mobile applications.

Chapter 5 (Design Practice of ICH Mobile Application in a Design Course) we implemented ICH design guideline and ICH gamification design in an ICH design course and surveyed the effectiveness of the course.

Chapter 6 (Conclusion) presents the conclusions of the three sub-research objectives and the conclusion of the main research objective. The author elaborates the academic and practical contributions of this dissertation and its contributions to knowledge science. Furthermore, an outlook for future research is provided.

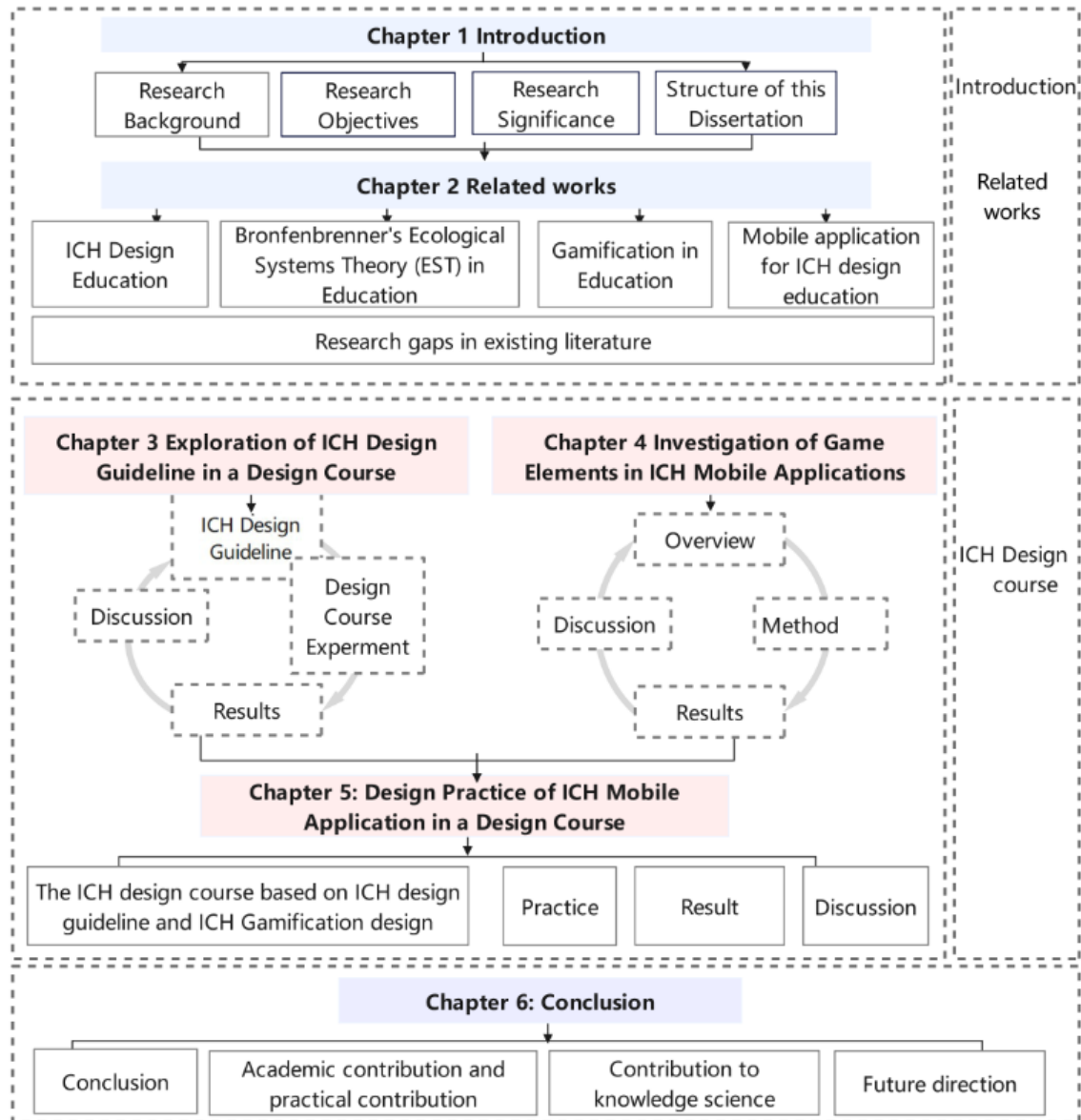


Figure 1.3 The research map and framework

Chapter 2 Related works

2.1 ICH Design Education

The UNESCO established in 1945 is dedicated to promoting international cooperation in education, science, and culture as a means of building peace. With the advancement of *the World Heritage Convention (1972)*, UNESCO realized that the long-term nature of heritage conservation required the involvement of youth groups. In 1994, UNESCO launched *the Youth Participation in World Heritage Conservation and Education Program* (Ri et al., 1994). It was an initiative to promote the interest and participation of young people worldwide in World Heritage conservation and education. Through school curricula, workshops, and activities, the program educates young people the values of World Heritage and encourages them to participate directly in ICH conservation practices. It aims to foster awareness and some of responsibility for cultural and natural heritage among the younger generation and to promote cross-cultural understanding and sustainable development.

The importance and urgency of safeguarding ICH were demonstrated when UNESCO promulgated *the Convention for Safeguarding of ICH* in 2003, establishing the first international treaty for safeguarding of ICH. *The Convention* places special emphasis on safeguarding and transmitting ICH through formal and non-formal education (UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage, 2003). In 2005, UNESCO proposed the *Convention on the Protection and Promotion of the Diversity of Cultural Expressions*, which encourages and raises understanding the importance in protecting and promoting the diversity of cultural expressions, and particularly encourages activities to raise public awareness of ICH through education (Jagielska-Burduk et al., 2021; Yang et al., 2024; Yi & Tan, 2020; Zdybel, 2021). The important role of education in safeguarding and transmitting ICH is increasingly being recognized (Bouchenaki, 2003).

In recent years, with the increasing awareness of ICH preservation, more and more researchers, educational institutions and designers worldwide have begun to explore how to integrate ICH into the design education system (Cozzani et al. 2017a; Zhou et al., 2022; Li & Xie, 2023; Gómez-ruiz et al., 2021; Tan et al., 2021; Yan & Chiou, 2021). This trend not only promotes the living transmission of traditional culture but also injects unique cultural connotations and innovative impetus into modern design.

On the topic of ICH education, a large number of valuable research results have been achieved (Dimitropoulos et al., 2014; Dimitropoulos et al., 2018; Martín & Cuenca. 2011; Merillas et al., 2018.; Pagán et al., 2020; Sinakou et al., 2019; Xu & Zou, 2022; Zhang et al, 2022).

Yan and Li proposed a strategy for ICH education (Yan & Li, 2023). Hung et al. proposed a framework for inheritance of lacquerware art education, focusing on the educational philosophy of lacquerware art and the cultivation of students' learning and skills regarding the cultural value of lacquerware. (Hung et al., 2021). They do not focus on how to support students' interest in ICH. Li et al. demonstrated the practice of inheriting and innovating bead embroidery courses (Li & Xie, 2023). Lu cultivated students' ability to create cultural and creative products and design new artworks incorporating ICH elements through design workshops (Lu et al., 2022). They emphasized that students acquired both explicit and implicit knowledge of ICH during the design process, and found students' misunderstandings about the application of ICH elements in the design (Lu et al., 2022). However, their research did not propose solutions to address the misunderstandings. Yan and Li proposed strategies for ICH education and cultural heritage transmission by analyzing the practical outcomes of cultural innovation in ICH education (Yan & Li, 2023). However, they did not explain how to guide students in designing ICH products, nor did they describe how to support students in learning ICH during the design process.

Clearly, the above research, lacks specific exploration on how to improve design students' collection of ICH cultural data and analysis of cultural information. Moreover,

there is no specific exploration on how to support ICH learning in the classroom, or the students' interest in ICH.

2.2 Bronfenbrenner's EST in Education

Students' ICH learning is influenced by many factors, such as personal interests, educational resources at school, and the social and cultural environment. Bronfenbrenner's EST helps systematically understand the multidimensional factors that influence ICH learning and reveals the interactive relationships between different levels of the environment.

In the 1970s, based on the theories of acknowledging environmental impact by Vygotsky et al., Bronfenbrenner proposed EST (Bronfenbrenner, 1974). Bronfenbrenner situated children's development within the relational system of their environment and identifies how the interactions and relationships between the components of the system affect children's development.

EST consists of an ecosystem of multiple domains: the individual at the system center, the microsystem (family, school, etc.), the mesosystem (connections between microsystem structures), the exosystem (external environments affecting the learner), the macrosystem (e.g., worldviews, political systems, cultural practices), and the chronosystem (a dynamic system of change) (Bronfenbrenner, 1994). Bronfenbrenner states that children's development is influenced by their surroundings and their interactions, and explains how the environment around children can help or hinder their continued development (Perron, 2017).

Microsystem: It covers the relationships and interactions between children and their surroundings (Berk, 2000). Microsystem includes the home, school, community, or childcare environment. At this level, influence is bidirectional: the environment influences the child, and the child influences the environment. For example, a child's parents may influence his beliefs and behaviors but the child also influences his parents'

behaviors and beliefs. This two-way influence is the strongest and has the greatest impact on the child.

Mesosystem: It provides links between the child's microsystem structures (Berk, 2000). Examples include the links between the child's teachers and parents.

Exosystem: It defines a larger social system in which the child does not directly function. Structures in this layer influence the child development by interacting with certain structures in the child's microsystem (Berk, 2000). For example, parents' workplaces or neighborhoods where activities do not directly involve the child do not directly impact the child, but he can feel influences from these environments.

Macrosystem: As the outermost layer of a child's environment, this layer consists of cultural values, practices, and laws (Berk, 2000). This layer will have a cascading effect on the interaction of all the other layers. For example, if laws bind parents to raise their children, this will impact the parents and therefore the children.

Chronosystem: This layer consists of the temporal dimensions relevant to the child's environment. Elements in this layer can be external or internal, such as temporal change in the external environment, which is an external factor that impacts the child. Physiological changes that occur as the child ages. All of these factors impact the child's development.

However, there are some shortcomings in Bronfenbrenner's EST. Payne (1991) believed that the EST has limitations and pointed out the weaknesses in its connection with the current social work values (Payne, 1991). Christensen (2016) pointed out this theory over emphasizes individual adaptation and fails to consider the impacts of globalization and technological development, which have different impacts on different parts of the world (Christensen, 2016).

Despite its many drawbacks, researchers have applied Bronfenbrenner's EST in various fields, especially in education (Drakenberg et al., 2013). Although this theory

originated from developmental psychology, it is useful for educational research because it provides practical applications for building better educational environments. Bluteau et al. (2017) described the interactive influence of socio-ecological elements on professional knowledge and understanding (Bluteau, et al., 2017). McLinden (2017) used this ecological model as a lens to analyze ‘proximal’ and ‘distal’ influences on part-time students and their respective learning experiences within a series of nested and interconnected ‘systems’ (McLinden, 2017). Patricia et al. (2017) used EST to describe the complexity of students' cross-professional field development (Patricia et al., 2017). Peppler et al. used EST to illustrate the factors influencing art making and extend the artwork's meaning of paintings (Peppler et al., 2023). They combined Papert’s constructionist concept of thinking through the object with Bronfenbrenner’s EST to create an artifact-oriented learning model, offering a holistic way to represent arts education literature and providing a new lens for organizing studies of learning in the arts (Peppler et al., 2023). There are also several studies that expand the model to some extent. Chkaif et al. (2022) extended the EST macrosystem to include global dimensions, generating a refined model of international education (Chkaif et al., 2022). Conceição et al. (2021) revised their study on the temporal system in EST to explain the personal growth and development of international students over time (Conceição et al., 2021). Elliot et al. (2016) proposed an academic acculturation model based on EST illustrating the transition between two ecosystems of a study-abroad sojourn (Elliot et al., 2016). Marangell (2023) applied the Person-in-Context (PiC) Framework (Volet 2001), adapted from EST, to present students' experiences (Marangell, 2023). The PiC model explores how the interplay of personal and environmental dimensions can contribute to active and productive learning. Xu and Tran (2022) extended the investigation of the person at the center of EST by employing the needs–response agency theory (Xu & Tran, 2022).

The EST-based studies above provide valuable insights into Bronfenbrenner's early use of EST in education. In particular, Peppler’s et al. (2023) interpretation of the reasons for art work creation in art education is crucial to understanding the influence

on art work creation in different cultural contexts and in different social contexts (Peppler et al., 2023). This research inspires me.

The ICH design work covers several fields of knowledge. It encompasses the history of ICH, national culture, ethnic beliefs, knowledge of art and design, and digital technology. The author applied EST to explain the different areas involved in students' ICH design learning, built ICH design guideline based on ICH Ecological Systems, and designed ICH mobile application prototypes.

2.3 Gamification in Education

2.3.1 Gamification

To increase university students' interest in ICH, the author considered activating their intrinsic motivation. Piaget, famous child psychologist and educator, put forward the cognitive development theory, stating that children can develop attention, memory, reaction, and problem-solving skills by playing games (Piaget, 1976). Play, as an important tool in human cognitive development, helps promote the social and cognitive development of children (Zdybel, 2021). Educational neuroscience research suggests that the best way to teach children is to consolidate their skills by playing, engaging their attention, participating, and receiving feedback (Sigman et al., 2014). Liang and Dong (2022) combined Piaget's theory with gamification training to improve children's cognition (Liang & Dong, 2022). Gamification activates children's intrinsic motivation.

Gamification refers to the use of game elements in non-game environments (Deterding et al., 2011; Huotari et al., 2017; Koivisto et al., 2019; Marache-Francisco et al., 2012) to infuse tasks and content with fun and excitement and thus to capture the viewer's attention or motivate the viewer. It was coined by Nick Pelling in 2004 (Marczewski, 2012; Rughinis, 2013), who sought to use gamified and enhanced interfaces for electronic trading and to make it more engaging and participatory, thus

creating game-like fun for trading.

It was not widely used until 2010 (Detering et al., 2011) and was applied in different domains to enhance user engagement and experience (Allam et al., 2015; Arai et al., 2014; Benito-Santos et al., 2021; Christy & Fox 2014; Denny, 2013; Dicheva et al., 2015; Domínguez et al., 2013; Fernandes et al., 2012; Hakulinen et al., 2013; Hamari, 2013; Hamari, 2016; Hamari & Koivisto, 2015a; Hamari & Koivisto, 2015b; Johnson et al., 2016; Jones et al., 2014; Kalogiannakis et al., 2021; Kara, 2024; Koivisto & Hamari, 2014; Kuo et al., 2016; Landers & Landers 2014; Laureyssens et al., 2014; Lee et al., 2013; Leitão et al., 2022; Marache-Francisco & Brangier, 2012; O'Donovan et al., 2013; Putz et al., 2020; Robson et al., 2015; Rocha Seixas et al., 2016; Ryan et al., 2006; Sailer & Homner, 2020; Sardi et al., 2017; Seaborn & Fels, 2015; Shen et al., 2022; Simões et al., 2013; Toda et al., 2019 a; Toda, et al. 2019 b), especially in the field of education (Aldemir et al., 2018; Bonde et al., 2014; Casanova-Mata, 2023; De-Marcos et al., 2014; Dicheva et al., 2015; Diéguez et al. 2024; Grangeia et al., 2019; Hamari et al., 2014; Hang et al., 2023; Hanus & Fox, 2015; Hendrix et al., 2013; Hakulinen et al., 2015; Grammatikopoulou et al., 2019; Putz et al., 2020; Sailer et al., 2020; Simões et al., 2013; Van Roy & Zaman, 2018). The implementation of gamification in education has been an intriguing area for many researchers as it is something familiar to students and draws their interest (Loganathan et al., 2019).

Gamification is not about turning primitive activities into games (Hamari and Koivisto 2015a), but is about using game mechanics to redesign the flow of activities so that people have more fun and engagement in what they are doing (Robson et al., 2015; Thomas et al., 2023). Gamification can increase motivation and engagement with the course (Hakulinen et al., 2015; Lee & Hammer, 2011; Hamari et al., 2016; Muntean, 2011). It can be used to motivate desired behaviors in education and help students achieve desired learning outcomes (Lee & Hammer, 2011; Simões et al., 2013; Van Roy & Zaman, 2018). As is well-documented, it stimulates the brain and facilitates knowledge acquisition, contributing to cognitive development. In addition,

gamification has many cognitive, affective, and social benefits (Domínguez et al., 2013; Lee & Hammer, 2011). Gamification can evoke senses of curiosity and disappointment (Lazzaro, 2004) and can potentially make non-game activities more fun (Grangeia et al., 2019), motivate people to complete tasks (Ryan et al., 2006), and keep them in a state of mind flow (Aldemir et al., 2018). We applied gamification to ICH design education to increase the interest of university students in ICH.

2.3.2 Game elements

Game elements are a collection of all relevant virtual information that may change during a game (Kuo & Chuang, 2016). They are elements found in most games, but not necessarily in all games. Game elements are crucial in gamification design, creating an engaging activity experience.

Achievement

Achievement is one common gameplay element in the game (Hamari et al., 2011). It contains badges, trophies, and leaderboard. It first appeared in games where players could earn badges or trophies after completing specific tasks. Badges appeared in MSN Games in 1996, where players could earn badges during the game (Deterding, et al., 2011). Badges can be regarded as the prototype of achievement. In 2005, the Xbox Live platform saw the first large-scale successful use of achievement in an online game (Deterding et al., 2011). Since then, achievement has been widely used in other domains (Filsecker & Hickey, 2014). A large number of researchers have studied achievements (Mekler et al., 2017).

Interaction

Interaction initially refers to a set of basic interactions that are repeated cyclically during gameplay (Mekler et al., 2017). It represents an active mutual relationship

between the player and the game (Groh, 2012.; Sedig et al., 2017). Through interaction, players engage with game information and perform cognitive activities, such as problem-solving, planning, decision-making, and learning (Sedig et al., 2013).

Storytelling

Storytelling, as a narrative technique, employs words, images or sounds to convey contents through various formats, including single-person narratives, multi-person dialogues, or character interaction to develop plotlines. This approach serves as an effective medium for imbuing contents with contextual meaning and purpose (Toda et al., 2019b). Through its immersive nature, storytelling facilitates audience engagement by drawing them into the narrative framework (Tan & Ng, 2024; Jemmali et al., 2018; Shang & Ni, 2023). Within the domain of cultural heritage, storytelling has emerged as a fundamental communication strategy, and is particularly effective in bridging the knowledge gap for audience unfamiliar with cultural contexts, facilitating the transmission of artistic, historical and cultural information (Torsi et al., 2020). Empirical studies demonstrate the efficacy of storytelling in museum settings and cultural venues, where it significantly enhances visitor engagement, immersion (Bormann & Greitemeyer, 2015), and stimulates interest in cultural exhibits (Sylaiou et al., 2020). Other research has applied storytelling into education to improve student learning (Salsabila & Maureen, 2022).

The above research implies that many studies have used gamification to increase young people's enthusiasm and participation in learning, but there is no exploration into improving students' interest in learning ICH in ICH design courses.

2.4 Mobile application for ICH design education

In recent years, the rapid development of mobile application technology and the increasing popularity of mobile devices such as smartphones and tablets have made

mobile applications a powerful tool. They are considered as a new potential tool for protecting ICH and connecting visitors, students, and other groups with cultural heritage (Li & Li, 2021). Combining mobile applications with ICH offers unparalleled advantages over traditional methods in terms of recording, showcasing cultural innovation, and promoting ICH (Zhang & Peng, 2020). In particular, mobile applications play a significant role in ICH education. They can present complex knowledge in an engaging and interactive way, making learning both enjoyable and easy to understand. This improvement helps enhance awareness and interest, particularly among younger generations.

The current research on ICH mobile applications focuses on three areas:

a) Mobile applications designed for ICH tourism. Researchers are exploring mobile applications to introduce heritage knowledge to users in an attractive way, promoting heritage tourism (Basaraba et al., 2019; Bousbahi & Boreggah 2018; Bhaskara & Sugiarti 2019; Cardoso et al. 2020; Ekonomou & Vosinakis 2018; Hiramatsu et al. 2017; Lee et al. 2021; Ma et al., 2024; Slavec et al., 2021).

b) ICH mobile applications for museum-based learning. Researchers aim to provide visitors with interactive and meaningful learning experience within museums (Arias-Espinoza et al., 2018; CIUREA et al., 2014; Mantzou et al., 2023; Piccialli et al., 2020; Xu et al., 2024).

c) Mobile applications for cultural heritage education in the classroom. These applications use images to enhance students' understanding of heritage and promote learning.

Specifically, research on mobile applications for cultural heritage tourism and mobile learning in museums is abundant. However, research on mobile applications for cultural heritage education in the classroom is relatively scarce (Chin & Wang, 2021; Lumpoon & Thiengburanathum, 2016; Ruiz-Calleja et al., 2023; Yidan et al., 2025).

2.5 Research gaps in existing literature

Through the above related research, the author has found that:

a) Previous research on ICH design education has focused on the construction of digital platforms to disseminate and teach ICH traditional skills, but few studies focus on ICH practice workshops. The current research lacks specific exploration into improving design students' collection of ICH cultural data, analysis of cultural information, and how to support their ICH learning.

b) The implementation of gamification in education has always been a topic of interest to many researchers. Previous studies focus on using gamification to enhance course engagement and participation to encourage desired behaviours in education, help students achieve expected learning outcomes, or encourage student participation. However, there has been no exploration into improving design students' engagement and interest in ICH in ICH design courses.

c) Mobile applications present complex knowledge engaging and interactive, making learning fun and easy to understand. They help improve students' cognitive abilities and interest. However, most studies on ICH design education mobile applications focus on learning in museums and heritage sites. There is little research on ICH mobile applications, and there is no research on students designing ICH mobile applications

Chapter 3 Exploration of ICH design guideline in a design course

3.1 ICH Design Guideline

ICH design involves many areas such as the history of ICH, ethnic culture, ethnic beliefs, knowledge of art and design, and digital technology. Currently, ICH design is limited in the classroom. The course does not provide students with comprehensive knowledge and information about ICH, and it emphasizes the expression of the design work while ignoring the derived meaning of the design work, which leads to students' superficial understanding of ICH and inaccurate ICH meanings in the design work.

Bronfenbrenner's EST provides a new perspective on organizing ICH design learning research. It emphasizes that learning occurs in a system that contains multiple nested domains (Bronfenbrenner, 1994). The system includes the learner at the center of the system; a microsystem centered on the individual learner; the mesosystem emphasizing interactions between environments in the learner's immediate environment; an exosystem emphasizing interactions between environments outside of the immediate environment; a macrosystem consisting of values and practices influencing interactions between the other layers; and a temporal system (Bronfenbrenner, 1994). The author created an ICH Ecological System based on EST, containing microsystems, mesosystems, exosystems, and macrosystems. This makes it easier for students to gather and understand the connections between ICH cultural data.

Based on the ICH Ecological System, a design guideline linking ICH learning was established. The author linked ICH learning through a design guideline that provided a structured basis for students to understand and collect ICH cultural data, analyze ICH cultural information, involve multiple disciplines in ICH property design learning, and create a dialogue between different fields. The guideline also provided a design method for students. The author constructed new assessment criteria for ICH design work that

incorporate cultural attributes. The evaluation criteria contain the following five criteria: cultural fit, creativity, aesthetics, experience, and diversity. Of these, cultural fit is an important component of cultural products (Chai et al., 2015), and creativity, aesthetics, and diversity are often evaluation criteria for assessing artifacts and creative products (Christensen et al., 2015). And diversity is one of the factors that affect product evaluation (Ozer, 2005). Experience is the criterion by which interactive products are judged. Then, in an ICH design course, the effectiveness of the ICH design guideline is explored, and we also explored the efficiency of interdisciplinary teams utilizing digital technologies beyond ordinary single-discipline teams under the guideline.

Therefore, this research aims to address two key research questions:

RQ1.1: How do ICH design guideline on the Bronfenbrenner's EST support design students learning about ICH?

RQ1.2: What differences do ICH design guideline based on the Bronfenbrenner's EST between an interdisciplinary approach with digital technology and in conventional approach?

The two main contributions of this study are as follows:

The ICH Ecological System used Bronfenbrenner's EST was made. Then, the ICH design guideline was established based on this system. The ICH design guideline based on Bronfenbrenner's EST provides learning guidance of ICH knowledge for students through the design process. Guided by the ICH design guideline, students collected ICH cultural data, analyzed ICH cultural information, and used ICH elements to reconstruct ICH products. Through this step-by-step process, students learned about ICH knowledge and were encouraged to understand ICH culture from multiple perspectives.

Second, the author constructed evaluation standards from five criteria: cultural fit, creativity, aesthetics, experience, and diversity, which can be useful for ICH educators. This study provided design aids and evaluation standards for ICH design education and

enriches the research field of ICH design education and teaching. This design course will offer practical insights or effective tools for ICH educators to guide students and support their design processes.

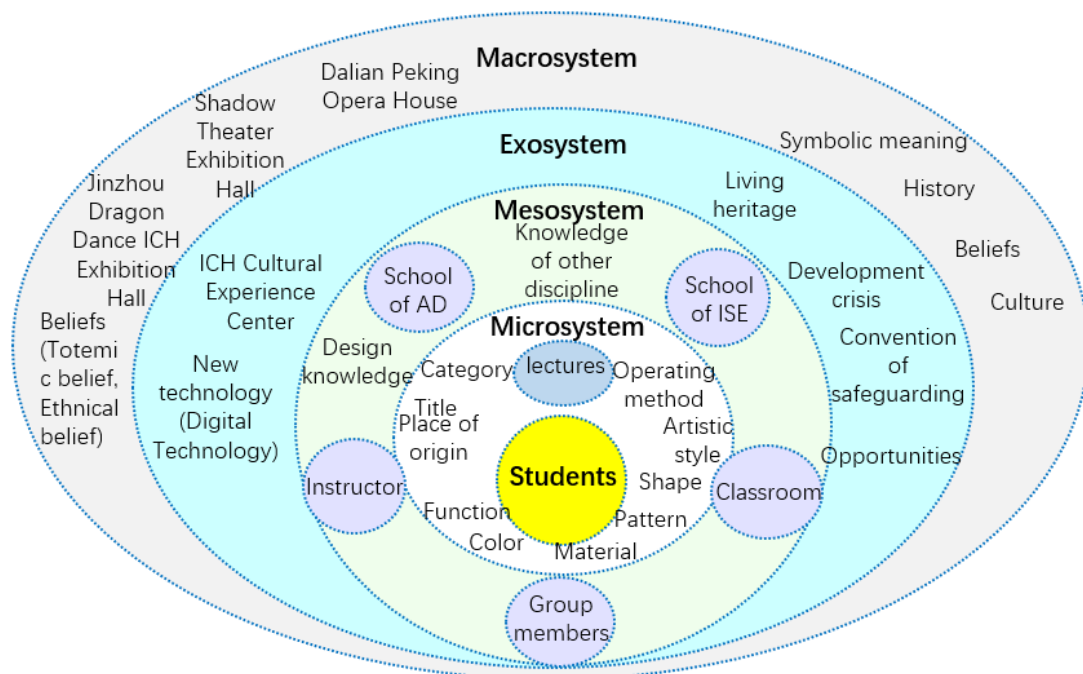


Figure 3.1 ICH Ecological system

ICH design refers to the design of intangible cultural resources based on their original culture, using modern compositions to derive derivative artifacts or culturally derived products with cultural connotations. ICH design is a highly practical course, different from other design courses because it cannot be divorced from the history, culture, and beliefs of the people who are the basis of the intangible cultural resources (Leong & Clark, 2003), requires a great deal of creativity and involves a wide range of knowledge and skills. An ICH Ecological System was used Bronfenbrenner's EST, which is a system of multiple nested domains (Figure 3.1). The relationship between the position of each domain in the ecosystem and the penetration and influence of each element is shown in Figure 3.1.

In this system, the student is at the main body of the classroom and at the center of the system. The microsystem is centered around the student as the subject. It includes

course resources and learning activities that the student is in direct contact with, such as the impact of what the instructor teaches in the classroom on the students, that is the "nearest" impact on the center of the system. Surrounding the microsystem are the activities that take place within the mesosystem. That is the interrelationships between students and their classmates, instructors, and the environment in which they are educated. The instructor's teaching in the classroom and the university teaching environment, the relationships between team members, and the university's support for the course are all factors that can have an impact on the relationships between the various elements of the mesosystem. The exosystem does not have a direct effect on the center of the system, but because it encompasses the context in which teaching and learning take place, the policies for the preservation and transmission of ICH, the policies of institutions of higher education, the emergence of new technologies, and so on, it therefore has an indirect impact on the center of the system—the learning of students. At the same time, it also affects the relationships between various elements in the system. The macrosystem describes the broader cultural context of ICH, encompassing its history, ethnic beliefs, etc. It provides background knowledge for students' learning. It's noted that, due to the short duration of our course, the chronosystem was not set up.

The ICH design guideline (Figure 3.2) was constructed based on Bronfenbrenner's EST and previous research (Chai et al., 2015; Christensen et al., 2015). We separated the students who served as the center of the system and grouped the ICH related information into four systems. First, the microsystem contains basic information and characteristics (e.g., shape, pattern, color, style, material) about ICH. Second, the mesosystem includes mutual learning and influence among students. Third, the exosystem consists the current problems encountered by ICH, mainly including the dilemma and requirements of ICH, and the opportunities brought by the development of digital technology. Fourth, the macrosystem contains the historical and cultural knowledge of ICH.

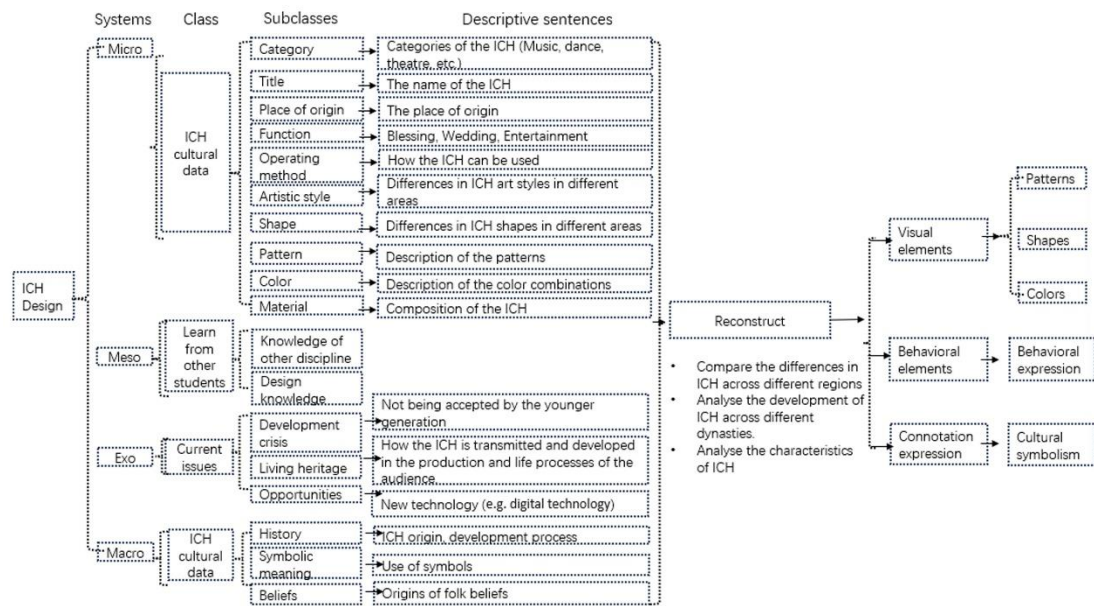


Figure 3.2 ICH design Guideline

In addition, in this design guideline, based on the cultural specificity of ICH, we proposed to reconstruct the three levels of ICH design work as follows: cultural identity, behavioral elements, and connotation expression. These levels can guide students in the early stages of the design process and help them make informed decisions by examining cultural identity, behavioral elements, and connotations of previous use.

3.2 Design Course Experiment

3.2.1 Design of the practice

Course Plan

The ICH design course spanned 5 weeks, with each lesson lasting 3 h, and contained 16 sessions (e.g., 3 lessons in the first 4 weeks and four lessons in the last week). This course applied both the interdisciplinary approach with digital technology and the conventional teaching methods to compare their effectiveness. The author structured the course design and divided the design section of the student project into four phases. The design process includes four stages: (Stage 1) divergent thinking,

(Stage 2) convergent thinking, (Stage 3) design implementation, and (Stage 4) design work presentation and evaluation. The schedule and tasks for ICH design course are listed in Table 3.1.

Table 3.1 Schedule and task of the course

Week	Focus of the week	Tasks	Assignment
1	Lecture1(ICH-related information- VC teacher) Lecture2(Methods of ICH design- VC teacher) Divergent thinking (Search for ICH-related information) Applying the guideline Survey- Cultural Places For ID teams: Lecture by ISE teacher	T1: Examples of design work, T2: ICH information T3: Each team shall choose one ICH, check its background information and related design works, and analyze the design methods of its design works.	Presenting information on the selected topic, and analyzing of related design works
Stage 1 Divergent thinking			
2	Generating ideas (Follow the design guideline) Forming a mind map based on generated ideas, For ID teams: Acquiring some knowledge about digital technology from a lecture	T4: Team discussion to brainstorm and generate as many ideas as possible, draw a mind map, and report the results T5: Team members explain the process of idea formation.	Mind map
Stage 2 Convergent Thinking			
3	Summarizing ideas based on mind maps Sketching For ID teams: Running experiments to test specific equipment (motion tracking or lighting)	T6: Each team is asked to draws sketches T7: Team members explained the process of forming the sketches. (ID teams present the process of the experiment and the problems encountered)	Sketches
Stage 3 Design Implementation			
4	Electronic sketches	T8: Each team is asked	Electronic sketches

	For ID teams: Implementing technical functions	to draw e-sketches (ID teams to present how the visual design section is combined with the technology, and the problems they encountered.)	
Stage 4 Design work presentation and evaluation			
5	Finishing the design work Experiencing and evaluating each other's design work	T9: Teams are asked to produce objects. Teams report on their designs and make suggestions for other teams' designs.	Outcomes (Creative products or art installations)

Use of the ICH Design Guideline

In the first stage (divergent thinking stage), students collected ICH cultural data from the microsystem (the immediate environment, such as the instructor's lecture), exosystem (external environments that affect the individual, Such as the use of new technologies to showcase ICH in cultural places, or government policies for safeguarding ICH, or international conventions for the protection of ICH), and macrosystem (broader cultural attitudes and societal values). In the second stage (convergent thinking stage), students analyzed the ICH cultural information (Figure 3.2), formulated design options, and drew sketches. The extraction of ICH cultural data can be categorized into three areas: basic information (e.g., shape, color, and pattern); development status and challenges faced; and connotations related to spiritual and symbolic culture.

Students will collect ICH cultural data, analyze ICH cultural information, and design ICH products. Students should focus on the origins and original functions of ICH, its meaning, and forms of expression. They may deepen their understanding by comparing differences in shape, color, and behavior among similar categories of ICH from different regions. Furthermore, by examining the development and evolution of

ICH across various dynasties, students can trace shifts in its meaning over time.

The ICH design necessitates imaginative interpretation rather than simply repeating the interpretation. The students are encouraged to use divergent thinking and to generate multifaceted ideas by considering diverse perspectives and directions. They can achieve this task in three ways:

- a) Visual elements: The students use the principles of formal beauty to deconstruct and reconstruct external cultural features (patterns, colors, shapes) and to create an attractive visual appearance.
- b) Behavioral elements: They focus on behavioral elements in the ICH and consider incorporating digital technologies to transform them into design outcomes;
- c) Connotation expression: They transform the intrinsic cultural elements into design outcomes, and particularly focus on spiritual dimensions and conveying cultural symbolism.

The students then transform the creative concepts generated in the transformation phase into design outcomes. At this step, the students are influenced by their classmates in the mesosystem and by new technology, especially digital technology. Consequently, they think about ICH design from the perspective of technology and materials.

Assessment Method

The author constructed evaluation criteria for the ICH design course by considering ICH education and the design of the ICH product. Chai et al. (2015) studied the relationship between traditional cultural elements and customer satisfaction (Chai et al., 2015). Their study showed that local cultural elements and cultural elements that can resonate with are most likely to enhance product satisfaction (Chai et al. 2015). Christensen et al. (2015) indicate that creativity and aesthetics are distinct factors in product evaluation, where creativity encompasses novelty and aesthetics refers to

typicality (Christensen et al., 2015). Hassenzahl (2010) noted that experience is crucial for evaluating products. (Hassenzahl, 2010). Diversity is one of the factors that affect product evaluation (Ozer, 2005).

ICH design works belong to cultural products, but they are different from ordinary cultural products. Whether they express the cultural meaning of ICH is an important criterion for evaluating ICH design works. Therefore, the author established new evaluation criteria (Figure 3.3).

Criteria	Detailed contents	Example
Cultural fit	Meaning of the visual part	Redesigning traditional patterns based on symbols
		Using traditional colors
	Meaning of the behavioral part	Behaviors in rituals Actions in dance Behaviors in opera
Creativity	Novelty	Novelty
	Originality	Non-copying
Aesthetics	Color artistry	Followed the principles of formal beauty
	Pattern artistry	
Experience	Interaction	Immersion/ Arousing audience interest
	Entertainment	Arousing audience interest
Diversity	Diversity of expression	Combination of traditional elements and modern design
	Diversity of interaction	Modern technological methods to present traditional culture

Figure 3.3 Evaluation standard for ICH design

The first criterion is the cultural fit. The core of ICH design works is to carry cultural attributes. In traditional Chinese cultures, the use of graphics, colors, and behaviors becomes a subjective symbol and icon and is endowed with emotions and cultural concepts. The design of ICH needs to be innovative by following its intrinsic meaning. The key to testing an ICH design work is to see if the design fits the cultural nature of ICH. There are two ways of testing. In the visual aspect, the designer recombines traditional colors and reconstructs traditional patterns based on symbolism. In the behavioral aspect, the designer presents the behavioral parts shown in rituals or plays in other ways.

The second criterion is creativity which is one of the most important criteria for testing the quality of performance of art and design works. Creativity means whether or not a student creates his/her design independently, rather than copying someone's design. Novelty is an important feature of creativity (Jagtap, 2019), and refers to whether the designer has applied a new idea, design method, or way of expressing a design (Cascini et al., 2022). For example, if a student takes a symbol from a traditional motif not used in other works and applies it to a new design. It is also considered to be a novelty if the student applies a design method that has been applied in other fields but not in the field of ICH.

Aesthetics is the expression of the unique aesthetics characteristics of a design work. It includes the artistry of pattern and color. It is used in product evaluation (Christensen et al., 2015). An ICH design work involves the reconstruction of the stylistic design of the pattern and the recombination of colors to achieve the beauty of harmony.

Experience is crucial for evaluating products (Hassenzahl, 2015). It includes interaction and entertainment. The purpose of the ICH innovative design is to generate interest in ICH. The interactive part and the entertaining part of a work are to increase the immersion and interest of the participants respectively.

Diversity indicates the extent to which people are exploring the design work. It contains a variety of creative processes and expressive forms in design works. The innovative design of ICH is often presented by combining traditional culture and modern design. Designers use digital technology to display traditional culture or use modern composition to redesign it to meet the aesthetic standards of contemporary people.

3.2.2 Practice implementation

Participants

The comparative practice was approved by the university in Dalian, China, in December 2021. Thirty students participated in ICH design course, hailing from this university, including 22 women and 8 men. There were 24 fourth-year students from the Visual Communication Design Department (VC), 3 Master students from the Design History and Theory (DHT) department of the Art and Design School, and 3 were third-year students from the Lighting Department of the School of Information Science and Engineering (ISE). Participation in the study was voluntary, and all students were informed about the aims of the experiment and had the option to withdraw from the experiment at any time. We set up four teams: two interdisciplinary teams (ID1 and ID2) and two visual communication teams (VC1 and VC2). Therefore, the ID teams used interdisciplinary approach with digital technology, although the VC teams used conventional single-discipline approach. We randomly assigned the students to the four teams, with ID teams composing students from VC, ISE, and DHT, while VC teams consisted solely of VC students. Each team followed a distinct course plan. The ID teams and the VC teams attended lectures from a VC teacher during the first week. The ID team also attended a lecture by an IST teacher and gained some knowledge of digital technology.

Topics in North China Culture

The university, located in Northern China, is surrounded by significant ICH practices and artistic expressions. Students chose a representative ICH, including Shadow Play, Dragon Dance, Lion Dance, and the Legend of the White Snake. Shadow Play, a traditional form of theatre, was used first to disseminate the Buddhist concept of karma and reincarnation, and later was transitioned to secular stories. The Dragon Dance, originally a rain ritual, was integrated into a festive entertainment trend, specifically the Lantern Festival. The lion's reverence traces its origins to Chinese Buddhism, where it symbolizes protection from disasters. The Lion Dance, initially a part of military performance, gradually diffused into folklore. The Legend of the White Snake, one of the four great Chinese love folklore legends, is often presented as a piece

of Peking Opera repertoire. However, with the development of society, electronic products based on sound and light have replaced traditional forms of entertainment. These four traditional forms of performance cannot arouse people's interest. They lack creative products and are gradually moving away from people's lives.

These four teams visited and investigated a Cultural Place during the first week of the course (Figure 3.4). The purpose of the investigation was to collect information related to the topic. The ID1 Team surveyed the Ancient City of Fuzhou, which is a cultural park where the origin and development process of Fuzhou Shadow Play is displayed in the Shadow Theater Exhibition Hall. Students carefully observed the stylized features of the characters in the Shadow Play and collected relevant information. The ID2 team visited the Jinzhou Dragon Dance ICH Exhibition Hall, where students took notes on the props of the Dragon Dance, especially the shape of the dragon head. The VC1 team visited the Dalian Peking Opera House. The manager introduced the students to the dressing of the Peking Opera "Legend of the White Snake". Students learned about the characteristics of the Peking Opera headdress and costumes of the "Legend of the White Snake" and took detailed notes. The VC2 team visited the ICH Cultural Experience Center, where valuable props of the Lion Dance were presented. The students documented their visit through photos and writing.

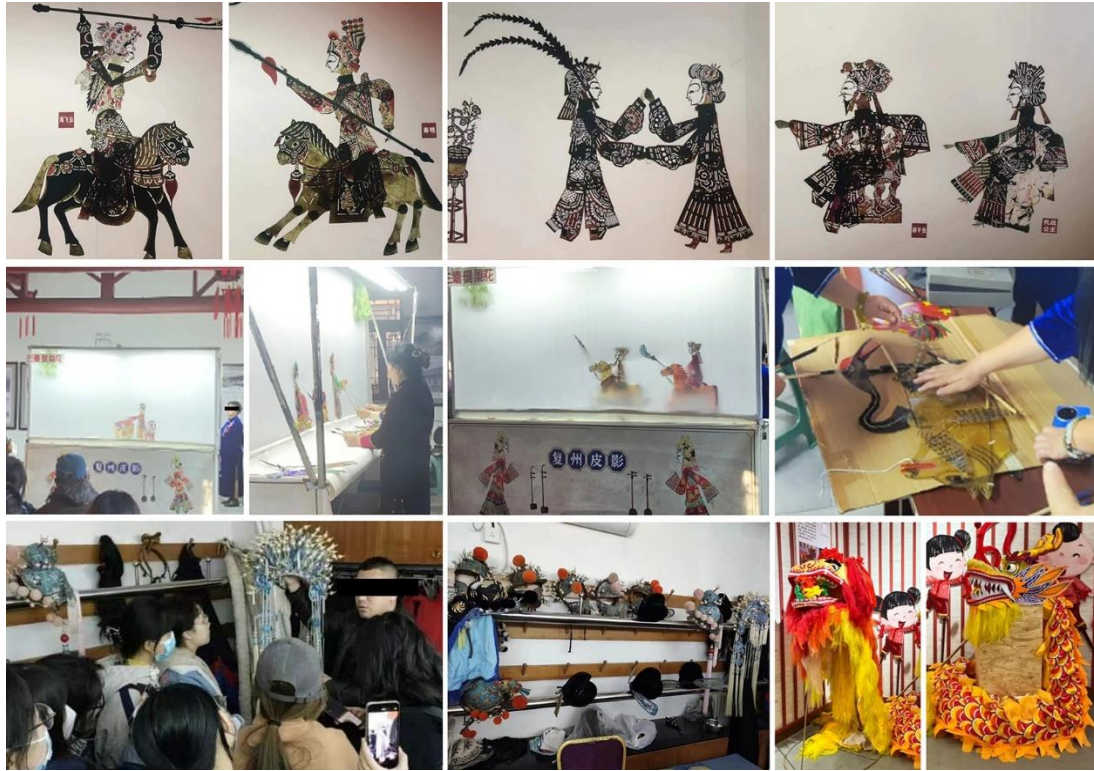


Figure 3.4 Visited and investigated Cultural Place

Evaluation Method

Expert assessment of four teams at four stages of design

Two associate professors and one professor with graphic design backgrounds from the visual communication design department were invited. With more than ten years of work experience in the design field, they all have published several academic papers, and have been involved in many evaluation projects.

In stages one to four, the experts were asked to evaluate the mind maps, sketches, electronic sketches, and final designs. They assessed the outcomes of each team at each stage across the five criteria: cultural fit, creativity, aesthetics, experience, and diversity (Figure 3.3). Notably, the experts did not assess the aesthetics and experience in the first stage, which were considered inappropriate.

Each expert assessed the designs of any team in a random order to avoid order effects. For each stage and aspect, the experts used a seven-point Likert scale to assess the design work. There was no discussion among the experts, which ensured independent evaluation.

Interview

One week after the course, the author conducted focus group interviews with all participants via Tencent meetings. Focus groups facilitate dynamic group discussions and information collection (Alshenqeeti, 2014). This approach encourages students to consider aspects they may not have considered individually. The interview in each group lasted 10-15 min, during which the students were asked to answer two questions as follows: (1) Please review the creative process and how ideas are generated, and (2) please tell us what you think about the ICH design guideline. The interviews were recorded on transcribed and translated videos. The author collected and analyzed relevant data. Open-ended responses were coded and categorized using inductive qualitative analysis. In this process, the responses from the students were divided into small paragraphs of texts and labeled with open codes that were used to summarize the themes in each paragraph. These interviews provide valuable insights into teaching and learning from the students' perspectives, and help better analyze the underlying reasons (Alshenqeeti, 2014; Fontana & Frey, 2000).

3.3 Results

3.3.1 Final design of interdisciplinary team

For the final design of the interdisciplinary team, team ID1 made a design for the Dalian Fuzhou Shadow Play (Figure 3.5, Figure 3.6, Figure 3.7, Figure 3.8) and used digital technology to design a Shadow Play film related to its history. Team ID2 made an innovative design for the Dalian Jinzhou Dragon Dance using digital technology

(Figure 3.9, Figure 3.10, Figure 3.11, Figure 3.12) and integrated Dragon Dance into a music video game. Both design works were interactable.

 Basic information	Category	Traditional theater
	Title	Shadow Play
	Place of origin	Unknown
	Function	Buddhism Propaganda
Micro	Operating method	Actors maneuvering shadow figures behind a curtain
	Artistic style	Exaggerated character modeling.
	Shape	Facial Characteristics of Shadow Figures: Wide forehead, high bridge of nose
	Pattern	Auspicious pattern
Meso	Color	Five colors: black, red, green, yellow, white
	Material	Donkey or cowhide
	Learn from ISE students	Digital technology
	Learn from VC students	Principles of formal beauty
Exo	Learn from DHT students	Design theories
	Development crisis	Replaced by other entertainment programs
	Living heritage	Shadow Play creative products, Shadow play animation film
	Opportunities	Digital technology
Macro	History	Origin of Shadow Play
	Symbolic meaning	Different colors symbolize different characters
	Beliefs	Origins of folk beliefs

Figure 3.5 ID1's design work: ICH for Shadow Play-ICH guideline results

Micro	Comparison of the shapes and patterns of shadow play in different areas.			
	 Northwest		 Northeast	
Exo & Macro	Shape		pattern	
	The Development of Shadow Play in Different Dynasties		South	
Exo & Macro	Han Dynasty and Tang Dynasty		Ming Dynasty	
	Song Dynasty		Modern Society	
Exo & Macro	Jin Dynasty and Yuan Dynasty		North	
	Characteristics of Fuzhou Shadow Play			
Exo & Macro	平面性		地域性	
	戏曲性		皮影戏人偶的美学特点	

Figure 3.6 Analysis results of ICH cultural information of ID1

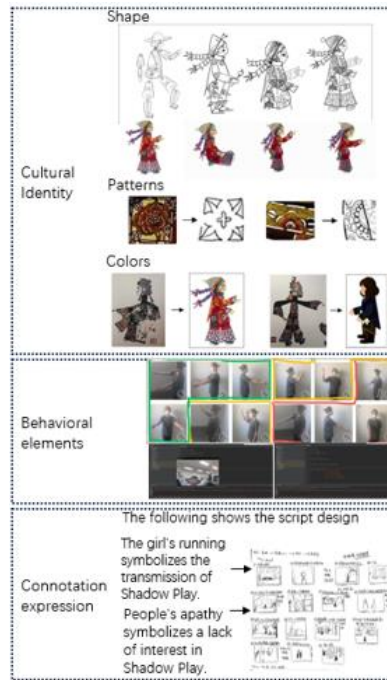


Figure 3.7 sketches of ID1's final design work

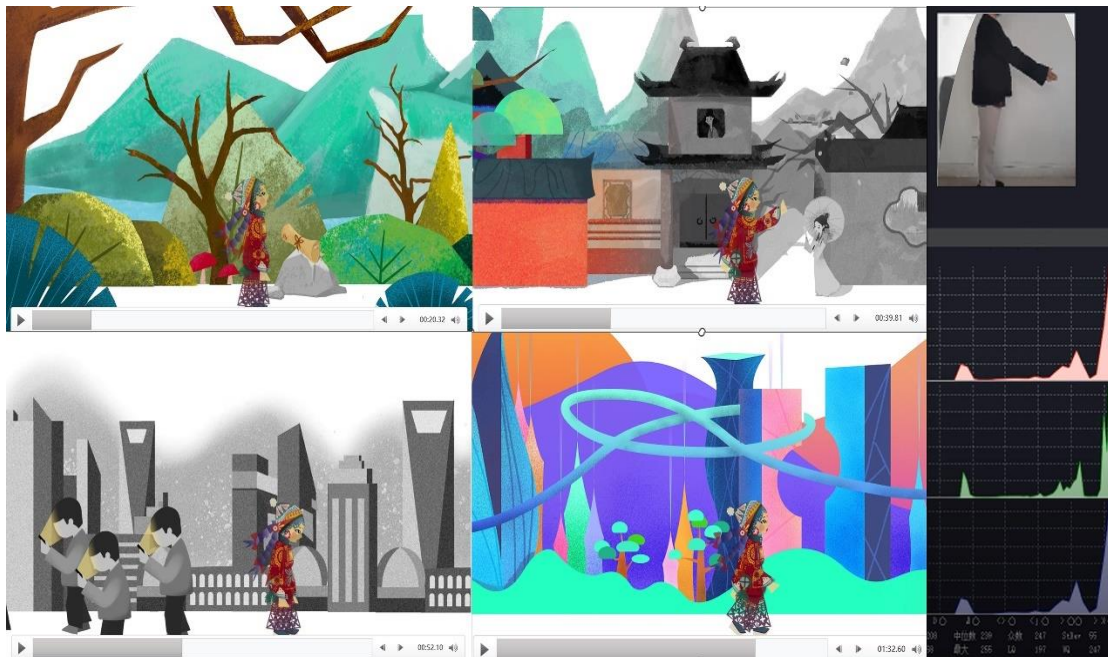


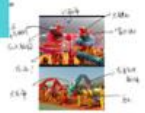
Figure 3.8 ID1's final design work: designing a Shadow Play film relating to the history of Shadow Play with motion capture

	Basic information	Category	Traditional dance
		Title	Dragon Dance
		Place of origin	Ximenwai Village
		Function	The ritual of praying for rain-entertainment
		Operating method	Actors dancing cloth dragons
Micro	Form information	Artistic style	Rough and has strong features of the ethnic cultures of the North
		Shape	The dragon's mouth is longer
		Pattern	Dragon scales (splints from a fishbowl)
		Color	Yellow, white, green, red and black
Meso	Learn from other students	Material	Paper Materials-Cloth material
		Learn from ISE students	Digital technology
		Learn from VC students	Principles of formal beauty
		Learn from DHT students	Cross media theory
Exo	Current issues	Development crisis	Replaced by other entertainment programs
		Living heritage	No
		Opportunities	Digital technology
Macro	Culture knowledge	History	Origin of Dragon Dance
		Symbolic meaning	The yellow dragon is the most honorable.
		Beliefs	Origins of folk beliefs

Figure 3.9 ID2's design work: ICH for Dragon Dance-ICH guideline results

Comparison of the patterns and dance movements of Dragon dance in different areas.

Pattern



Northern



Southern

Dance movements



Jinzhou



Anhui



Tongliang



Zhejiang



Shanwei



Nanxiong

The Development of Dragon dance in Different Dynasties

The functions and meanings

past



today



Characteristics of Jingzhou Dragon dance



The Origin of Jinzhou Dragon Dance



Shape characteristics



Meaning

Figure 3.10 Analysis results of ICH cultural information of ID2

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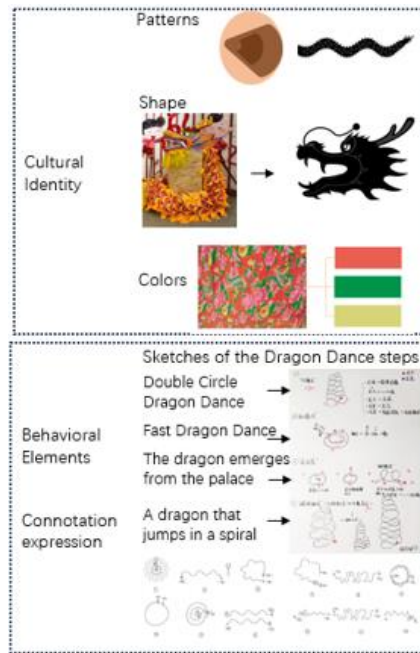


Figure 3.11 Sketches of ID2's final design work

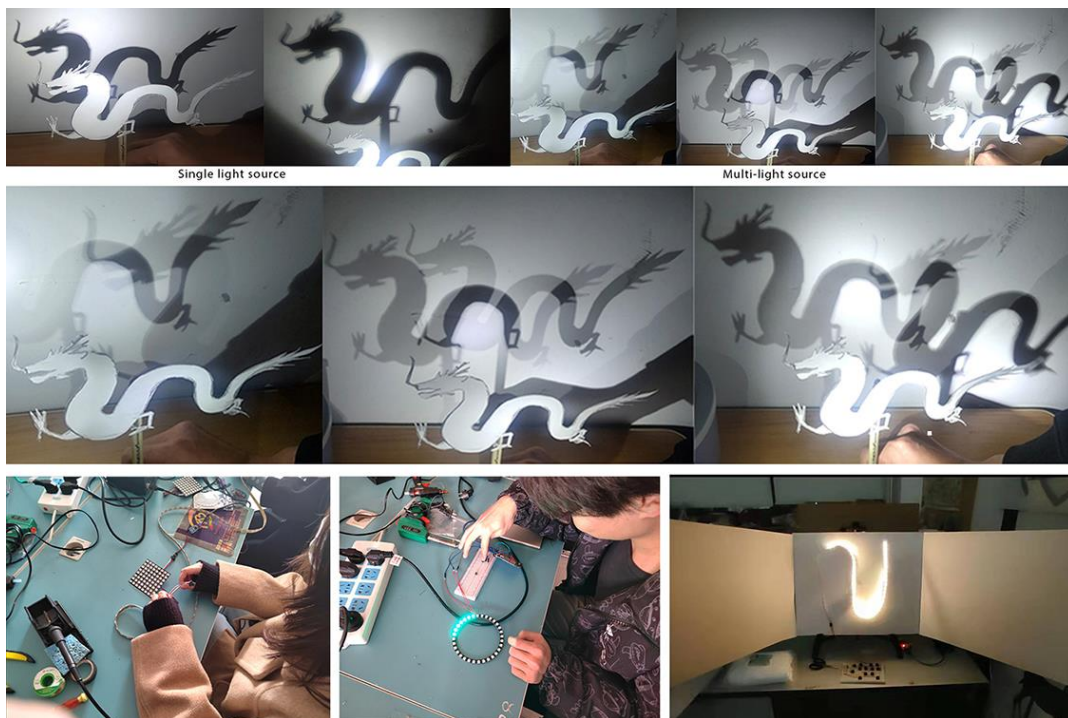


Figure 3.12 ID2's final design work: Integrating Dragon Dance into a music video game

3.3.2 Final design of single-discipline team

Team VC1 produced White Snake Intellectual Property (IP) image designs, illustrations, and cards related to the Legend of the White Snake (Figure 3.13, Figure 3.14, Figure 3.15, Figure 3.16). Team VC2 made an innovative design for the Dalian Jinzhou Lion Dance (Figure 3.17, Figure 3.18, Figure 3.19, Figure 3.20), and used elements of lion dance to make several posters about traditional festivals and puzzles.

Folk legend	Basic information	Category	Folk legend
		Title	Legend of the White Snake
		Place of origin	Unknown
Micro	Form information	Function	Folk legend
		Operating method	Fiction
		Artistic style	Folk legend, no images
		Shape	Folk legend, no images
		Pattern	Folk legend, no images
		Color	Folk legend, no images
Meso	Learn from other students	Material	Folk legend, no images
		Learn from VC students	Principles of formal beauty, color combination, design pattern
Exo	Current issues	Development	Young people are not interested in the Legend of the White Snake
		Living heritage	Movies, TV series
Macro	Culture knowledge	History	Origin of Legend of the White Snake
		Symbolic meaning	Different colors symbolize different characters
		Beliefs	Origins of folk beliefs

Figure 3.13 VC1's design work: ICH for Legend of the White Snake-ICH guideline result

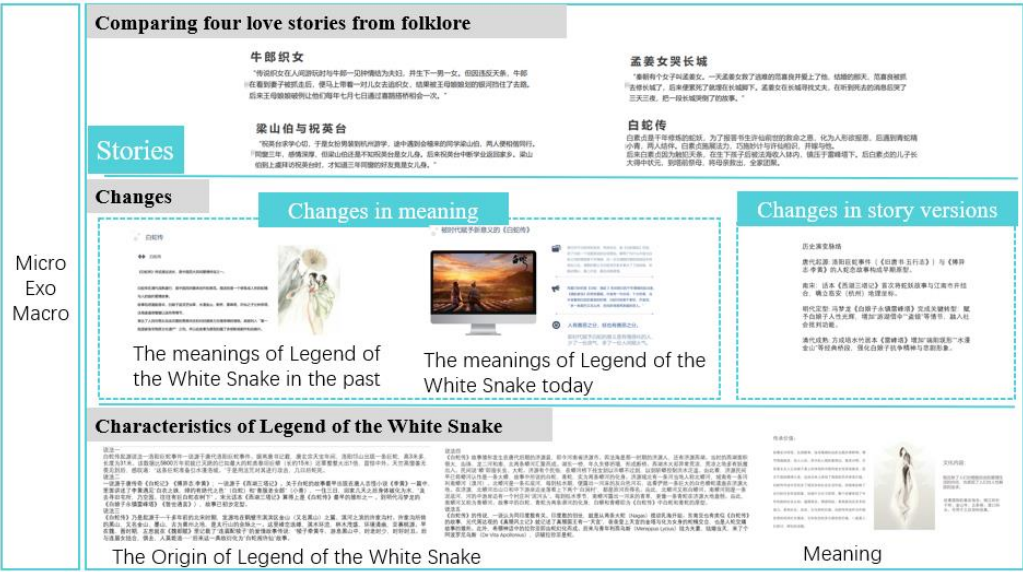


Figure 3.14 Analysis results of ICH cultural information of VC1

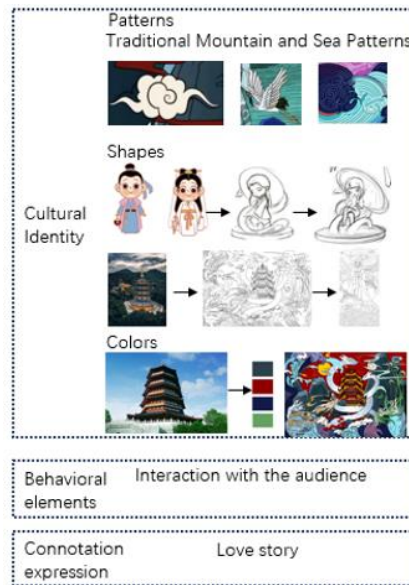


Figure 3.15 sketches of VC1's final design work



Figure 3.16 VC1's final design work: Designing postcards with cartoon-like characters of Legend of the White Snake

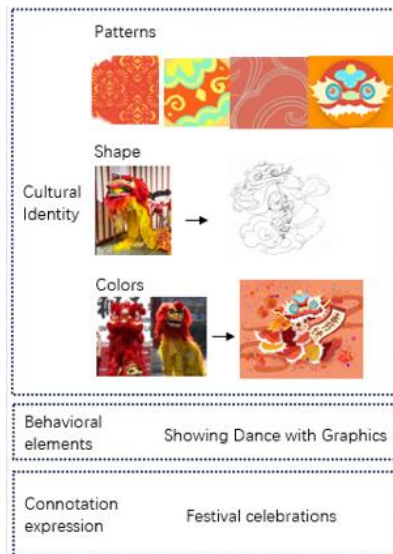


Figure 3.19 Sketches of VC2's final design work



Figure 3.20 VC2's final design work: ICH for Lion Dance-designing traditional festival posters and puzzles containing Lion Dance elements

3.3.3 The scores of the teams in four stages of the design

The scores of teams are shown in the Table 3.2. A consistency test was performed to test the reliability of the experts. The intraclass correlation coefficient (ICC) of the

three experts was 0.753, indicating that the experts' scores were consistent and reliable.

Table 3.2 Team Scores

Criteria	team	Stage1 (Divergent thinking)	Stage2 (Convergent Thinking)	Stage3 (Design Implementat ion)	Stage4 (Design Presentation and evaluation)	Average score
Culture fit	ID1	6.3	6.7	7.0	6.7	6.8
	ID2	6.0	6.0	5.0	5.0	5.5
	VC1	3.7	4.0	4.7	3.7	4.0
	VC2	5.7	5.0	5.3	5.3	5.3
Creativity	ID1	6.0	6.3	6.3	7.0	6.1
	ID2	6.7	6.7	6.7	7.0	6.8
	VC1	5.3	4.7	5.0	4.7	4.9
	VC2	3.7	3.7	3.7	3.7	3.7
Aesthetics	ID1		6.7	6.7	6.7	6.7
	ID2		3.7	4.0	3.7	3.8
	VC1		6.0	6.3	6.0	6.2
	VC2		5.3	4.7	5.3	5.0
Experience	ID1		6.3	6.3	6.3	6.3
	ID2		6.7	6.7	6.7	6.7
	VC1		4.7	4.7	4.7	4.7
	VC2		3.7	3.0	3.7	3.5
Diversity	ID1	6.7	6.7	6.7	6.0	6.6
	ID2	6.3	6.3	6.0	6.7	6.3
	VC1	4.7	4.7	5.3	4.7	4.8
	VC2	3.7	3.0	3.7	3.7	3.5

The author performed a two-factor ANOVA. From the results (see Table 3.3, Table 3.4, Table 3.5), there were significant differences between the ID and VC teams in Stage 2, Stage 3, and Stage 4 ($p < 0.05$). There was no significant difference in the five dimensions of ICH in the ID teams in Stage 2, stage 3, and Stage 4 ($P > 0.05$), and there was no significant difference in the five dimensions of ICH in the VC teams in Stage 2, stage 3, and stage 4 ($P > 0.05$).

Table 3.3 Stage2 two-factor ANOVA

Results of two-factor ANOVA						
Source of differences	Sum of squares	<i>df</i>	mean square	<i>F</i>	<i>p</i>	Partial η^2
Intercept	571.380	1	571.380	698.936	0.000**	0.986
Criteria	0.167	4	0.042	0.051	0.994	0.020
Team	14.964	1	14.964	18.305	0.002**	0.647
Type*group	6.263	4	1.566	1.915	0.184	0.434
Residual	8.175	10	0.818			

Remarks: $R^2 = 0.724$

* $p < 0.05$ ** $p < 0.01$

Table 3.4 Stage3 two-factor ANOVA

Results of two-factor ANOVA						
Source of differences	Sum of squares	<i>df</i>	mean square	<i>F</i>	<i>p</i>	Partial η^2
Intercept	581.042	1	581.042	524.406	0.000**	0.981
Criteria	0.248	4	0.062	0.056	0.993	0.022
Team	11.250	1	11.250	10.153	0.010**	0.504
Type*group	4.840	4	1.210	1.092	0.412	0.304
Residual	11.080	10	1.108			

Remarks: $R^2 = 0.596$

* $p < 0.05$ ** $p < 0.01$

Table 3.5 Stage4 two-factor ANOVA

Results of two-factor ANOVA						
Source of differences	Sum of squares	<i>df</i>	mean square	<i>F</i>	<i>p</i>	Partial η^2
Intercept	575.664	1	575.664	619.327	0.000**	0.984
Criteria	0.413	4	0.103	0.111	0.976	0.043
Team	13.284	1	13.284	14.292	0.004**	0.588
Type*group	6.493	4	1.623	1.746	0.216	0.411
Residual	9.295	10	0.929			

Remarks: $R^2 = 0.685$

* $p < 0.05$ ** $p < 0.01$

From the results for culture fit, both ID teams scored higher than the VC teams. In the mesosystem, mutual learning helped the team ID1's students understand the motion capture technology and the design method. Therefore, they applied this technology to their design works and utilized digital technology to interact with the audience, which solved the problem of being unable to represent the Shadow Play movements in the

traditional Shadow Play creative works. In the visual part, they followed the traditional pattern that “a picture must be intentional, and being intentional must have good meanings and good luck is on the way” to reconstruct the traditional graphics. The color elements of the traditional Shadow Play were also selected and recombined. They were assigned with 6.8. According to the experts, their design works ‘s patterns and colors have followed the characteristics of traditional Shadow Play. It presented the dynamics of Shadow Play figures through digital technology, which are very much in line with the cultural attributes of traditional Shadow Play and the requirements of the living ICH in the systems. VC1 was assigned with the lowest score of 4.0. The VC1 members used traditional colors in their design works but chose anime shapes from modern popular elements, especially anime images leaning towards the Japanese style, to design characters from traditional stories. The experts thought their design works did not reflect the traditional Chinese cultural connotations.

For creativity, the design work of ID2 combined digital technology to represent the Dragon Dance with a Music Video Game. The Dragon Dance is a type of traditional dance, and the Music Video Game is done through dancing. What they have in common is the dancing part. The students considered the most creative idea by combining the two through the same point. They received an average score of 6.8. The VC2 members received the lowest score of 3.7. They used their classroom knowledge to create several posters of traditional festivals and puzzles that contained Lion Dance elements. The combination of traditional festivals and posters was not considered innovative.

In terms of experience, the ID teams were all scored higher than the VC teams, and team ID2 was scored the highest of 6.7. The Music Video Game, a combination of Dragon Dance and digital technology, lighted up the dragon light strip on the top of the device by touching the sensor button at the bottom of the device according to the sequence of the dance steps. Experts agreed that this work was more participatory, experiential, and fun.

For diversity, team ID1 had the highest average score of 6.6. The team

ID1 members designed shadow features for innovation, and they designed the characters and the patterns on the costumes using a modern style combined with traditional elements. The interactive animated short work expresses traditional culture in a modern and diverse way. The VC2 members had the lowest average score of 3.5. Their design work consisted of posters and puzzles that were presented without innovation and appears monotonously.

In terms of scores, the ID teams were scored higher than the VC teams, indicating the guideline was effective for the ICH design course that applied both pedagogical approaches. However, the application of an interdisciplinary approach with digital technology has had a more positive impact on these four criteria. Nevertheless, in terms of aesthetics criteria, team ID2 received a score of 3.7, which was the lowest among the four teams (see Table 3.2). The experts felt that the final design work for ID2 lacked graphics and color. The scores of teams ID1, VC1, and VC2 were 6.7, 6.0, and 5.3, respectively. The experts believed that team ID2 emphasized more on the application of technology and ignored the performance of the visual design. It suggested that the guideline does not positively impact on aesthetics when applied to these two types of pedagogical methods.

Interdisciplinary teams' design practice

The design work of team ID1 was considered to meet the requirements in the cultural fit criteria. It continued the color combination and pattern design of the characters and objects and the character styling of the traditional shadow play and used digital technology to show the dynamic part of the shadow play. Hence, this work carried on the traditional culture in both the visual and dynamic parts. Through understanding the traditional culture, ethnic beliefs, the history and development of Shadow Play, they learned that white, green, black, red, and yellow in Northern traditional shadow play correspond to the five elements of gold, wood, water, fire, and earth, respectively, and are given symbolic meanings. By learning from each other in

the mesosystem, the students learned that the color of Fuzhou Shadow Play has strong regional characteristics, with its high brightness and purity and bright colors. To make the color combination more harmonious and consistent with modern aesthetics, they weakened the color contrast. In terms of graphic design, to conform to the traditional Chinese custom of symbolizing good luck, they followed the expression "the picture must be meaningful, and the meaning must have good meanings and good luck is on the way " to redesign the traditional graphics. As for the shapes of the shadow play characters, they showed the more rugged and realistic shape of the northern shadow play. The design work of team ID1 was considered to be a creative and ingenious original design according to the creativity criteria. It utilizes digital technology (motion capture) to interact with the audience at story points and connects the stories in the short film through audience participation. Their creativity originated from discussion. In the microsystem, students from the three disciplines communicated, learned from each other, and generated many new ideas. Different from the previous creative product with flat shadow play figures, their creative point is based on the performers' manipulation of the Shadow Play figures, and applied a new way of presentation by transforming the audience into performers to manipulate the animated short film, which completed the storytelling through the audience's participation. ID1's design work was regarded to be the best of the four works in the visual design section in terms of aesthetic criteria. Its design was based on symmetrical forms of traditional patterns and simplifies complex traditional patterns. The colors of the Shadow Play figures were harmonious and aesthetically pleasing, and the tone of the entire work was unified. The design work of team ID1 was considered to be highly interactive and interesting in the experience criteria. The story in the short film creates a scenario in which interactions were interspersed with the story, making the audience being characters and more interested in the story. This design work was recognized in the diversity criteria as being diverse in both interactivity and expression. The students combined traditional graphic color elements with modern compositional approaches. It simplified the graphics from traditional elements and reorganized them according to the compositional approaches.

According to the tonal contrast in color composition, the color saturation was reduced to make the contrast softer and consistent with contemporary aesthetics. Students utilized digital technology to display the dynamic parts of the Shadow Play figures and form an interaction with the audience, which was more diversified compared to the previous flat expression.

The design work of team ID2 was considered to meet the requirements in the cultural fit criteria. It flattened the dragon shape and used digital technology to combine the steps of the Dragon Dance with the basic steps of a Music Video Game, so both the visual and dynamic parts inherited the traditional culture. Team ID2 did not reconstruct the traditional pattern and therefore scored lower than team ID1. The idea of team ID2 was to change during implementation. Team ID2 scored 6.0 in stages 1, 2, and 4, which dropped back to 5.0 in stage 3. At one point in stage 3, team ID2 gave up on presenting the steps of the Dragon Dance in favor of free stepping. The movements of the Dragon Dance are the core, and presenting the visual design part without showing the steps lacks the core part of the heritage. According to the teacher's suggestion and the students' discussion, team ID2 chose to show the steps of the Dragon Dance. It scored high in creativity, experience, and diversity. In particular, the design work was considered to be the most innovative and original design in the creativity criteria. The ID2 members used digital technology to combine the steps in the traditional Dragon Dance with a Music Video Game so that the audience could learn about the steps in the Dragon Dance during participation. The design work of team ID2 was scored the lowest on the aesthetic criteria. The ID2 members designed the shape and pattern of the dragon but did not apply it to the final design work. The visual design part cannot fit with the behavioral design part. This design work was regarded to be highly interactive and interesting in the experience criteria. The audience stepped on a Music Video Game according to the steps of the Dragon Dance, and the dragon-shaped light strip lit up simultaneously. It was more interactive and interesting than the other three design works.

Conventional Single-disciplinary teams' design practice

The average score of the design work of team VC1 in the culture fit criteria was 4.0, which was the lowest among the four teams. The score of team VC1 in the first stage was 3.7. The VC1 members combined Japanese cartoons with traditional Chinese stories, which did not reflect the heritage of traditional Chinese culture. In the second stage, the design style was changed gradually to a national style by adjusting the design according to the teacher's suggestions. The scores gradually increased from 4.0 at stage 2 to 4.7 at stage 3. In Stage 4 their score dropped back to 3.7 because they designed cards with English letters. Experts considered the presence of traditional cultural elements in the design work as a test of whether it meets the criteria of cultural fit. It was inappropriate to include English letters in a design work that was based on traditional Chinese culture. This design work was scored relatively high in the aesthetic criteria. The members designed graphics and colors for traditional images and redesigned ICH characters and scenes. The work of team VC1 was scored low in the creativity, experience, and variety criteria. Although this work is original, graphic illustration is a common form rather than being novel. This work was mainly a static design and lacked interactivity and interest. It combined traditional graphic colors with modern character styling design and partially met the diversity criteria. However, the members did not have diversity in the way of presentation.

Team VC2's design did not present traditional dance movements, resulting in a lower average score of 5.3 on the cultural fit criterion than teams ID1 and ID2. This design work scored lower than the other three teams in the creativity criteria as the experts considered it was more similar to previous designs and lacked originality. In addition, the poster is a traditional form of design and lacks novelty in terms of the presentation according to the experts. The work of team VC2 scored poorly in the experience and diversity criteria because it was mainly a static design, which was weak in interaction with the audience and fun through a single mode of expression.

3.3.4 Students' perceptions of ICH design course.

The thirty participants provided open-ended responses about their perceptions of the course. We found mutual learning among students in the mesosystem influenced the process of idea formation and design implementation, especially in the two ID teams. The students mentioned 17 times that mutual learning among students from different disciplines was beneficial (see Table 3.3).

Table 3.6 Results of the interview

Semi-structured interview	Frequency
Benefits of learning from each other under the design guideline	17

The students' opinions characteristically mentioned three kinds of actions. Under the guideline, students from different disciplines learned from each other in the mesosystem, which (Action 1: new idea) facilitated the generation of new ideas and (Action 2: change thinking) changed their way of thinking. For the design implementation, the digital technology offered students from art backgrounds opportunities to implement more physical design works (Action 3: design implementation).

SA018: As ISE students, communication with VC and DHT students can enrich our knowledge of product presentation. (Action 1: new idea)

SA022: The motion capture in our previous work was a simple light-effect modulation. However, after seeing the design work shown by the VC students, we had the idea of adding motion capture to the shadow-play animation short film, and we wanted to interact with the audience through this presentation. (Action 1: new idea)

SA023: The communication with VC students provided us with new ideas. I think we can present technology in a more artistic and accessible way to the audience. (Action

1: new idea)

SB012: I gained a lot from doing the project. VC students think differently from us, and they have more innovative ideas than us. (Action 2: change thinking)

SB013: We felt the collision of ideas in the process of combining art and technology, and we experienced different ideas in design implementation. (Action 2: change thinking)

SA003: We talked to VC students and found it better to utilize digital technology-motion capture technology to allow visitors to interact with the short film. (Action 3: design implementation)

SA019 Our work presentation may give the audience a rather dull feeling. With the help of VC students, we can present technology better through art and thus further enhance the audience's experience. (Action 3: design implementation)

SA021: The combination of art and ISE students' technology can facilitate physical design. (Action 3: design implementation)

SB016: Our biggest takeaway was the experience of interdisciplinary design implementation. (Action 3: design implementation)

SB017: We think about the practical aspects of design implementation. (Action 3: design implementation)

3.4. Discussion

3.4.1 Fulfillment of the five criteria of ICH by the ICH design course using an ICH design guideline

For RQ1.1 (How do ICH design guideline on the Bronfenbrenner's EST support design students learning about ICH?) For the five criteria, the four teams had average

scores of 3.5, and all achieved the teaching goals, indicating the ICH design course is effective in ICH design for the students. With the aid of the design guideline, the participants clarified the knowledge areas involved in ICH design, and learned how to conduct research on ICH starting from the historical and cultural background investigation of ICH in the macrosystem. They focused on the application of new technologies in cultural venues within external systems, as well as governmental initiatives for the safeguarding of ICH. These factors influenced the students' design works.

Research findings indicate that ICH design guideline can support students in collecting ICH cultural data, analyzing ICH cultural information, and designing ICH products. By selecting comparable intangible cultural heritage projects from diverse regions, ethnic groups, or categories for comparative analysis, students identified significant variations in stylistic characteristics, color schemes, expressive forms, and transmission mechanisms across different regional ICH projects. Furthermore, they gathered ICH cultural data spanning various dynasties to examine the evolution of ICH forms, colors, and meanings over time. They further explored the cultural symbols, beliefs, and societal values underlying intangible cultural heritage (see Figure 3.6, Figure 3.10, Figure 3.14, Figure 3.18). Through this cultural data, students revealed the cultural roots of intangible cultural heritage.

The two ID teams collected ICH cultural data and analyzed ICH cultural information according to the design guideline. The results show that ID1 students selected shadow play from different regions for comparative analysis and found that there are significant differences in stylistic features, color features, singing voices, and production materials between different regions. For example, the characters of shadow play in the Northeast have large eyes and high noses, while the characters of shadow play in the Northwest are more slender and smaller in shape (see Figure 3.6). ID2 students chose dragon dances from different regions for comparative analysis and found that there are big differences between the Northern and the Southern in terms of the

shape of the dragons, and the steps of the dragon dances (see Figure 3.10). In addition, students from both teams compared the changes in shape, color, and meaning of shadow play and dragon dance over time. While studying the changes, the students traced the causes of ICH and explored the cultural symbols, beliefs, and social values behind ICH.

Two VC teams collected ICH cultural data and analyzed ICH cultural information according to the design guideline. The results showed that the students of VC1 collected time series data on the story of the Legend of the White Snake, the changes in the story of the Legend of the White Snake in different dynasties, and dug deeper into the reasons for the different versions of the story with different dynasties (see Figure 3.14). They compared the different social values of different dynasties. VC2 compared the differences in shape, color, dance movements, and performance forms of the lion dance between the North and the South (see Figure 3.18). In addition, they trace the origin of the Dalian Lion Dance, as well as the cultural symbols and beliefs.

The ID1 members focused on the requirements of the living heritage of ICH and on the development of digital technologies (see Figure 3.5, Figure 3.6, Figure 3.7, Figure 3.8), which are the parts ignored by visual communication students in the previous classes. In the interviews, VC students mentioned that the previous courses, they could only innovate at visual aspects to increase the novelty of their works.... ..they achieved the combination of the visual design part with the technology in this course ...

The design guideline also facilitated the students in learning from each other in the mesosystem. In the interviews, students explained their perceptions of learning from other students in the mesosystem. "...interacting with VC and DHT students enriches our knowledge of product presentation...", "...with the help of VC students, we can present technology better through art..."

This result is the same as Peppler et al. (2023), who utilized Bronfenbrenner's EST to investigate the factors influencing the creation of drawings and paintings. EST-based

artifact-oriented learning models enable interdisciplinary study of artworks and promote understanding of learning (Peppler et al., 2023). It is a good attempt by EST in art education. Our contribution is to introduce EST into the field of ICH design education. The EST-based design guideline extends students' knowledge of ICH in broader areas and at deeper levels and leads to the emergence of new ideas. The system of multiple nested domains highlights the value of supportive relationships through students, teachers, classmates, and the university environment, the social environment, and so on. It emphasized how an EST-supported design guideline can lead to the construction of new ideas and support students' learning about ICH and innovative design. The design guideline based on EST supported the implementation of ICH, facilitated the design of new projects, and community engagement approaches to meet contemporary societal needs. By emphasizing the integration of ICH with other fields and outcomes and the development of modes of professional development that go beyond the teaching of ICH form itself, and that will lead to the development of ICH design into a wider space.

3.4.2 Differences in Application between Interdisciplinary Approaches with Digital Technology and ordinary teaching methods

For RQ1.2 (What differences do ICH design guideline based on the Bronfenbrenner's EST between an interdisciplinary approach with digital technology and in conventional approach?) Expert ratings of the students' design processes and final design works, as well as the results of the interviews reveal that the ICH design guideline was better applied in interdisciplinary approaches with digital technology than in conventional teaching methods.

The two ID teams had higher average scores than the two VC teams in the four criteria of culture fit, creativity, experience, and diversity. It indicated that digital technology and interdisciplinary approaches are superior over conventional teaching methods in these four criteria. The mean score of the team ID2 in the aesthetics criteria

was 3.8, which is lower than in team ID1 and the two VC teams. It indicates that the interdisciplinary approach with digital technology has no advantage over conventional methods in terms of aesthetics.

As for culture fit, the scores of the ID teams are slightly higher than the VC teams in all four stages of design. The digital technology significantly impacted the ID teams, as digital technology combined with visual design better interpreted the behavioral part of ICH and to achieved a living legacy of ICH. However, the VC teams embodied the representation identity of ICH in ordinary two-dimensional graphic design that did not reflect its behavioral component.

Creativity is reflected in the scores and the results of the interviews. The scores for creativity of the ID teams in all four design phases are higher than in the VC teams. The scores of 7 for both ID teams in the fourth stage sufficiently prove that the interdisciplinary approach has a positive impact on creativity. The results of the interviews also showed the students in the ID teams recognized such positive impact. Hence, the interdisciplinary approach plays a positive role in the generation of new ideas during ICH design. This finding is consistent with Kuusk's (2020) and other researchers' findings that interdisciplinary approaches positively impact on design creativity (Kuusk, et al., 2020; Braßler & Schultze, 2021; Yu, 2023) and help students to "think outside the box" (Kuusk, et al., 2020), breaking the research perspective of the discipline and seeing problems from new perspectives (Newell, 1994). Through the understanding of the ISE in the course, and the communication and discussion among students from different disciplines, students can recognize the connections between what they learn in different disciplines and ICH, which can initiate new thinking. Some students thought that the interdisciplinary approach facilitated the generation of new ideas and changed their way of thinking, such as "...provided us with new ideas", "...had the idea of adding motion capture...", "...felt the collision of ideas...", and "...experienced different ideas...".

In terms of experience and diversity, the ID teams had significantly higher scores

than the VC teams, which was because the ID students and the VC students had different backgrounds. The ID and VC team's design works followed local visual culture, history, and ethnic beliefs. And they were influenced by the convention of safeguarding and living heritage. However, as the ID teams were made up of students from three different disciplines with different learning backgrounds, learning styles, and modes, resulting in their design work being different from that of the VC teams. The VC students learn graphic design courses, such as poster design and museum memorabilia design, they are better at visual design of patterns, colors, etc. The ISE students are educated with information technology courses, they are better at presenting works through digital technology. The DHT students learn the theories, history, and trends of the design, they are more specialized in the study of the styles and characteristics of traditional patterns, as well as giving deeper connotations to their works. Students were inspired by the conversations and discussions that took place in the mesosystem. They paid more attention to human participation in their design works and tried to use digital technology to change the design work of ICH from "static" to "dynamic", and convert a single visual experience into an interactive communication mode with a multi-sensory experience. The ID team did not score much higher than the VC team as we expected. This is because some factors in the microsystem and metasystem can affect the design process, such as classmates. The ID teams were composed of students from three disciplines, who were not familiar with each other. There were conflicts in cooperation and labor division. The second reason is that the ID teams needed to complete more work. ISE students did not understand visual design and or visual expression. They needed more time to communicate. The cooperation in team VC1 was very harmonious. Firstly, VC1 students were classmates from the same class and were very familiar with each other. Secondly, their team leader played a good role in coordinating labor division among the members.

One unexpected result is that in the score of aesthetics in team ID2 was lower than both VC teams, indicating the interdisciplinary approach did not positively affect aesthetics. There are several possible explanations for this result. Firstly, ICH designs

were based on the prior social experience of the authors and the shared cultural history behind the design work (Franks et al., 2007). In the microsystem, the prior knowledge of the students affected the aesthetics of team ID2. The students in ID2 had less prior knowledge in the visual design section than students in other teams. Hence, the design skills and prior experience of students more greatly influence aesthetics. The interdisciplinary approach does not improve the prior knowledge of students. In future research, it may be possible to explore and refine the design steps of ICH graphic restructuring and thus incorporate diverse design approaches into the guideline.

3.4.3. Factors leading to the difference between the two types of teams

For RQ1.2, their design works revealed the factors that contributed to this result (see Table 3.4).

The design focus is different. The two ID teams utilizing digital technology focused more on human participation in the design works and starting from the living transmission of ICH (Figure 3.5, Figure 3.6, Figure 3.7, Figure 3.8, Figure 3.9, and Figure 3.10, Figure 3.11, Figure 3.12). The students combined their behavioral characteristics with those of ICH and focused on the interplay of human emotions in the interaction process. They considered the transmission of ICH in their design from multiple perspectives, including behavioral and visual perspectives. Specifically, they used the human body as a tool to guide the entire experience. This model allowed the audience to gain a sense of joy from physical actions and participate in presenting the design work. Instead of passively receiving information, such design work allowed the audiences to actively explore ICH information and disseminate ICH content. The interdisciplinary approach provided the two ID teams with more ways to present ICH. Their design works were not only visual but also aural and behavioral, adding variety and interest to their works. However, the two VC teams leaned towards graphic design (Figure 3.13, Figure 3.124, Figure 3.15, Figure 3.16, Figure 3.17, and Figure 3.18, Figure 3.19, Figure 3.20). The VC members focused on designing graphics and colors for traditional images and redesigned the characters and scenes of ICH. They passed on

ICH from a visual perspective and neglected other aspects. Their works were static; and thus, they were less attractive and not particularly fun to the audience.

Different types of knowledge were used. The ID teams consisted of VC students, ISE students, and DHT students. The VC teams only involve VC students. Due to the different areas of knowledge specialized in among different students, the types of knowledge used in the design processes differ. The ID team students expanded their knowledge and learned the basics of other disciplines in the microsystem and mesosystem before the divergent thinking stage. At the design implementation stage, the students learned how to use different technologies in the mesosystem. The acquired knowledge supported the students in integrating visual design with technology. However, the VC team students had no chance to acquire such knowledge and only used the knowledge of VC in their design.

Table 3.7 Characteristics of each ID and VC teams in design processes

	Stage1 Divergent thinking	Stage2 Convergent Thinking	Stage3 Design Implementation	Stage4 Design work presentation
ID1	Understanding the basics of the lighting field digital technology	Developing detailed design process and practicing arrangement Forming a preliminary design plan Designing the story of the animated short film Determining character movement Taking movement photos of people Starting to train artificial intelligence (AI)	Electronic sketches balance aesthetics and traditional culture AI and electronic sketching combination	Participating the design work experience Finding problems Adjusting design works
ID2	Understanding the basics of the lighting field digital technology	Forming of a preliminary design plan Conducting light source experiments	Redevelopment of the design plan	
VC1			Adjustment of electronic sketches that lack traditional cultural expressions	
VC2			Detailed design	

Chapter 4 Investigation of ICH game elements in design course

4.1 Overview

As an important carrier of human civilization, the transmission of ICH relies on intergenerational cultural identity and practical participation (UNESCO, 2003). However, with the acceleration of globalization and digitization, the living environment of ICH has changed drastically, and many ICH items (e.g. farming practices, handicrafts) are out of touch with the living scenes of contemporary young people. In addition, urbanization has weakened the cultural ties of clans and communities, leading to a decline in participation in folk festivals (e.g., social fires, Nuo opera). The younger generation's interest in traditional skills and folklore activities has gradually waned. Therefore, enhancing the interest in ICH of young people, especially university students, is a problem that needs to be solved urgently in the contemporary transmission of ICH.

In the exosystem of the Ecological Systems (Figure 4.1), the Convention for the Safeguarding of the ICH explicitly defines the concept of ‘living transmission of ICH,’ emphasizing the dynamic development of ICH. Numerous ICH cultural venues and museums have utilized new technologies and employed gamification approaches to showcase ICH. The aspiration is to achieve a fundamental shift from ‘museum-style preservation’ to ‘living transmission.’ It offers valuable insights.

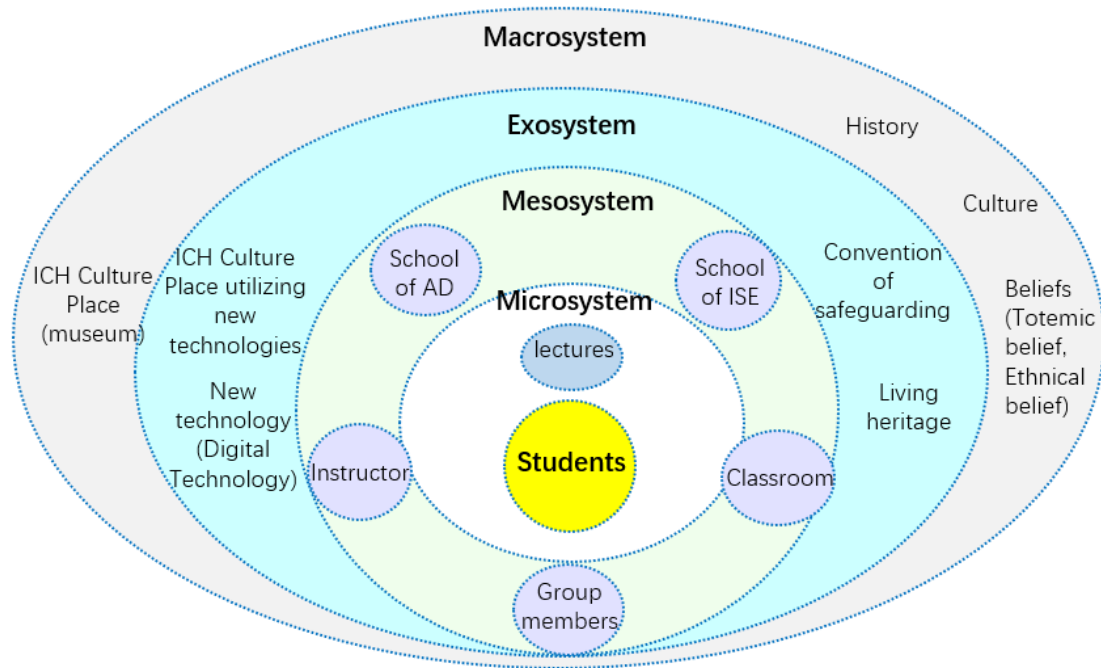


Figure 4.1 ICH Ecological system

Gamification is an emerging trend that can be used to increase audience engagement or promote certain behaviors. Gamification can evoke curiosity (Lazzaro, 2004) and provoke intrinsic motivation.

Advances in mobile digital technologies have brought new possibilities for engaging user experiences and interactions (Kotsopoulos et al., 2019; Li, 2022). Researchers have investigated how mobile digital technologies can be used to transmit ICH information (Ami-Williams et al., 2024; Kim et al., 2017; Papangelis et al., 2016; Hannewijk et al., 2020). Moreover, user acceptance of these applications may be different. In other words, not all applications are created equal and some are more useful than others. Researchers have attempted to incorporate game elements into mobile applications, and demonstrated these elements can enhance younger generations' motivation to explore cultural heritage (Tan & Ng, 2024; Jemmali et al., 2018; Shang & Ni, 2023). For instance, achievement can improve student performance (Landers et al., 2014) and increase audience engagement (Hamari, 2013), while storytelling positively impacts user experience (Jemmali et al., 2018). Other researchers combine

different game elements to test the effects of gamification in different situations (Shang & Ni, 2023). However, questions which game elements or combination of game elements positively affects ICH mobile applications, and which game elements promote young people's acceptance of and interest in ICH information in ICH mobile applications have not yet been fully explored.

The study is aimed to investigate the effects of different game element combinations in ICH mobile applications on the interest in ICH. By evaluating three game elements in nine applications: achievement, interaction, and storytelling and the effects of combinations of these three game elements on participants' interest in ICH information, the author explored the design of ICH mobile applications from the perspective of facilitating the young generation's learning and experiencing of ICH. Instead of focusing on games, the ICH mobile application in this study focuses on the introduction of ICH information.

Therefore, the research questions are

RQ2.1: How basic game elements do affect students' impressions of ICH mobile applications?

RQ2.2: How do students' design ICH mobile prototypes to support students' interest in ICH by using game elements?

This study has several contributions. First, the effects of three game elements on ICH mobile applications were compared. Second, interaction significantly affected and was appropriate for ICH mobile applications. Third, I demonstrated that achievement has a negative effect on the ICH mobile application and is not appropriate for the ICH mobile application. Finally, the author confirmed the combination of interaction and storytelling had a good effect on ICH mobile applications.

4.2 Method

To address the research questions, the author conducted two studies. First, game elements that positively impact ICH mobile game applications were identified from a game element survey. Participants experienced ICH mobile game application samples, think-aloud, and then rated the samples (RQ 2.1). In the second study based on the findings, the author evaluated student ICH mobile application prototypes to further explore the effects of game element combinations on ICH mobile application prototypes (RQ 2.2).

4.2.1 Participants

Forty students from the Visual Communication Department of Dalian Polytechnic University were enrolled in the practice, including 31 females and 9 males. All participants were regular users of mobile application and had smartphone.

4.2.2 Procedures

The practice was approved in April 2023 by Dalian Polytechnic University and conducted at the same university in May 2023. The students were told that this practice was about experiencing ICH mobile applications and that they could opt out of the practice any time. The researcher introduced the requirements of the practice and the 9 applications shown in Table 1. These participants were asked to experience ICH mobile game applications containing game elements and think-aloud (Figure 4.2). Participants experienced of the samples in a random order to avoid order effects. At the end of the practice, they fill out a questionnaire. A researcher observed each participant as he/she experienced the mobile application and audio-recorded each participant. After the questionnaire, the researcher conducted semi-structured interviews with each team.



Figure 4.2 Participants experience the ICH mobile application

4.2.3 Evaluation criteria

Evaluation criteria for mobile applications designed by ICH based on common methods of evaluating mobile applications (Weichbroth, 2020) and assessing the quality characteristics of serious games (Calderón & Ruiz, 2015), were used functional appropriateness and the sense of experience brought by the software to people.

Criterion 1 is “ICH fitness”. The fundamental criterion for evaluating ICH mobile game applications lies in their ability to embody cultural attributes and effectively disseminate ICH. This criterion examines the application's integration of culturally significant elements, including symbolic graphics, traditional color schemes, and behavioral representations. It focuses on two critical aspects: (1) designers reinterpret traditional color and reconstruct symbolic patterns while maintaining their original significance; (2) behavioral elements derived from traditional rituals or dramatic performances are represented through digital transformation.

Criterion 2 "usability" assesses the intuitiveness and user-friendliness interface and functionality in an ICH mobile game application. Usability is critical for mobile applications because it directly affects user engagement and retention. Poor usability can reduce user interest and satisfaction, and cause frustration, leading to application abandonment and less cultural engagement.

Criterion 3 "enjoyment and pleasure" examines user engagement and emotional satisfaction, and specifically assesses the degree of enjoyment and pleasure derived from application use experience. This dimension represents a crucial component in evaluating the overall quality of user experience. A good experience in the use of the application is intrinsically motivating and will promote its long-term use (Hamari & Koivisto, 2015 a). When users feel enjoyment and pleasure while using an application, they are more likely to become loyal users. This positive emotional feedback is critical to the long-term success of the application.

Criterion 4 "interesting" focuses on the application's capacity to generate and sustain users' interest, and assesses the degree to which the interface and content stimulate user engagement. It increases users' motivation and changes their behaviors, prompting them to explore and learn actively. This intrinsic interest enhances immediate user satisfaction and generates positive emotional responses, including pleasure and contentment during the interaction. Furthermore, this heightened satisfaction reinforces user motivation which contributes to both user retention and effective knowledge acquisition.

Criterion 5 "perceived usefulness" assesses the application's perceived usefulness, and specifically focus on users' perceptions regarding its efficacy in facilitating the promotion and dissemination of ICH information. It encompasses two key dimensions: (1) users' fundamental belief in the application's capacity to serve as an effective medium for ICH transmission, and (2) users' subjective evaluation of the extent to which the application successfully fulfills its intended cultural dissemination functions. Assessment of perceived usefulness is particularly crucial as it directly influences user

acceptance, engagement levels, and the ultimate effectiveness of digital ICH preservation efforts.

4.2.4 Evaluation

Samples of ICH mobile game application

Nine ICH mobile applications were selected from all 36 applications available for Android and iOS (Table 4.1). The samples chosen here have two characteristics: First, these samples describe the history, style, and production of ICH. Second, these samples contain achievement (badges, trophies, and leaderboards), interaction (interaction game, interactive production), and storytelling (narratives).

Questionnaire

One questionnaire was distributed to the students who used a five-point Likert scale (1: Very disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Very agree) to rate the nine mobile applications based on five evaluation criteria. The questionnaire was designed by a researcher and consisted of two types of questions. The first type included two basic questions, while the second type included questions about the students' ratings and evaluation (advantages and disadvantages) of the mobile applications.

Table 4.1 Sample mobile applications

Mobile App. Name	Content	Game elements
Forbidden City 365 *1	It introduces traditional Chinese architecture. Users can explore architectural knowledge and earn achievements by completing tasks.	Achievement
Dougong*2	It introduces knowledge related to traditional Chinese wooden architecture.	Interaction
Han Xizai's Night Banquet *3	In storytelling, the story is told how Emperor Li Yu of Southern Tang commissioned court painters to depict The Night Banquet, and how Han Xizai used strategic banquets to respond to political challenges.	Storytelling
Crafted wood *4	It introduces the knowledge of mortise and tenon joints. Users can learn knowledge through interactive learning and earn achievements by completing levels.	Achievement, Interaction
Chinaware *5	It introduces history and craftsmanship of Chinese porcelain. Users can interact and experience porcelain manufacturing.	Achievement, Interaction
Folding fan *6	It introduces history and production of Chinese folding fan. User can interact and experience folding fan production and its craftsmanship.	Interaction, Storytelling
Fantastic Traditional Festivals *7	It introduces traditional Chinese festivals through storytelling. Users can make traditional festival foods or toys through interaction.	Interaction, Storytelling
Everlasting Regret *8	It recreates unique charm of classic Chinese poetry through storytelling, interaction, collecting objects, and unlocking new chapters.	Achievement, Interaction, Storytelling
A Day in the Life of an Emperor *9	It introduces ICH in the Qing Dynasty imperial palace through storytelling, interaction, and embodied achievement.	Achievement, Interaction, Storytelling

*1: <https://www.dpm.org.cn/Creative.html#app> (accessed on 25 May 2023)

*2: <https://apps.apple.com/cn/app/%E6%96%97%E6%A0%B1-dougong/id1054240089?l=en>
(accessed on 16 April 2023)

*3: <https://www.dpm.org.cn/Creative.html#app> (accessed on 27 May 2023)

*4: <https://lewan.baidu.com/lewan?gameName=%E5%8C%A0%E6%9C%A8&type=11&gameId=153125026610130944&idfrom=5019&sid=60359,60466,60491,60501> (accessed on 27 May 2023)

*5: <http://api.yc.ywbjchina.com/free/en.html> (accessed on 27 May 2023)

*6: <https://havefan.taguxdesign.com/fan.html> (accessed on 29 May 2023)

*7: <https://cn.babybus.com/product/app/detail?id=125> (accessed on 29 May 2023)

*8: https://appgallery.huawei.com/app/C104600329?sharePrepath=ag&locale=zh_CN&source=appshare&subsource=C104600329&shareTo=weixin&shareFrom=appmarket&shareIds=80a7131230384d218ced0cdd541206f3_1&callType=SHARE (accessed on 29 May 2023)

*9: <https://www.dpm.org.cn/Creative.html#app> (accessed on 29 May 2023)

Interviews

The semi-structured interviews were conducted with all 40 participants from the 8 teams to better understand how they felt during their experience with the ICH mobile game applications. With the participants' consent, we audio-recorded the interviews. The interviews in each team lasted 10-15 minutes, during which the participants were asked two questions: (a) Which of the game elements in these applications is your favorite? (b) Which game elements would make you keep going or continue to use the application? The interviews were audio-recorded with the participant's consent.

4.2.5 ICH Mobile Application Prototype

Based on the five-step design process by Kotsopoulos et al (Kotsopoulos et al., 2019), we described the design steps for the ICH mobile application and invited three associate professors specializing in visual communication to evaluate the students' work.

The ICH mobile application included five parts: ICH works display, ICH history, ICH traditional skills or production techniques, ICH design products, and ICH workshops. In the ICH design products section, students can apply their previous design works.

Design Steps

Define the goal

The first step in the design is to define the focus system (an ICH mobile application using game elements). Students were required to create an ICH mobile application that would generate user interest and increase user engagement through game elements.

Describe the users

Our target group is young people. First, young people are the focus of ICH dissemination. Only when young people understand, accept, and enjoy ICH can it stand the test of time and gain lasting vitality. Therefore, understanding the user needs of young people has become the focus of ICH transmission. Secondly, young people generally have smartphones and are willing to try new things.

Planning the content of gamification

The content is summarized in four parts: first, demonstrate ICH and make users aware of the pattern or form of it. Second, it introduces further information about the culture, history, and region of ICH - giving the user a general idea of the background of ICH. Third, ICH's production process will be introduced. It can be simplified into a few main steps through graphics and simple interaction, which is easy to understand and deepens the user's impression, adding interest. At last, it is possible to introduce outstanding heritage workshops, or inheritors and their works.

Designing an Activity Cycle - How it's Gamified

Designers need to consider how to utilize game elements to engage users to ensure that the game elements both stimulate users' interest and fit with the core values of ICH. Designers also need to consider how to present ICH information to users, both by providing a brief overview of the historical background, cultural connotations, and unique values of ICH, and by highlighting the core skills and production processes of ICH. In addition, the way to inform users how to use the mobile application is also a part of the designers' consideration, especially the core functions and operation of the

mobile application.

ICH Mobile App Interface Design Aesthetic Principles

Designers can draw on traditional Chinese layouts, focusing on hierarchy and logic. Traditional Chinese colors have a deep cultural heritage and symbolic meaning. The designers can use traditional colors to convey specific cultural emotions and aesthetic interests. The elements of ICH contain rich cultural connotations and unique artistic styles, and designers can refine and reconstruct these elements and incorporate them into their design works to make them conform to the cultural characteristics of ICH.

Team discussion

After concluding their experience, the participants participated in the ICH mobile application prototype design. Each participant's team chose an ICH as the topic for the mobile application. 8 teams discussed the topic and determined the content to be presented in the mobile application and the style of the page (Figure 4.3). At the same time, the students in their team discussions identified the game elements to be used in the mobile application and how ICH messages could be conveyed to the users through the game elements. All the design concepts proposed by the students were redrawn after the discussion.



Figure 4.3 Team discussion

Evaluation of ICH Mobile Application prototypes

Three associate professors from the visual communication design department were invited. With more than ten years of work experience in the design field, they all have published several academic papers, and have been involved in many evaluation projects. The experts were asked to evaluate the design works of the ICH mobile application designs against the five criteria above and using a five-point Likert scale (1: Very disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Very agree). Each expert evaluated the design of any team in a random order to avoid order effects. There was no discussion between experts to ensure independent assessment.

4.3 Results

4.3.1 Results of the game elements

Result of the questionnaire

Table 4.2 The result of multiple regression analysis

Criterion	F	Pr(>F)
Functional	A 7.34	0.01**
appropriateness	I 18.00	0.00***
(ICH fit)	S 2.36	0.125
Usability	A 21.90	0.00***
	I 2.28	0.13
	S 2.60	0.11
Enjoyment and	A 0.16	0.69
Pleasure	I 11.28	0.00***
	S 2.92	0.09
Interesting	A 3.22	0.07
	I 22.06	0.00***
	S 2.11	0.15
Perceived usefulness	A 13.44	0.00***
	I 2.07	0.15
	S 0.83	0.36

A: Achievement, I: Interaction, S: Storytelling

The author first compared the effect of achievement, interaction, and storytelling on the ICH mobile application by multiple regression analysis. From Table 4.2, we can see that there is a statistically significant effect of achievement on functional appropriateness, usability, and perceived usefulness, and a statistically significant effect of interaction on functional appropriateness, enjoyment and pleasure, and interesting. Therefore, we were unable to determine whether this considerable impact was a positive one, and could not find evidence to support the difference in effects of achievement, interaction, and storytelling for the ICH mobile application.

Finally, the interactions among achievement, interaction, and storytelling were compared through a mixed model for linear analysis (Table 4.3). As shown in Table 4.3, the scores of achievement in “ICH fitness”, “usability”, and “perceived usefulness” are negatively significant, but the negative effects in “enjoyment and pleasure”, and “interesting” are not significant, indicating achievement motivation is not effective in

all cases. ICH mobile game applications are an introduction to ICH, and people default to this as understanding and learning ICH rather than hedonic services such as games. Achievement incentives do not cause the desired psychological effect or make users interested in the information conveyed by mobile application. Interaction significantly and positively impacts functional appropriateness, enjoyment and pleasure, and interesting but no significant in “usability” and “perceived usefulness”, suggesting interaction has a very positive effect on ICH mobile game applications. Interaction allows users to learn traditional cultures by experiencing the process of making traditional skills or rituals. It allows users to understand and remember traditional culture more intuitively, and thus promotes acceptance and interest in ICH information. Storytelling showed no significant.

Table 4.3 The result of mixed model for linear analysis

ICH fitness	Coefficients	Standard Error	t-statistic	p-value
(intercept)	3.62	0.17	28.62	0.00***
Achievement	-0.23	0.09	-2.71	0.01**
Interaction	0.41	0.10	4.24	0.00**
Storytelling	-0.13	0.09	-1.54	0.13
Usability				
(intercept)	3.65	0.14	25.52	0.00***
Achievement	-0.48	0.10	-4.68	0.00***
Interaction	0.18	0.12	1.51	0.13
Storytelling	-0.17	0.10	-1.61	0.11
Enjoyment and Pleasure				
(intercept)	2.94	0.15	20.17	0.00
Achievement	-0.04	0.11	-0.40	0.69
Interaction	0.40	0.12	3.36	0.00***
Storytelling	0.18	0.11	1.71	0.09
Interesting				
(intercept)	2.82	0.14	19.59	0.00***
Achievement	-0.20	0.11	-1.79	0.07
Interaction	0.58	0.12	4.70	0.00***

Storytelling	0.16	0.11	1.45	0.15
Perceived usefulness				
(intercept)	3.60	0.14	25.91	0.00***
Achievement	-0.37	0.10	-3.67	0.00***
Interaction	0.16	0.11	1.44	0.15
Storytelling	-0.09	0.10	-0.91	0.36

Results of Think-Aloud

Forty students provided open-ended responses about game elements. The researcher used inductive qualitative analysis to code and categorize these responses into four main types:

Students' opinions on whether game elements 1) are easy for users to remember/understand ICH, 2) can arouse users' interest in ICH, 3) are appropriate for promoting ICH, and 4) are meaningful for ICH mobile applications.

The main finding is that the students viewed interaction as a key element of the game. They reported that interaction made it easier for users to remember and understand ICH and increased users' interest in ICH (Table 4.4).

Students mentioned the value of interaction 36 times in relation to remembering and understanding ICH, while achievement was mentioned only once (Table 4.4).

Result of the interviews

In the interviews, the students responded about their favorite game elements, and 25, 8 and 2 students mentioned interaction, storytelling and achievement respectively. The students believed that “Interaction is more appealing to me, and I would only be concerned with storytelling if the interaction is well-designed.”; “... the interaction can increase young people's engagement and arouse their interest.” “I enjoyed learning about the making of ICH through the interaction.”

Table 4.4 The result of think-aloud

Think-aloud	Frequency
(Interaction) This game element makes it easy for users to remember/understand ICH.	36
(Interaction) This game element can arouse users' interest in ICH.	24
(Interaction) This game element is appropriate for the promotion of ICH.	12
(Storytelling) This game element can arouse users' interest in ICH.	16
(Storytelling) This game element is appropriate for the promotion of ICH.	4
(Achievement) This game element can arouse users' interest in ICH.	6
(Achievement) This game element is meaningless for ICH mobile applications.	3
(Achievement) This game element makes it easy for users to remember/understand ICH.	1

4.3.2 Result of the ICH mobile application prototypes

The experience of the mobile application influenced the game elements and combinations of game elements that students included in their prototyping. Four Teams: Team1, Team 3, Team 5, and Team 6 used the game elements of interaction and storytelling. Three Teams: Team 2, Team 4, and Team 7 used achievement and interaction. One Team, Team 8 used interaction.

Prototypes using interaction and storytelling

Team 1 mobile application prototype of tea ceremony

This application describes the history and tools of tea-making and the tea-making process (Figure 4.4; Figure 4.5). The avatar rabbit narrates the process of tea-making and helps users to understand the content quickly. Users can also interactively complete the tea-making process to add to the experience.

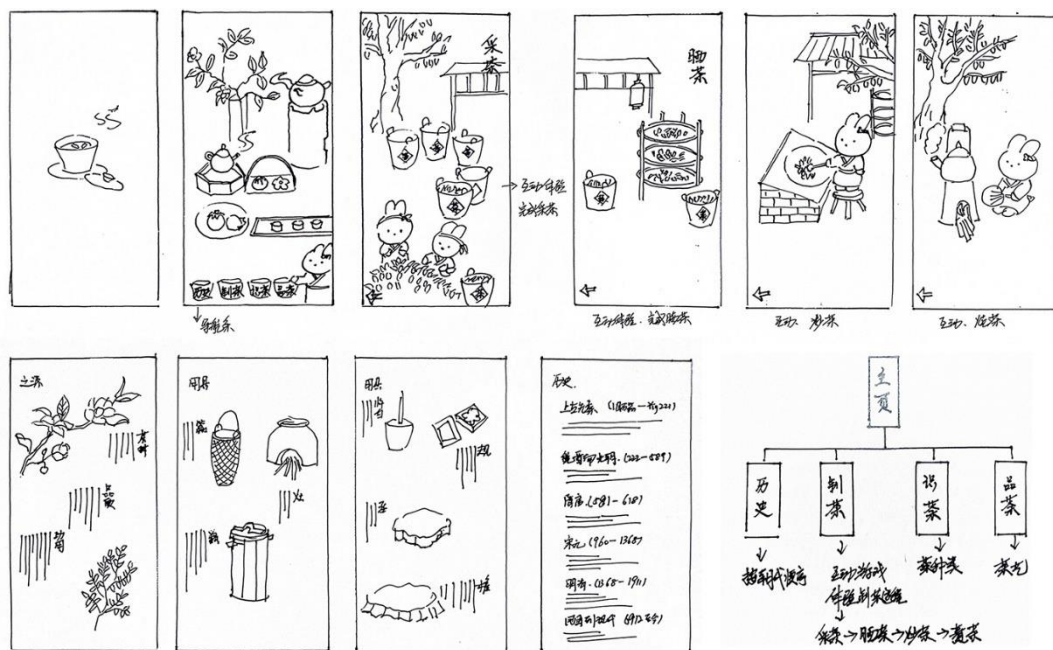


Figure 4.4 Team 1 Sketches of ICH mobile application design work



Figure 4.5 Team 1 ICH mobile application design work

Team 3 mobile application prototype of a lion dance culture

The application introduces the history and characteristics of the southern lion dancing, the process and tools used to make lion dancing props, and a guide to the lion dancing cultural heritage of Foshan City (birthplace of lion dancing) (Figure 4.6; Figure 4.7). It uses storytelling to guide users through the history of lion dancing. It also uses interactive features to guide users through the process of making lion dancing props.

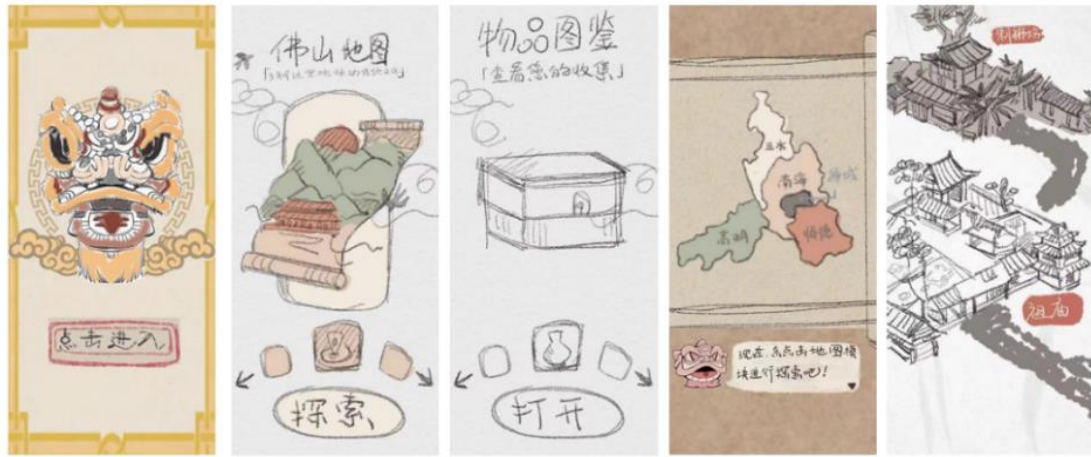


Figure 4.6 Team 3 Sketches of ICH mobile application design work



Figure 4.7 Team 3 ICH mobile application design work

Team 5 mobile application prototype of Dunhuang ICH

This application introduces the murals, sculptures, color paintings, woodblock prints, and paper-cutting art (Figure 4.8; Figure 4.9). It guides users by telling stories about the history of ICH. Users can earn achievements by completing interactive games, thereby unlocking the next item of ICH.

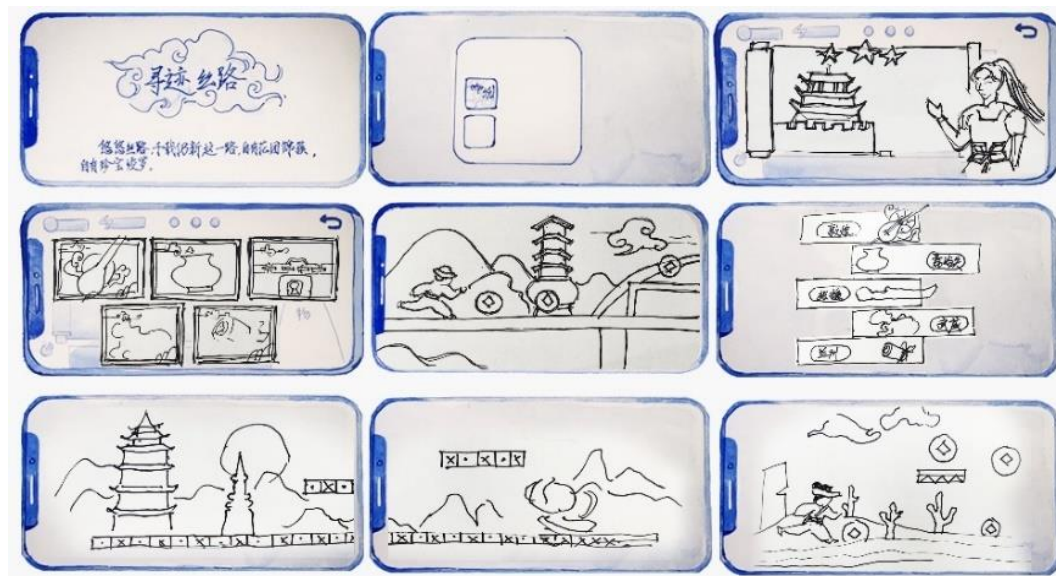


Figure 4.8 Team 5 Sketches of ICH mobile application design work



Figure 4.9 Team 5 ICH mobile application design work

Team 6 mobile application prototype of yellow wine

This application describes the history of yellow wine, the utensils used to make

yellow wine, and the process of making yellow wine. Users can participate in the making process interactively. (Figure 4.10; Figure 4.11).



Figure 4.10 Team 6 Sketches of ICH mobile application design work



Figure 4.11 Team 6 ICH mobile application design work

Prototypes using achievement and interaction

Team 2 mobile application prototype of Peking Opera

This application introduces the history, roles, singing styles, and costumes of Peking Opera (Figure 4.12; Figure 4.13). Users can unlock different Peking Opera characters by completing interactive games for achievements.

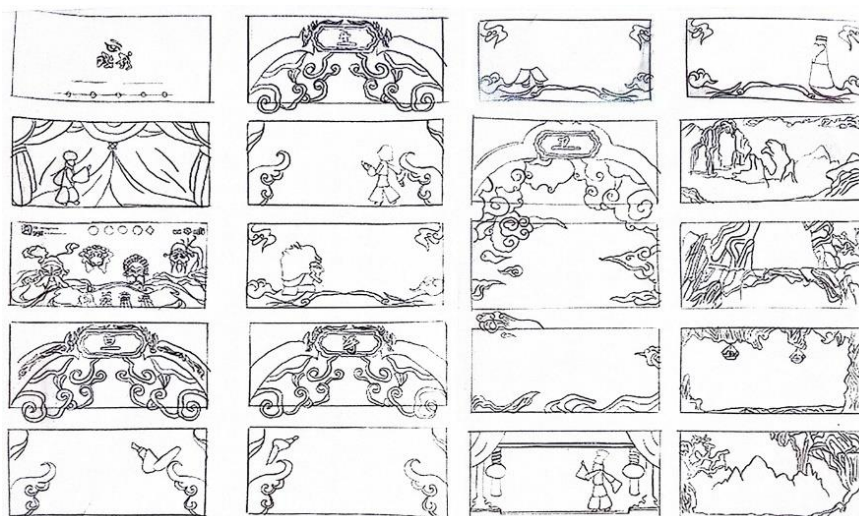


Figure.4.12 Team 2 Sketches of ICH mobile application design work



Figure 4.13 Team 2 ICH mobile application design work

Team 4 mobile application prototype of Tibetan theatre

This application describes the history, the culture of masks, the costumes, the instruments, and the music of Tibetan theatre. Users can achieve achievements through interactive games to unlock more Tibetan theatre music and costumes (Figure 4.14; Figure 4.15).

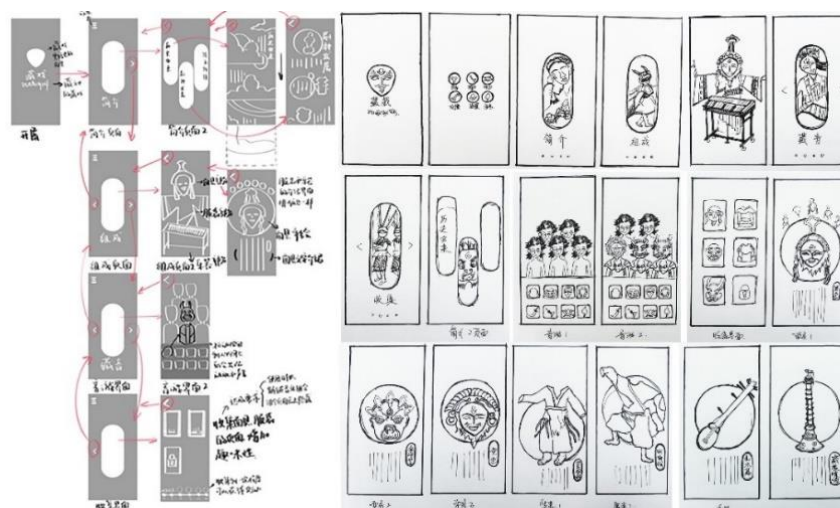


Figure 4.14 Team 4 Sketches of ICH mobile application design work



Figure 4.15 Team 4 ICH mobile application design work

Team 7 mobile application prototype of Weifang kites

This application introduces the history, classification, and meaning of Weifang kites, how to make Weifang kites, and builds a community of kite enthusiasts (Figure 4.16; Figure 4.17). User can make achievements by reaching the kite-flying locations shown in the application. User can upload the kite photos to the kite enthusiast community space to interact with other kite enthusiasts.

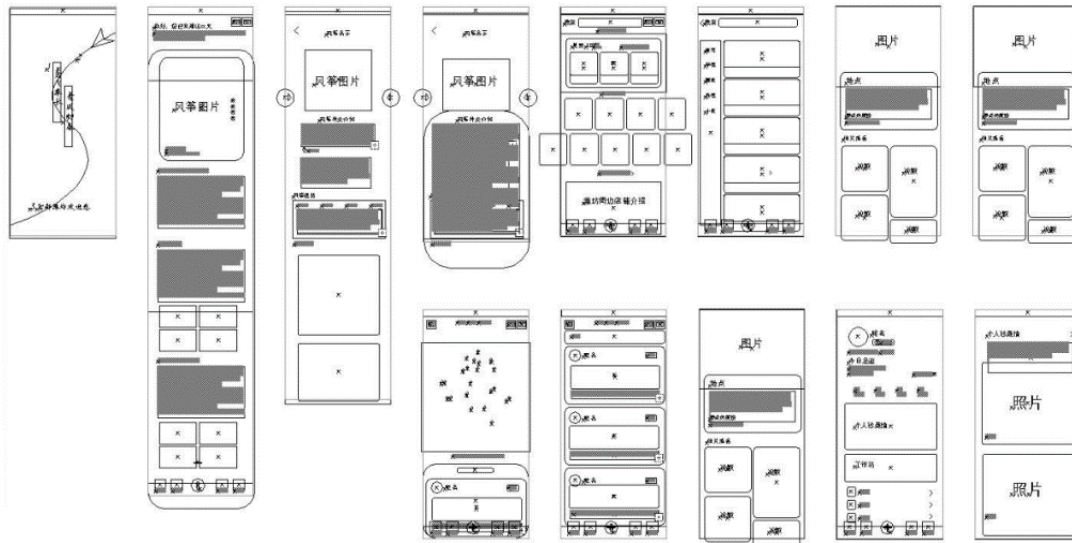


Figure 4.16 Team 7 Sketches of ICH mobile application design work



Figure 4.17 Team 7 ICH mobile application design work

Prototypes using interaction

Team 8 mobile application prototype of Tea Ceremony

This application introduces the history of the tea ceremony, tea-tasting tools, and the tea-tasting process (Figure 4.18; Figure 4.19). Users can interactively complete sections of the tea-tasting video.

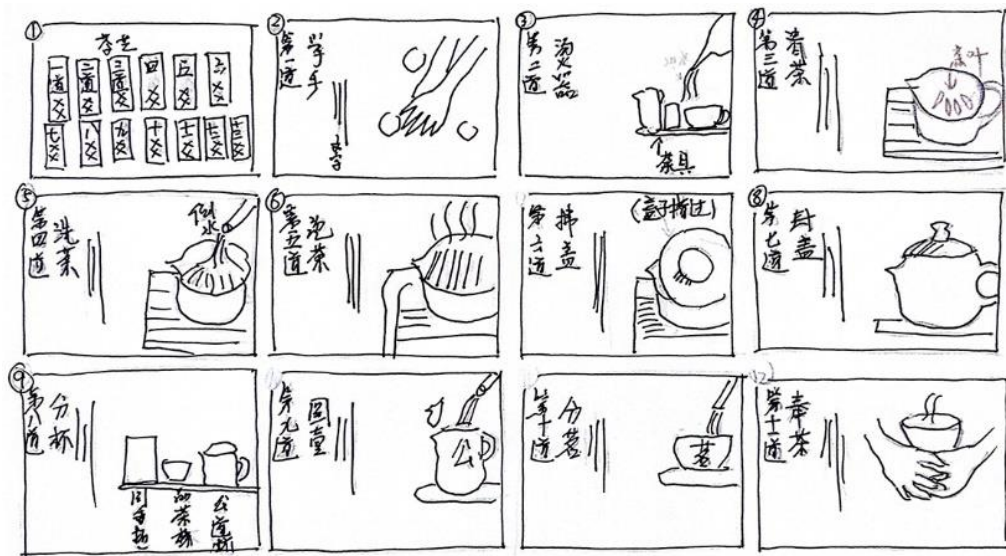


Figure 4.18 Team 8 Sketches of ICH mobile application design work



Figure 4.19 Team 8 ICH mobile application design work

4.3.3 Results of prototype evaluation

Experts assessed the ICH mobile application prototypes using a five-point Likert scale (Table 4.5). The author conducted a consistency test to check the reliability of the results. The intraclass correlation coefficient (ICC) of the three experts is 0.681, indicating the experts' ratings are highly consistent.

Table 4.5 The scores of Prototype Evaluation

Team	ICH fitness	Usability	Enjoyment and Pleasure	Interesting	Perceived usefulness
T1	5.0	4.0	4.3	4.3	5.0
T3	5.0	4.0	4.3	4.7	4.7
T6	3.7	4.0	3.3	4.0	4.0
T5	4.0	3.7	4.0	3.0	3.7
T4	4.0	4.0	3.0	3.3	3.7
T2	3.7	3.3	3.0	2.3	3.3
T7	3.3	3.0	2.7	2.3	2.7
T8	2.7	3.3	1.7	1.7	1.7

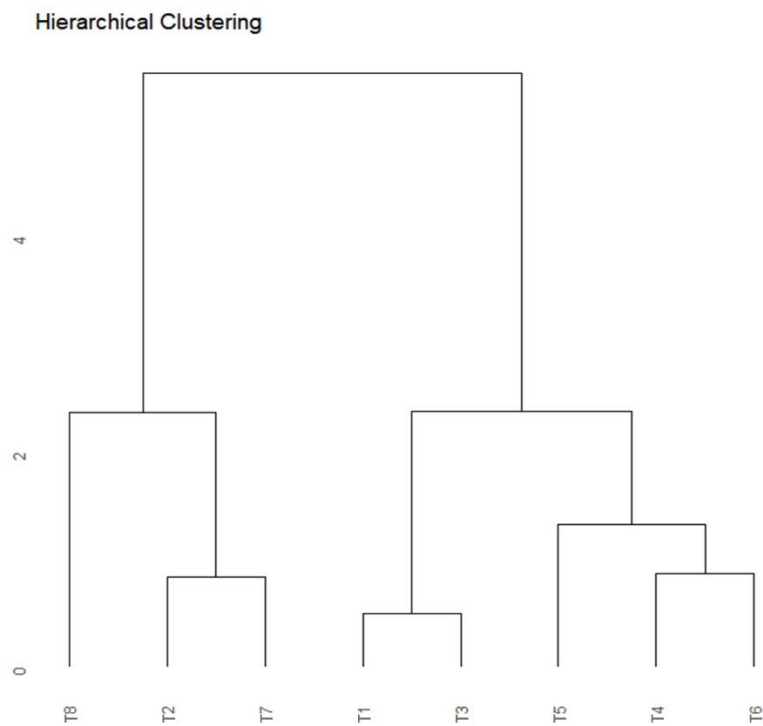


Figure 4.20 Hierarchical clustering of the Prototype Evaluation result

Hierarchical cluster analysis based on the scores (Table 4.5) yielded three cluster, with their hierarchical structures displayed as a dendrogram (Figure. 4.20). Team 1(T1) and Team 3 (T3) are grouped in one cluster owing to their very similar prototype scores. Team 5 (T5), Team 4 (T4), and Team 6 (T6) form a second cluster, while Team 2 (T2), Team 7 (T7), and Team 8 (T8) make up the third cluster. Based on the hierarchical cluster

analysis results, we ranked these groupings according to their prototype scores (Table 6).

For “ICH fitness”, the prototypes of Teams 1 and 3 which used interaction and storytelling earned the highest score of 5 points (Table 6), while the prototype of Team 8 received the lowest score.

For “usability”, prototypes from Teams 1, 3, 4, and 6 were scored highest with 4 points. Teams 1, 3, and 6 used interaction and storytelling, and Team 4 used achievement and interaction. Team 7 which used achievement and interaction was scored the lowest with 3 points.

For “enjoyment and pleasure”, prototypes from Teams 1, 3 and 5 which used interaction and storytelling were scored 4 points or higher. These Teams used virtual characters and interactive game elements to enhance interest. Only Teams 1 and 3 involved participants directly in traditional skills.

For “interesting”, Teams 1, 3 and 6 scored above 4 points. These Teams allow participants to experience making ICH. Team 3 receiving the highest score (4.7) used a lion avatar for storytelling and guided participants in making the lion head prop, increasing immersion.

The prototype of Team 1 was scored the highest on “perceived usefulness”. It used interaction and storytelling to introduce the history and culture of the tea ceremony. It also used an avatar to guide the participants through the tea production process. The prototype of Team 3 was also scored 4.7. It used avatars to tell participants the history and characteristics of the Southern Lion dance and guided them through the making of lion head props. The prototype of Team 3 included a map of the ICH site and a live introduction. The prototype of Team 8 was scored the lowest.

Table 4.6 The result of Prototype Evaluation

Team	ICH fitness	Usability	Enjoyment and Pleasure	Interesting	Perceived usefulness			
						A	I	S
T1	5.0	4.0	4.3	4.3	5.0	-	O	O
T3	5.0	4.0	4.3	4.7	4.7	-	O	O
T6	3.7	4.0	3.3	4.0	4.0	-	O	O
T5	4.0	3.7	4.0	3.0	3.7	-	O	O
T4	4.0	4.0	3.0	3.3	3.7	O	O	-
T2	3.7	3.3	3.0	2.3	3.3	O	O	-
T7	3.3	3.0	2.7	2.3	2.7	O	O	-
T8	2.7	3.3	1.7	1.7	1.7	-	O	-

A: Achievement, I: Interaction, S: Storytelling

4.4 Discussion

4.4.1 How basic game elements do affect students' impressions of ICH mobile applications?

Achievement and interaction both affected ICH mobile game applications, but in different ways. Storytelling did not affect ICH mobile game applications. Interaction had a significant positive effect and achievement had a significant negative effect on ICH mobile game applications.

Interaction had significant positive effects on the dimensions of “cultural fitness”, “enjoyment and pleasure”, and “interesting” indicating it is crucial for enhancing the user experience of ICH mobile applications. This result may be attributed to the distinctive elements evaluated in these dimensions and the unique characteristics of the ICH mobile game applications. The results of the “Think-Aloud” session further confirmed these findings: interaction features enhance students’ understanding and retention of ICH contents, a viewpoint expressed 36 times. Additionally, students indicated that interaction increased their interest in ICH, a view expressed 24 times in

the “Think-Aloud” session. Based on these empirical research results, it can be concluded that maybe interaction will support the users' interest in ICH. To the best of our knowledge, this study represents the first systematic investigation into the role of interaction in ICH mobile applications.

Achievement had a significant negative impact on “ICH fitness”, “usability”, and “perceived usefulness”, and had a weak negative impact on “enjoyment and pleasure”, “interesting”. Hence, it has a negative impact on mobile applications for ICH. These results align with previous research (Domínguez et al., 2013; Seaborn & Fels, 2015; Leitão et al., 2022). Particularly, Domínguez et al. demonstrate that competitive elements, especially leaderboards in achievement systems, often deter student engagement in gamified learning activities (Domínguez et al., 2013; Seaborn & Fels, 2015). This result is further supported by Leitão, R et al. (2022), who identified leaderboards probably as a primary factor in reduced learning outcomes (Leitão et al., 2022). However, our findings present a contrasting perspective to several previous studies (Filsecker & Hickey, 2014; Denny, 2013; Hakulinen et al., 2013; Hamari, 2017; Hakulinen et al., 2015; Seaborn & Fels, 2015; Hamari, 2013; Rocha Seixas et al., 2016). Filsecker, M. et al. (2014) partially confirmed the positive effects of achievement, and showed its neutral impact on student motivation (Domínguez et al., 2013). Multiple studies have validated the motivational benefits of badges (Filsecker & Hickey, 2014; Denny, 2013; Hakulinen et al., 2013; Hamari, 2017; Hakulinen et al., 2015; Seaborn & Fels, 2015; Hamari, 2013; Rocha Seixas et al., 2016). This research reveals a distinct pattern in the context of ICH mobile applications. The observed negative impact may be explained by the absence of typical achievement motivation elements (e.g., social status, completionism, and prolonged engagement) in ICH mobile applications, as noted by Montola et al. (Montola et al., 2009). Without these motivating factors, the achievement features in ICH applications may fail to engage users, potentially leading to diminished motivation. The transient nature of ICH information exploration, in contrast to long-term gaming engagement, may explain the weak motivational effect of achievement in this context. Notably, our analysis revealed a low correlation between

achievement and ICH knowledge acquisition. This result suggests that the perceived disconnect between achievement and ICH content may limit the effectiveness of these features in supporting user learning.

Analysis revealed that storytelling did not demonstrate significant effects, which contrasts with previous research findings. While numerous studies consistently show that storytelling and rich narrative elements enhance user immersion and engagement (Tan & Ng, 2024; Jemmali et al., 2018; Shang & Ni, 2024; Rughiniş, 2013; Torsi et al., 2020; Sylaiou et al., 2020), this effect was not observed in the context of ICH mobile applications. This discrepancy may be attributed to the inherent nature of ICH information dissemination, which traditionally relies heavily on storytelling techniques. Interestingly, qualitative feedback from participants indicated that while storytelling alone did not show significant impact, its combination with other game elements was perceived as engaging and enjoyable. Participants particularly appreciated the integration of storytelling with interaction. This result suggests that the effectiveness of storytelling in ICH mobile applications may be contingent upon its synergistic implementation with interaction, rather than its standalone application.

4.4.2 How do students' design ICH mobile game application prototypes by using game elements?

In "ICH fitness," the prototypes of Teams 1 and 3, which used both interaction and storytelling, were scored significantly higher than the other Teams. For “enjoyment and pleasure”, prototypes from Teams 1, 3, 5, and 6 combining interaction and storytelling consistently outperformed Teams 2, 4, and 7 (achievement and interaction) and Team 8 (interaction alone). Similarly, in perceived usefulness, Teams 1, 3, 5, and 6 outperformed Teams 2, 7, and 8. These results suggest combining interaction and storytelling is more effective in attracting users and stimulating interest in ICH mobile game applications. A likely reason is that this combination create a more immersive and emotionally engaging experience, and stressed the importance of storytelling in

keeping users engaged and supporting meaningful learning. This conclusion aligns with Liu et al. who show that experience systems using interaction and storytelling greatly improve audience engagement and knowledge (Liu et al., 2022). Blythe et al. also argued that interaction should be integrated more deeply into storytelling to enhance experience (Blythe et al., 2011). While our findings suggest that combining interaction and storytelling is generally more effective than pairing achievement and interaction, we also notice an interesting result. Team 4 blending achievement and interaction, actually out performed better than Team 5 which combined interaction and storytelling. The prototype of Team 4 was scored higher in “usability” and “interesting” which might be because Team 5 focused more on surface-level engagement, rather than encouraging deeper cognitive involvement. In other words, the learning content was not fully woven into the game elements reducing the benefits of game-based learning. In contrast, the prototype of Team 4 did a wonderful job of connecting cognitive learning goals with game features, thus keeping users engaged and helping them meaningfully understanding of ICH. This thoughtful approach improved knowledge retention and created strong links between game mechanics and cultural learning. As a result, Team 4 achieved impressive performance. These findings are consistent with previous research by Kiili et al. (2019) and Manuel Ninaus et al. (2023). reporting that the advantages of game-based learning can be lost when game content and mechanics are not well integrated (Kiili et al., 2019; Ninaus et al., 2023).

4.4.3 Difference between results of practice and prototype

The results from practice and prototype differ. Findings from practice section indicate that interaction positively influence ICH mobile game applications, while storytelling has no significant effect. Achievement had a significant negative impact on “ICH fitness”, “usability”, and “perceived usefulness”, and a weak negative effect on “enjoyment and pleasure” or “interesting”. In prototype evaluation, prototypes employing both interaction and storytelling achieve the highest scores, which is unexpected. This result indicates that storytelling alone does not significantly impact

ICH mobile game applications, but when combined with interaction, it yields positive effects. A possible reason that traditional methods of transmitting ICH rely heavily on storytelling techniques. Consequently, in the ICH field, storytelling fails to play a positive role. However, the combination of interaction and storytelling enhance the narrative experience (Blythe et al., 2011), thereby exerting a positive influence on ICH mobile applications. Therefore, we recommend considering the combination of interaction and storytelling in the design of ICH mobile applications to heighten users' interest in and acceptance of ICH. Additionally, prototypes using interaction elements alone are scored the lowest. The prototype of Team 8, which uses interaction, receives relatively low scores, which may stem from the failure to effectively integrate gaming elements with ICH contents. Specifically, the design failed to establish substantive cognitive associations between the gaming elements and ICH, diminishing the advantages of incorporating gaming elements into ICH mobile applications.

Chapter 5 Design Practice of ICH Mobile Application in a Design Course

5.1 The ICH design course based on ICH design guideline and ICH Gamification design

Traditional ICH courses often fail to provide students with comprehensive knowledge of ICH. They frequently overlook the extended meanings embedded within design works. This leads to a superficial understanding of ICH and inaccurate reflections of its cultural significance in design pieces. Also, conventional ICH courses struggle to spark students' interest. In Study 1, the author established ICH Design Guideline. The guideline instructed students on collecting ICH cultural data and analyzing ICH cultural data, and designing ICH products. Results show that the ICH design guideline provided support to students throughout these processes. In Study 2, the author evaluated game elements. Integrating interaction with storytelling in an ICH mobile application prototype yielded positive outcomes. It bolstered students' interest in ICH. To evaluate the effectiveness of the ICH design guideline and ICH gamification in the same course, we implemented them in an ICH design course. It aimed to enhance students' learning of ICH and enhance their interest in ICH.

This research question is: RQ3.1 How the new course design works in ICH mobile application prototype by students?

5.1.1 The ICH design course

This course consists of two parts (Figure 5.1): (1) pre-design. This section contains the application of the ICH design guideline to collect ICH cultural data, analyze ICH cultural information, and design ICH product; (2) ICH mobile application design. This section applies the results of the analysis of the game elements in the previous ICH cultural information analysis to design the ICH mobile application prototype.

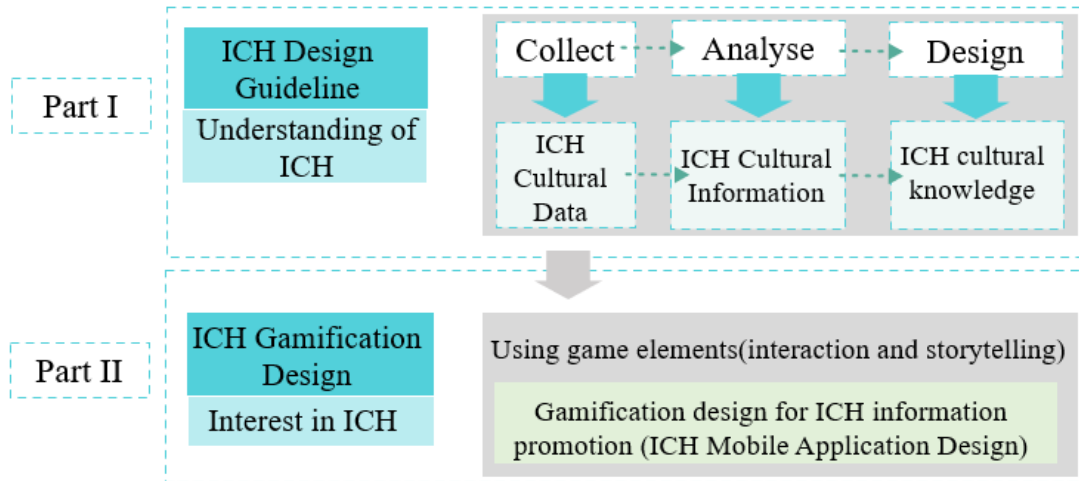


Figure 5.1 ICH Course design

5.1.2 Definitions of data, information and knowledge

Data

Data has experienced a variety of definitions. Data are unprocessed, primitive symbolic entities (Belkin & Roberstson, 1976; Blair, 2002); they are sets of characters, symbols, numbers, and audio/visual bits represented and/or encountered in raw form. (Zins, 2007 citing Haidar Moukdad). Data are the representation of concepts or other entities. (Zins, 2007 citing Wellisch, 1997), and representations of facts about the world. (Zins, 2007 citing H. M. Gladney), and they are defined as symbols that represent the properties of objects, events, and their environment (Ackoff, 1989). In this study, ICH cultural data refers to ICH name, Shape, Color, Pattern, Function, Material, etc.

Information

Information is an organized collection of disparate datum (Zins, 2007) . It is inferred from data. (Rowley 2007). It is data that is organized to produce meaning (Zins, 2007). It has real or perceived value for current or future actions or decisions (Bierly III et al., 2000 citing Davis & Olson, 1985). In this study, ICH cultural information refers to the collation of data on ICH culture and the selection of game elements that have a positive impact on ICH mobile applications through mobile application

experience (Interaction and Storytelling).

Knowledge

Knowledge does not exist objectively it is internalized by the perceiver and therefore 'shaped' by their existing perceptions and experiences (Hey, 2004). Knowledge is an appropriate collection of information (Bellinger et al., 2003), something that individuals take from information and data, and something that they incorporate into their beliefs, values, procedures, actions, etc. (Zins, 2007). In this study, ICH cultural knowledge means that students take design elements from ICH cultural data and ICH cultural information, use the design elements to reconstruct ICH shapes, colors, and patterns, and design ICH products. The students designed the ICH mobile application framework and designed the ICH mobile application prototype. The ICH mobile application prototype contains collated ICH cultural information and the ICH design product.

5.2 Practice

The program takes place in a fourth-year university class over five weeks. In the first week, the instructor provides two lectures: an introduction to ICH and an approach to ICH mobile application design. From week 2 to week 5, students design ICH mobile application prototypes. In the last lecture of week 5, students present their team's ICH mobile application prototypes.

5.2.1 Participants

This practice was conducted at Dalian Polytechnic University in October 2024. The participants were 26 students from a fourth-year class of Visual Communication Design Department students at this university. These students have studied pattern design, creative design, media design, and other courses and have a foundation in design. The students often use mobile applications and have smartphone devices.

5.2.2 Course Description

This practice was conducted in the ICH Design course, which is a 5-week course with a total of 64 class hours, with 2 instructor-led classes in the first week of 4 class hours each. The teaching process focuses on designing ICH mobile application prototypes using the ICH Design guideline. Students worked independently in teams and a collaborative learning environment. Students were divided into 13 teams of 2 students each. Instructors teach face-to-face and use specific cases to enable students to achieve precedent-based learning. Cases are screened for appropriateness and students are taught how to use the ICH Design Guideline and design ICH mobile applications for specific cases. And students were required to collaborate in the creative process, applying game elements to design ICH mobile application prototypes, to solve the problem of low awareness of and disinterest in ICH among university students.

5.2.3 Method

The author conducted semi-structured interviews with 26 participants from the Visual Communication Department to better understand their attitudes toward the ICH design guideline and the ICH mobile application prototype. With the participants' consent, the author recorded the interviews. Each team interview lasted 10 – 15 minutes, during which participants were asked to answer two questions: (1) Please share your thoughts on the ICH design guideline; (2) Please share your attitude towards the ICH mobile application design. Researchers used inductive qualitative analysis to code and categorize the open-ended responses.

The author also interviewed seven experts of inheritance to understand their attitudes toward the ICH design guideline and the ICH mobile application prototype. With the participants' consent, we recorded the interviews. Each interview lasted 10 – 15 minutes. The experts of inheritance were asked to answer two questions: (1) Please share your thoughts on the ICH design guideline; (2) Please share your thoughts on ICH gamification design. The researcher used inductive qualitative analysis to code and categorize the open-ended responses.

5.2.4 Practical process

The practice is divided into two parts:

Part I: Use the ICH design guideline to collect ICH cultural data, analyze ICH cultural information.

There are several steps in the first phase:

Data Collection Phase: First, students begin to collect and understand the data that shapes ICH design based on the ICH design guideline. Through this step, students use the design guideline to extract foundational data such as shape, pattern, color, material technology, structure, and function from the original cultural object. Successful design requires a deep understanding of the cultural attributes of ancient cultural artifacts. An important step in the creation of cultural value is the interpretation of the original cultural information. Proper interpretation of cultural artifacts avoids simple copying of the source of inspiration. According to the design guideline, students collected data on the external characteristics of ICH in (1) the microsystem, including shape, color, texture, pattern, and material, and (2) students collected data on the policies of the international community, national policies for the protection and heritage of ICH, as well as on new technologies in the exosystem, and (3) students learned about ICH connotations, beliefs, and cultural dimensions in the macrosystem to learn about its history, as well as the emotional and symbolic cultural connections. Internal ‘intangible’ and intermediate ‘behavioral’ dimensions can be more effective in increasing satisfaction with cultural offerings than external ‘tangible’ dimensions (Chai et al., 2006), and the ‘behavioral’ dimensions can be more effective in increasing satisfaction with cultural offerings (Chai et al. 2015).

Analyzing the information stage: The first step was to collate the ICH cultural data to form ICH cultural information. The students compared the collected ICH cultural data horizontally and vertically and gave their conclusions. For example, a team of students worked on the topic of clay sculptures, they compared the differences in shape and color of clay sculptures in different regions horizontally, compared the changes in shape and color of clay sculptures in different dynasties vertically, and finally concluded the characteristics of clay sculptures in this region, the reasons for their formation, and the meanings they expressed. At this point, the ICH cultural information was formed. The next step was the analysis of game elements to refine the game elements that are effective for ICH mobile applications (the analysis of game elements was completed in Study 2).

Part II: Prototyping ICH mobile applications using game elements: interaction and storytelling

In the second stage there are several steps:

Knowledge formation stage: Students used ICH cultural information to distill design elements and design new ICH products through decomposition, reframing, and transformation. Students also designed a prototype ICH mobile application using a combination of game elements interaction and storytelling. The content of the prototype application includes: the history of ICH, the analysis of ICH shape and color characteristics, the production process of traditional ICH handicrafts, ICH design works, etc. The prototype of the ICH mobile application shows the audience the cultural information of ICH and the knowledge of ICH culture.

Presentation Stage: In the work exchange session of the class, students present the prototype of the ICH mobile application designed by their team and explain how it is used. After the presentations, students evaluate each other's design work and give feedback.

5.3 Result

5.3.1 Result of the prototypes

The result of the students' ICH mobile application prototypes

Team1' design work: Nuo Mask-ICH mobile application

In the data collection stage, students categorized the ICH cultural data collected and analyzed the reasons for creating Nuo masks (Figure 5.2, Figure 5.3).

In this prototype, they introduced the content of each part of this mobile application through character introduction. The part of the history of Nuo masks is introduced through storytelling about the origin and development of Nuo masks. In the introduction of the production process of Nuo mask part, they introduced the production process of Nuo masks through the interactive game elements (Figure 5.4).

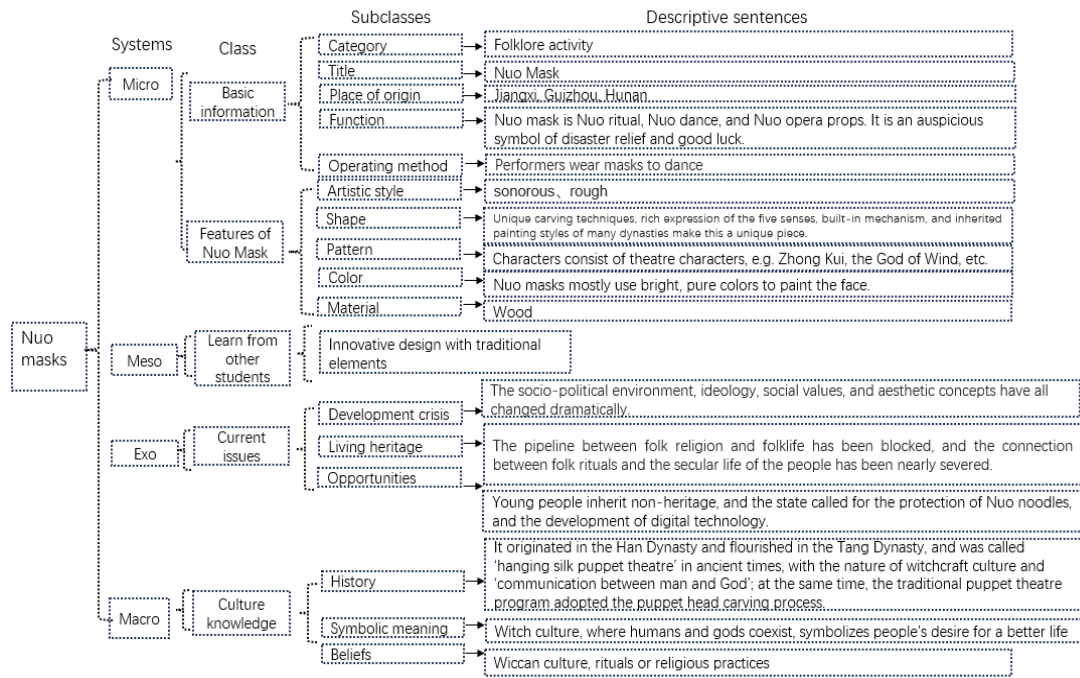


Figure 5.2 Team 1's ICH Design Guideline results-ICH cultural data

Micro

Basic Information on Nuo Masks

- Origin**
- Artistic style**
- Differences Between Nuo mask characters**
- Different Regional Variations of Nuo Masks**

The Traditional Craft of Nuo Masks

Exo & Macro

The Development of Nuo mask in Different Dynasties

- Tang Dynasty**
- Song, Yuan Dynasty**
- Ming, Qing Dynasty**
- Modern Society**

belief

Figure 5.3 Team 1's ICH design guideline result- Analysis of ICH Cultural Information



Figure 5.4 Team 1's design work- Nuo Mask mobile application prototype

Team 6' design work: Marriage Customs in the Tang Dynasty Mobile Application Prototype

However, team 6 did not conduct a thorough analysis of the ICH cultural information, failing to examine the characteristics of iron flower making across different dynasties (Figure 5.5, Figure 5.6).

In this prototype, they introduced the history of iron flower display through a combination of images and textual explanations (Figure 5.7). They employed interaction and storytelling to illustrate the operational process of the iron flower display. However, presenting history through images and text tends to be rather dull. Moreover, the interactive elements in the iron flower display process are scarce and lack appeal.

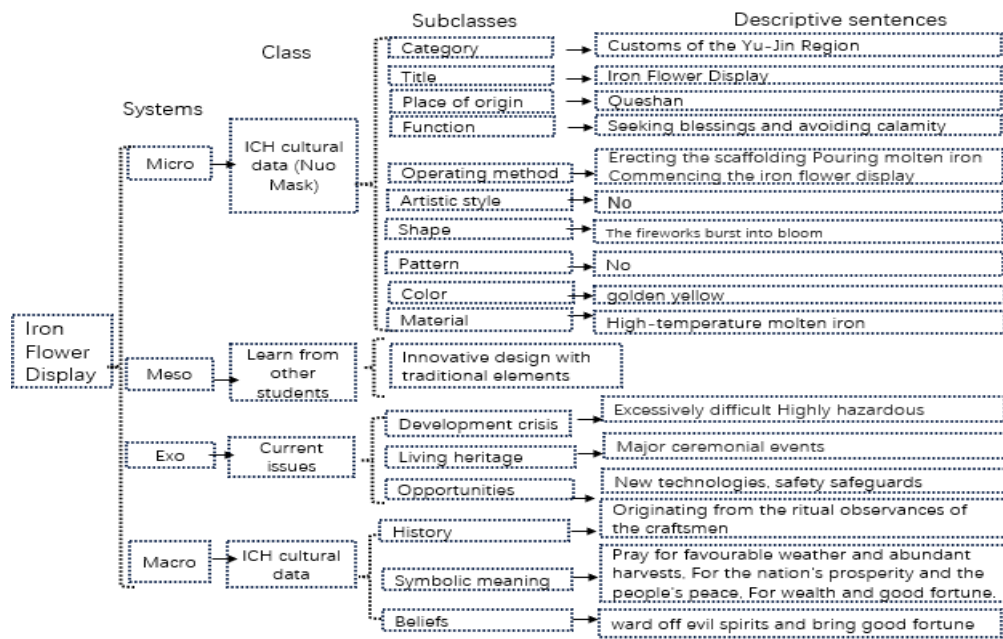




Figure 5.7 Team 6's design work- Iron Flower Display Mobile Application Prototype

The result of the evaluation of the prototypes

The author conducted a hierarchical cluster analysis on the prototypes' scores based on Table 5.1 (Figure 5.8). The analysis revealed three major clusters among the teams. The first cluster included teams 6,13, and 9, all of which had lower overall scores, with team 6 scoring the lowest. The second cluster consisted of teams 4, 5, 7, and 10 which generally had middle scores. The third cluster consisted teams 3, 11, 12, 2, 8, and 1, which generally had higher scores. Within the third cluster, teams 1 and 8 achieved the highest scores, and teams 2, 3, 11, and 12 had similar, relatively high scores (Table 5.1).

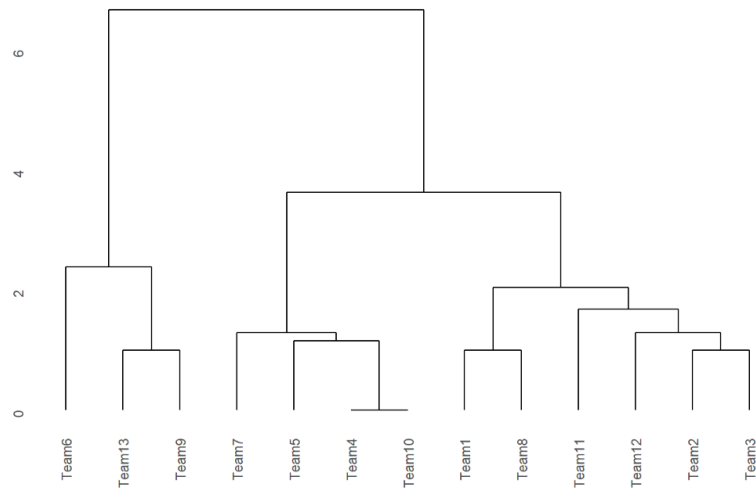


Figure 5.8 The result of expert evaluation- Hierarchical cluster

Table 5.1 The result of expert evaluation

Team	ICH fitness	Usability	Enjoyment and Pleasure	Interesting	Perceived usefulness
Team 1	5.0	5.0	4.7	5.0	4.7
Team 8	5.0	4.3	5.0	5.0	4.7
Team 2	5.0	4.3	4.7	4.7	4.3
Team 12	5.0	4.3	4.7	4.3	4.3
Team 3	4.7	4.3	4.3	4.7	4.3
Team 11	5.0	4.7	4.3	4.0	4.3
Team 10	4.3	4.0	3.7	3.7	4.0
Team 4	4.3	3.7	3.7	3.7	4.0
Team 5	4.3	4.0	3.7	4.0	3.3
Team 7	4.3	3.7	3.7	3.0	3.7
Team 9	3.3	3.7	3.3	3.0	3.0
Team 13	3.7	4.0	3.0	2.7	3.3
Team 6	3.0	3.0	2.3	2.0	2.3

5.3.2 The results based on classroom observations

The author observed the students during the teaching process and found that most of them were highly engaged in class. Students actively answered our questions and engaged with us. They collected, organized, and analyzed ICH cultural data according to the ICH design guideline to form ICH cultural information. Students also designed

ICH products based on the three directions outlined in the ICH design guideline. Especially in the ICH gamification design section of the model, students demonstrated particularly high enthusiasm. They actively discussed how to incorporate game elements into the design of ICH mobile applications.

5.3.3 The Result the Interview

The result of the students' interview

After the teaching practice, the author interviewed the students to ask their opinions on the ICH design model to evaluate its effectiveness. As shown in Table 5.2.

Table 5.2 The result of Student Interview

Student Interview (N: 26)	N
The ICH design guideline enhances students' understanding of ICH	15
ICH gamification design enhances students' interest in ICH.	19

Table 5.2 shows that in the interview results, the phrase "The ICH gamification design has enhanced students' interest in ICH" appeared frequently among students, with 19 individuals mentioning this point. Next was "ICH design guideline enhanced students' understanding of ICH," cited by 15 students. From the above results, we can see that students have a high level of recognition for the ICH course. Therefore, we infer that the ICH design course supported students' understanding of ICH and their interest in it.

The result of ICH experts of inheritance interview

The analysis of student interview results indicates that all students provided positive responses, with no negative feedback regarding the implementation of the ICH design framework in teaching practices. Therefore, the author conducted interviews with experts of inheritance. Each interviewee provided informed consent before the interview. After clearly informing the interviewees of the purpose of the interview, their informed consent was obtained. The purpose of the interview was to understand the perspectives of the experts of inheritance on the application of the ICH design guideline

and ICH gamification design in the classroom. The interviewees were seven experts of inheritance. The author coded the interviewees as E1, E2, E3, E4, E5, E6, and E7. Part of the interview records are shown in Table 5.2.

Table 5.3 The result of ICH experts of inheritance Interview

Interviewee	Description
E1	<i>We have been researching, developing, and improving our products for many years, designing lots of ICH products. I hope more young people will join us in carrying on and promoting the traditional skills of ICH. Therefore, I support you in offering this course at universities and using ICH design guideline and ICH gamification design.</i> <i>I believe that attempting to promote or pass on traditional culture using new methods is a very good thing, even if it is only in form, as it will have a significant impact on future development. Whether or not traditional styles are broken with is not important, because it is precisely. After all, these traditional styles do not meet contemporary needs and Chinese traditional culture has declined. Breaking with tradition can give Chinese traditional culture new vitality, which is very important.</i>
E2	<i>This ICH design guideline is excellent for helping students understand ICH, and ICH gamification design can enhance their interest in ICH. In addition, we often say that ICH disappears or has very few inheritors because it does not meet the needs of contemporary society and is therefore eliminated. If the course can spark students' interest or, through your design, give Chinese traditional culture new vitality, it will be a truly meritorious endeavor.</i>
E3	<i>Our excellent traditional culture also needs to be made known to more young people. The best way to promote it is through education, in university courses. This ICH design guideline is quite good, allowing students to gain a deep understanding of ICH. The ICH gamification design sparked their interest in ICH. By letting them know that our country has so many outstanding cultures, we can foster national confidence.</i> <i>Time is changing, and ICH should also adapt to the changing times. Using modern technology and modern forms is inevitable.</i>
E4	<i>From my perspective, I think it's quite good. The ICH gamification design is very interesting. Many young people visit my studio, and they become interested in it before delving deeper into it, only to discover that ICH is not as simple as they thought, but also involves many techniques and theories. Therefore, young people must first become interested in ICH before they can recognize its value.</i>

	<i>We have been discussing what aspects of our traditional culture should be preserved. Preservation is essential, but we cannot remain rigid; we must develop. We have preserved traditional craftsmanship and combined traditional elements with contemporary styles to suit modern tastes.</i>
E5	<i>Many universities have launched ICH-related activities on campus, which demonstrates the importance universities place on ICH education. The ICH design model is particularly effective in helping students understand the deeper aspects of ICH knowledge. I have also seen many works designed using ICH elements, but they arbitrarily alter the original graphic combinations of ICH. For example, the facial makeup is fixed and cannot be altered; if the pattern is changed, the entire meaning of the facial makeup is altered. I believe this is incorrect. When designing new functional products based on ICH, it is essential to design them while respecting the original meaning of ICH. Therefore, I think the ICH design guideline is excellent.</i>
E6	<i>I have been invited by several universities to teach traditional skills to university students. In our courses, students use traditional skills and combine them with modern forms to design functional ICH products. However, some students do not fully understand ICH, which can lead to mistakes in the meaning of their design works. I think this ICH design guideline is quite good. A correct understanding of ICH is the foundation for designing ICH products.</i>
E7	<i>The problem we are facing now is that young people are not willing to learn traditional ICH skills. I want to teach them everything I know, but they are not interested. It is great that you have set up such courses at the university. The ICH design guideline and ICH gamification design enable the students to learn more about ICH and become interested in it. Young people are unwilling to become inheritors of ICH because they do not understand it.</i>

The findings according to sorting and analysis of the interview transcripts are as follows:

Support for offering ICH design courses at university.

According to 3 of the 7 interviewees, believe that it is necessary to offer ICH design courses in universities. Respondent E1 mentioned the hope that more young people would join the ranks of ICH inheritors and supported the establishment of ICH design courses in universities. Respondent E2 believed that our good traditional culture

also needs to be made known to more young people. The best way to promote it is through education, specifically in university courses. Respondent E7 mentioned that establishing ICH design courses in universities would allow young people to gain a deeper understanding of ICH, which is very beneficial.

It is necessary to establish an ICH design model in university courses.

The interview records show that all seven interviewees believe the ICH design course is good. Respondent E2 believes that if the ICH design course can spark students' interest or, through our design, breathe new life into Chinese traditional culture, it would be a highly commendable endeavor. Respondents E3 and E4 mentioned that they hope the ICH design guideline can help young people gain a deeper understanding of ICH and develop an interest in it. They believe that increasing young people's interest in ICH is key, so the ICH gamification design is essential. Two respondents, coded as E5 and I6 noted that the ICH design course is crucial for students to deeply understand ICH, as a correct understanding of ICH is the foundation for designing ICH products. Only designs that respect the original meaning of ICH can truly inherit and continue its legacy. Respondent E7 pointed out that the lack of ICH inheritors stems from most young people's lack of understanding of ICH, making it essential for young people to gain a deep understanding of ICH. Therefore, the application of the ICH design guideline and gamification design in the course is necessary.

The inheritance of ICH must keep pace with the development of the times.

Three interviewees coded as E1, E3, and E4 suggested that ICH should keep pace with the times. Traditional handicraft techniques should be combined with modern forms to meet the aesthetic tastes of contemporary people.

5.4 Discussion

How the new course design works in ICH mobile application prototype by students?

Analysis of Prototype Evaluation Results

The results indicate that Team 1 and Team 8 achieved the highest scores. Regarding the application of the ICH design guideline, both teams demonstrated extensive collection of ICH cultural data and detailed analysis of ICH cultural information. They used storytelling and interaction as game elements throughout their ICH mobile application design. These elements were effectively integrated, reflecting efficient utilization of both the ICH design guideline and game mechanics.

Conversely, Team 6, which scored lowest, failed to collect ICH data effectively and conducted overly simplistic analysis of ICH cultural information. This resulted in a superficial understanding of ICH. Their mobile application demonstrated a scarcity of storytelling and interaction as game elements. Although they incorporated a small interactive game, this failed to connect meaningfully with ICH knowledge. Learning content was not deeply integrated with game elements, thereby diminishing the effectiveness of gamified learning.

Analysis of interview Results

According to interview data, students unanimously deemed the ICH design course used the ICH design guideline and gamification design to be effective. The ICH design guideline guided students through the process of collecting ICH cultural data, analyzing ICH cultural information, and designing ICH products and ICH mobile application prototypes. It bolstered their comprehension of ICH while heightening their interest in the subject. Experts of inheritance deemed it essential for universities to establish ICH design courses that utilize the ICH design guideline and gamification design. Such courses can support students' ICH learning and interest in ICH, assist them in creating design works with precise meaning, and facilitate the identification of potential bearers.

Chapter 6 Conclusion

6.1 Conclusion of this Dissertation

The main objective of this dissertation is building a design course for ICH with mobile application to support students' ICH learning and interest in ICH. Three specific sub-objectives were proposed: sub-objective 1 is to explore an ICH design guideline for design students, and sub-objective 2 is to evaluate gamification elements for ICH mobile application, sub-objective 3 to demonstrate design practice of ICH mobile application by combining ICH design guideline and game elements.

The following are the conclusions of the three objectives:

6.1.1 Conclusion for the Sub-Research Objectives

Sub-Research Objective 1 (SRO1): In this study (Chapter 3), the author created an ICH Ecological System based on EST and established an ICH design guideline. The author explored the effectiveness of the ICH design guideline and the efficiency of interdisciplinary teams in utilizing digital technologies to outperform ordinary single-disciplinary teams under the guidance of the ICH design guideline. Under the ICH design guideline, interdisciplinary teams with digital technologies can create innovative and effective product designs by comparing them to conventional single-discipline teams.

The ICH design guideline guided students through ICH data collection, information analysis, and extraction of cultural elements. The results showed that the students' designs scored well on all five evaluation criteria. These outcomes met the instructional objectives, indicating that the ICH design guideline was effective for the students' design process and ICH learning.

With the help of the ICH design guideline, participants learned to conduct research on intangible cultural wealth. They started from the historical and cultural context of intangible cultural properties in the macrosystem. They also focused on exosystem ICH preservation initiatives and new technologies used in cultural places.

Students selected similar ICH items from different regions, ethnic groups, or genres for comparative analysis, and found that there are significant differences in stylistic features, color characteristics, forms of expression, and inheritance mechanisms of ICH items from different regions. They collected time series data of ICH items, changes in ICH modeling, colors, and meanings over time. They also explored the cultural symbols, beliefs, and social values behind ICH.

This study primarily investigated whether interdisciplinary teams using digital technologies, guided by the ICH design guideline, could outperform traditional single-discipline teams. The results showed that such approaches were superior on four criteria: cultural fit, creativity, experience, and diversity, though there was no significant improvement in aesthetics. The study addresses how the guideline supports deeper student understanding of ICH, more meaningful design work, and engagement with ICH connotations. Interdisciplinary teams using digital tools generated new ideas, transformed student thinking, moved beyond mere graphic design, and enabled artistic students to engage more with physical design work than in traditional methods.

Sub-Research Objective 2 (SRO2): In this study (Chapter 4) the author evaluated the three gaming elements (interaction, achievements, storytelling) in the ICH mobile game application, analyzed the reasons for the differences and designed ICH mobile application prototypes.

The results of ‘Think-Aloud’ showed that students mentioned 36 times that ‘Interaction can make it easier for users to remember ICH’ and 24 times that ‘Interaction can arouse users’ interest’. The results show that interaction plays a positive role in ICH mobile applications, while achievement does not play a positive role in ICH mobile

applications. In other words, achievement influence the acceptance of information in ICH mobile applications. In the prototype section, students used game elements to design ICH mobile application prototypes. Four of the teams used two game elements: interaction and storytelling. The results of the evaluation of the ICH mobile application prototypes showed that the prototypes that used a combination of interaction and storytelling scored higher in terms of enjoyment and fun. Therefore, the combination of interaction and storytelling is more likely to arouse users' interest. Therefore, we can conclude that the proposed game elements applicable to mobile applications for ICH are a combination of interaction and storytelling. The results of this study address the issue of low student interest in ICH. The combination of game elements interaction and storytelling in ICH mobile applications is more likely to be interesting and memorable for university students.

Sub-Research Objective 3 (SRO3): In this study (Chapter 5) the author implemented the findings from Study 1 and Study 2, serving as a practical application and validation of the ICH design guideline and gamification design in the ICH design course.

First, guided by the ICH design guideline, students collected and categorized ICH cultural data. They conducted comparative analyses of similar ICH projects across different regions, ethnic groups, or genres, identifying significant variations in stylistic features, color schemes, and expressive forms. Chronologically, they examined how ICH evolved over time in terms of form, color, and meaning, while exploring the underlying cultural symbolism, beliefs, and societal values. Students synthesized their analysis of ICH cultural information into narrative introductions that highlighted the characteristics and history of ICH. Subsequently, they employed interaction and storytelling elements to design prototypes for an ICH mobile application. The prototype content encompassed introductions to the history and characteristics of ICH, alongside traditional ICH crafts. The author described the definitions of data, information, and knowledge; the author summarized the process of transforming ICH cultural data to

ICH cultural information to ICH cultural knowledge in practice, and explain the students' acquisition of wisdom about this process of transformation.

6.1.2 Conclusion for the Main- Research Objective

ICH design course, that combine the ICH design guideline with gamification in designing prototypes of mobile application.

First, the ICH design guideline aims to support students learning by their collecting ICH cultural data, analyzing ICH cultural information, and designing ICH product. Students learned about ICH through the process of collecting ICH cultural data and analyzing ICH cultural information. Guided by the ICH design guideline, they completed the design process and gained an understanding of ICH product design method.

Second, the game elements of interaction and storytelling aim to support students' interest in ICH. Therefore, within the field of ICH, integrating interaction and storytelling can have a positive impact on ICH mobile applications. The use of interaction and storytelling in ICH mobile applications supports students' ICH learning.

6.2 Academic contribution and practical contribution

6.2.1 Academic contribution

In contemporary society, young people's participation in protecting ICH is crucial for its transmission and development. Education plays a crucial role in encouraging students to gain a deeper understanding of ICH, and this is also one of the effective means for disseminating and developing ICH in contemporary society. Universities bear the important responsibility of ensuring that university students gain a thorough understanding of ICH. In particular, the integration of art and design education with ICH can lead to the creation of new ICH products.

The primary contribution of this study lies in establishing an ICH design guideline based on Bronfenbrenner's EST. This provides learning guidance on ICH knowledge for students through the design process. And evaluated game elements, designed ICH mobile application prototypes, and used interaction and storytelling to support students' interest in ICH.

6.2.2 Practical contribution

ICH is difficult to preserve and develop for two reasons. First, changes in the environment in which ICH exists have distanced it from people's lives, especially those of young people. Second, the traditional forms of ICH are not suited to modern society, and young people are not interested in them and lack awareness of ICH. The purpose of ICH education is to enable young people to understand ICH and preserve it. In particular, the integration of art and design courses in universities with ICH, such as ICH design courses, aims to utilize visual elements to design ICH products, bridging the gap between ICH and people's daily lives, and facilitating the development of ICH in modern society. However, conventional ICH design courses place too much emphasis on theory rather than practice, the ICH training method emphasizes the form in which the design work is presented rather than the meaning of the ICH product. Educators often neglect whether students have a deep understanding of ICH. Students often have a superficial understanding of ICH, and many design projects are formalized by ignoring the derivative meanings of ICH. Furthermore, ICH design works often lack interest and fail to attract the attention of young people.

This study aims to explore the theory and practice of enhancing university students' ICH learning and interest in ICH, with a particular emphasis on the use of the ICH design guideline and gamification design. In this study, the author take the ICH design course in the Visual Communication Design Department as an example. Based on Bronfenbrenner's EST, the author designed the ICH design guideline and implemented teaching practices. In this study, the author evaluated the effectiveness of

the ICH design guideline and the gamified ICH mobile application prototype within the ICH design Ecological System.

The practical construction of this study is that the ICH design course will offer practical insights and effective tools for ICH educators to guide students and support their design processes and ICH learning. The assessment technique of the ICH prototypes will provide a basis for designing a gamification product or service for ICH.

6.3 Contribution to knowledge science

The field of knowledge sciences is problem-oriented and interdisciplinary, which means that knowledge synthesis is essential for solving complex real-world problems. Knowledge science aims to organize and process subjective and objective information to create new knowledge and value. This doctoral research significantly contributes to the field of knowledge science, particularly in the domain of teaching methods for ICH education in universities. The research is based on the creation and application of meta-knowledge, a concept central to Knowledge Science. Meta-knowledge refers to knowledge about knowledge itself, including understanding how to effectively collect, organize, validate, and apply specific domain knowledge effectively across various fields.

The primary objective of this doctoral research is to build an ICH design course that supports university students' learning about and interest in ICH. To achieve this, the author established an ICH Ecological System based on Bronfenbrenner's EST and established an ICH design guideline. The ICH design guideline guided students to collect ICH cultural data, analyze ICH cultural information, and design ICH products, resulting in ICH cultural knowledge. Students designed ICH mobile application prototypes that used game elements to support students' interest in ICH. During the process, students mastered methods for designing ICH products and mobile applications. They organized and analyzed cultural data to extract ICH information, which became the basis for their designs. The students' work offered new interpretations

and explanations of ICH and its cultural knowledge. This approach embodies the knowledge students gained (Figure 6.1). The course generates meta-knowledge, promotes ICH development, and increases learning opportunities for university students.

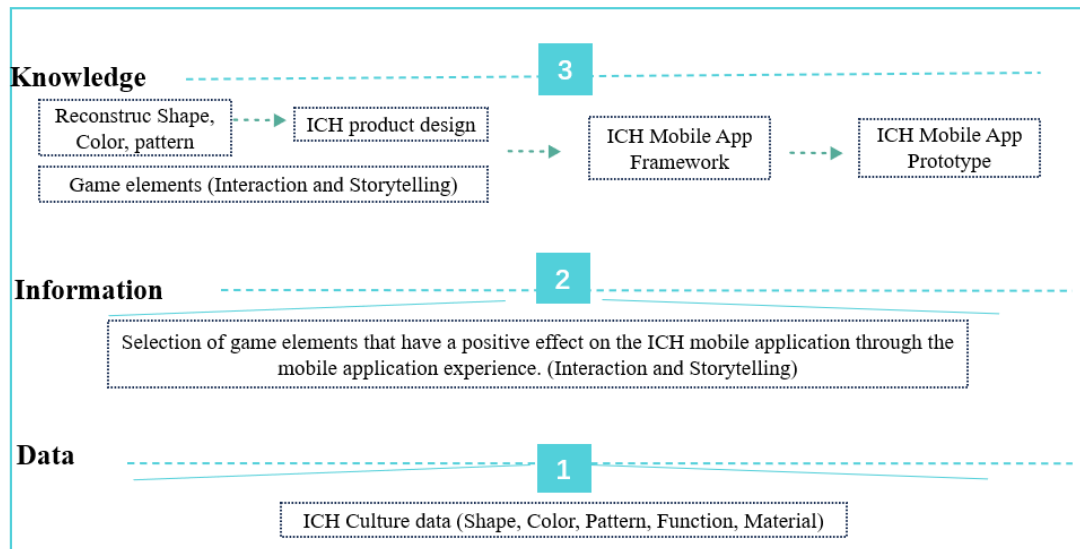


Figure 6.1 The process of knowledge formation

Furthermore, this dissertation contributes to the practical aspects of knowledge science by providing policymakers, institutional leaders, and lecturers with actionable insights and policy implications. It equips them with the necessary meta-knowledge to make informed decisions regarding enhancing the efficiency and quality of students' ICH learning and improving the efficiency and quality of teaching in ICH design courses. The study, therefore, has practical relevance for education providers and instructors.

This study serves as a valuable supplement to existing ICH design education. Educators or instructors will gain insights and frameworks for ICH design education and the design of ICH curricula from this study. Guided by meta-knowledge in the field, it in turn generates new meta-knowledge, thereby informing and shaping future ICH educational practices and policies. This dual role underscores the impactful nature of research within the field of knowledge science domain, particularly when addressing

the evolving challenges and opportunities in ICH teaching.

6.3 Future direction

This study established an ICH mobile application design course that included ICH design guideline and ICH gamification design.

The generalizability of the results is not assured beyond the studied context without conducting replication studies in diverse educational landscapes. This replication will help to determine the generalizability of the application of ICH design guideline and ICH gamification design and the applicability of the insights gained to teaching programs in other fields.

The author will apply the ICH design guideline and ICH gamification design to a wider range of professions and programs, incorporating participants from diverse backgrounds, to validate its effectiveness and improve the reliability and applicability of the findings.

References:

- Abdul Aziz, Noor Azramalina, Noor Fazamimah Mohd Ariffin, Nor Atiah Ismail, and Anuar Alias. 2023. "Community Participation in the Importance of Living Heritage Conservation and Its Relationships with the Community-Based Education Model towards Creating a Sustainable Community in Melaka UNESCO World Heritage Site." *Sustainability (Switzerland)* 15(3).
- Ackoff, Russell L. 1989. From data to wisdom. *Journal of applied systems analysis*, 16(1), 3-9.
- Aldemir, Tugce, Berkan Celik, and Goknur Kaplan. 2018. "A Qualitative Investigation of Student Perceptions of Game Elements in a Gamified Course." *Computers in Human Behavior* 78: 235–54. <https://doi.org/10.1016/j.chb.2017.10.001>.
- Allam, Ahmed, Zlatina Kostova, Kent Nakamoto, and Peter Johannes Schulz. 2015. "The Effect of Social Support Features and Gamification on a Web-Based Intervention for Rheumatoid Arthritis Patients: Randomized Controlled Trial." *Journal of Medical Internet Research* 17(1): e14.
- Alshenqeeti, Hamza. 2014. "Interviewing as a Data Collection Method: A Critical Review." *English Linguistics Research* 3(1): 39–45.
- Ami-Williams, Temi, Christina Georgia Serghides, and Andreas Aristidou. 2024. "Digitizing Traditional Dances under Extreme Clothing: The Case Study of Eyo." *Journal of Cultural Heritage* 67: 145–57. <https://doi.org/10.1016/j.culher.2024.02.011>.
- Arai, Satoshi, Kazunori Sakamoto, Hironori Washizaki, and Yoshiaki Fukazawa. 2014. "A Gamified Tool for Motivating Developers to Remove Warnings of Bug Pattern Tools." *Proceedings - 2014 6th International Workshop on Empirical Software Engineering in Practice, IWESEP 2014 (October)*: 37–42.
- Arias-Espinoza, P. et al. 2018. "E-Pumapunku: An Interactive App to Teach Children the Cañari and Inca Indigenous Cultures during Guided Museum Visits." 2018 Congreso Internacional de Innovacion y Tendencias en Ingenieria, CONIITI 2018

- Proceedings.

- Barghi, Rabeeh, Zuraini Zakaria, Aswati Hamzah, and Nor Hashimah Hashim. 2017. "Heritage Education in the Primary School Standard Curriculum of Malaysia." *Teaching and Teacher Education* 61(May 2020): 124–31.
- Basaraba, Nicole, Owen Conlan, Jennifer Edmond, and Peter Arnds. 2019. "Digital Narrative Conventions in Heritage Trail Mobile Apps." *New Review of Hypermedia and Multimedia* 25(1–2): 1–30. <https://doi.org/10.1080/13614568.2019.1642963>.
- Belkin, N.J., & Robertson, S.E. (1976). Information science and the phenomenon of information. *Journal of the American Society for Information Science*, 27, 197–204.
- Bellinger, Gene, Durval Castro, and Anthony Mills. 2003. "Data , Information , Knowledge , and Wisdom." : 5–7.
- Benito-Santos, Alejandro et al. 2021. "Playing Design: A Case Study on Applying Gamification to Construct a Serious Game with Youngsters at Social Risk." *Journal on Computing and Cultural Heritage* 14(2).
- Berk, L. E. 2000. *Child Development* (5th ed.). Boston, MA: Allyn and Bacon.
- Bhaskara, Gde Indra, and Dian Pramita Sugiarti. 2019. "Enhancing Cultural Heritage Tourism Experience with Augmented Reality Technology in Bali." *E-Journal of Tourism* 6(1): 102.
- Bidin, Samsiah, and Azidah Abu. 2013. "Adoption and Application of Mobile Learning in the Education Industry." *Procedia - Social and Behavioral Sciences* 90(InCULT 2012): 720–29. <http://dx.doi.org/10.1016/j.sbspro.2013.07.145>.
- Bierly III, P. E., Kessler, E. H., & Christensen, E. W. (2000). Organizational learning, knowledge and wisdom. *Journal of organizational change management*, 13(6), 595-618.
- Blair, David C. 2002. "Knowledge Management: Hype, Hope, or Help?" *Journal of the American Society for Information Science and Technology* 53(12): 1019–28.
- Bluteau, P., Clouder, L., & Cureton, D. (2017). Developing interprofessional education

- online: An ecological systems theory analysis. *Journal of Interprofessional Care*, 31(4), 420–428. <https://doi.org/10.1080/13561820.2017.1307170>
- Blythe, Mark, John McCarthy, Peter Wright, and Daniela Petrelli. 2011. “History and Experience: Storytelling and Interaction Design.” *Proceedings of HCI 2011 - 25th BCS Conference on Human Computer Interaction* (Scott 1991): 395–404.
- Bonde, Mads T. et al. 2014. “Improving Biotech Education through Gamified Laboratory Simulations.” *Nature Biotechnology* 32(7): 694–97.
- Bormann, Daniel, and Tobias Greitemeyer. 2015. “Immersed in Virtual Worlds and Minds: Effects of In-Game Storytelling on Immersion, Need Satisfaction, and Affective Theory of Mind.” *Social Psychological and Personality Science* 6(6): 646–52.
- Bouchenaki, M. 2003. “The Interdependency of the Tangible and Intangible Cultural Heritage.” *ICOMOS 14th General Assembly and Scientific Symposium* (October 27-31, 2003): 1–5.
- Bousbahi, Fatiha, and Bayan Boreggah. 2018. “Mobile Augmented Reality Adaptation through Smartphone Device Based Hybrid Tracking to Support Cultural Heritage Experience.” *ACM International Conference Proceeding Series*: 48–55.
- Braßler, Mirjam, and Martin Schultze. 2021. “Students’ Innovation in Education for Sustainable Development—a Longitudinal Study on Interdisciplinary vs. Monodisciplinary Learning.” *Sustainability (Switzerland)* 13(3): 1–17.
- Bronfenbrenner, U. (1974a). Developmental research, public policy, and the ecology of childhood. *Child Development*, 45, 1–5.
- Bronfenbrenner, U. 1994. “Ecological models of human development.” *Ecological models of human development. International Encyclopedia of Education* 3(2).
- Calderón, Alejandro, and Mercedes Ruiz. 2015. “A Systematic Literature Review on Serious Games Evaluation: An Application to Software Project Management.” *Computers and Education* 87: 396–422.
- Capecchi, Irene et al. 2024. “Augmented Reality and Serious Game to Engage the Alpha Generation in Urban Cultural Heritage.” *Journal of Cultural Heritage* 66:

- 523–35. <https://doi.org/10.1016/j.culher.2024.01.004>.
- Cardoso, Pedro J.S. et al. 2020. “Cultural Heritage Visits Supported on Visitors’ Preferences and Mobile Devices.” *Universal Access in the Information Society* 19(3): 499–513.
- Carrozzino, Marcello et al. 2011. “Virtually Preserving the Intangible Heritage of Artistic Handicraft.” *Journal of Cultural Heritage* 12(1): 82–87. <http://dx.doi.org/10.1016/j.culher.2010.10.002>.
- Casanova-Mata, Irene. 2023. “Enhancing English Acquisition: Effects of among Us Game-Based Gamification on Language Competence, Motivation, Attention, and Attitude towards the English Subject.” *Education Sciences* 13(11).
- Cascini, G. et al. 2022. “Perspectives on Design Creativity and Innovation Research: 10 Years Later.” *International Journal of Design Creativity and Innovation* 10(1): 1–30. <https://doi.org/10.1080/21650349.2022.2021480>.
- Chai, Chunlei, Defu Bao, Lingyun Sun, and Yu Cao. 2015. “The Relative Effects of Different Dimensions of Traditional Cultural Elements on Customer Product Satisfaction.” *International Journal of Industrial Ergonomics* 48: 77–88. <http://dx.doi.org/10.1016/j.ergon.2015.04.001>.
- Chin, Kai Yi, and Ching Sheng Wang. 2021. “Effects of Augmented Reality Technology in a Mobile Touring System on University Students’ Learning Performance and Interest.” *Australasian Journal of Educational Technology* 37(1): 27–42.
- Chkaif, Bouchaib, Marwan H. Sallam, Minghua Xu, and Hanane Thamik. 2022. “African Students’ Mobility To China an Ecological Systematic Perspective.” *Trames* 26(2): 185–206.
- Christensen, Bo T., Tore Kristensen, and Rolf Reberb. 2015. “Contributions of Consumer-Perceived Creativity and Beauty to Willingness-to-Pay for Design Products.” *International Journal of Design Creativity and Innovation* 3(3–4): 164–76.
- Christensen, Jonas. 2016. “A Critical Reflection of Bronfenbrenner’S Development

- Ecology Model.” *Problems of Education in the 21st Century* 69(1): 22–28.
- Christy, Katheryn R., and Jesse Fox. 2014. “Leaderboards in a Virtual Classroom: A Test of Stereotype Threat and Social Comparison Explanations for Women’s Math Performance.” *Computers and Education* 78: 66–77.
<http://dx.doi.org/10.1016/j.compedu.2014.05.005>.
- CIUREA, Cristian, Alin ZAMFIROIU, and Alin GROSU. 2014. “Implementing Mobile Virtual Exhibition to Increase Cultural Heritage Visibility.” *Informatica Economica* 18(2/2014): 24–31.
- Conceição, Simone C.O., Liliana Mina, and Todd Southern. 2021. “Brazilian Students Studying in the United States: Perceptions of Their Lived Experiences 6 Months After Returning Home.” *Journal of Transformative Education* 19(2): 127–46.
- Costabile, Maria F. et al. 2008. “Explore! Possibilities and Challenges of Mobile Learning.” *Conference on Human Factors in Computing Systems - Proceedings*: 145–54.
- Cozzani, G. et al. 2017. “Innovative Technologies for Intangible Cultural Heritage Education and Preservation: The Case of i-Treasures.” *Personal and Ubiquitous Computing* 21(2): 253–65.
- Cuenca, José María. 2003. “Análisis de Concepciones Sobre La Enseñanza Del Patrimonio En La Educación Obligatoria.” *Enseñanza de las ciencias sociales: revista de investigación* (2): 37–45.
<http://www.raco.cat/index.php/EnsenanzaCS/article/view/126155/174274>.
- De-Marcos, Luis, Adrián Domínguez, Joseba Saenz-De-Navarrete, and Carmen Pagés. 2014. “An Empirical Study Comparing Gamification and Social Networking on E-Learning.” *Computers and Education* 75: 82–91.
<http://dx.doi.org/10.1016/j.compedu.2014.01.012>.
- Denny, Paul. 2013. “The Effect of Virtual Achievements on Student Engagement.” *Conference on Human Factors in Computing Systems - Proceedings*: 763–72.
- Deterding, Sebastian, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. “From Game Design Elements to Gamefulness: Defining ‘Gamification.’” *Proceedings of the*

- 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011 (September): 9–15.
- Dicheva, Darina, Christo Dichev, Gennady Agre, and Galia Angelova. 2015. “Gamification in Education: A Systematic Mapping Study.” *Educational Technology and Society* 18(3): 75–88.
- Diéguez, Ángel, Joan Canals, Sergio Moreno, and Anna Vilà. 2024. “Gamification for Teaching Integrated Circuit Processing in an Introductory VLSI Design Course.” *Education Sciences* 14(8).
- Dimitropoulos, Kosmas et al. 2014. “Capturing the Intangible: An Introduction to the i-Treasures Project.” *VISAPP 2014 - Proceedings of the 9th International Conference on Computer Vision Theory and Applications* 2: 773–81.
- Dimitropoulos, Kosmas et al.. 2018. “A Multimodal Approach for the Safeguarding and Transmission of Intangible Cultural Heritage: The Case of i-Treasures.” *IEEE Intelligent Systems* 33(6): 3–16.
- Domínguez, Adrián et al. 2013. “Gamifying Learning Experiences: Practical Implications and Outcomes.” *Computers and Education* 63: 380–92. <http://dx.doi.org/10.1016/j.compedu.2012.12.020>.
- Doulamis, Anastasios et al. 2017. “Transforming Intangible Folkloric Performing Arts into Tangible Choreographic Digital Objects: The Terpsichore Approach.” *VISIGRAPP 2017 - Proceedings of the 12th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications* 5: 451–60.
- Drakenberg, Margareth, and Therese Vincenti Malmgren. 2013. “School Principals’ Perceptions of ‘basic Values’ in the Swedish Compulsory School System in Regard to Bronfenbrenner’s Ecological Systems Theory.” *Citizenship, Social and Economics Education* 12(2): 118–28.
- Ekonomou, Theodora, and Spyros Vosinakis. 2018. “Mobile Augmented Reality Games As an Engaging Tool for Cultural Heritage Dissemination: A Case Study.” *Ekonomou & S. Vosinakis Scientific Culture* 4(2): 97–107.

<https://www.researchgate.net/publication/325416755>.

- Elliot, Dely Lazarte, Vivienne Baumfield, and Kate Reid. 2016. "Searching for 'a Third Space': A Creative Pathway towards International PhD Students' Academic Acculturation." *Higher Education Research and Development* 35(6): 1180–95.
- Fernandes, João et al. 2012. "IThink : A Game-Based Approach towards Improving Collaboration and Participation in Requirement Elicitation." *Procedia Computer Science* 15(December): 66–77.
- Filsecker, Michael, and Daniel Thomas Hickey. 2014. "A Multilevel Analysis of the Effects of External Rewards on Elementary Students' Motivation, Engagement and Learning in an Educational Game." *Computers and Education* 75: 136–48. <http://dx.doi.org/10.1016/j.compedu.2014.02.008>.
- Fontana, Andrea, and James H Frey. 2000. "From Structured Questions to Negotiated Text." *Handbook of Qualitative Research*: 645–72.
- Franks, Daniel et al. 2007. "Interdisciplinary Foundations: Reflecting on Interdisciplinarity and Three Decades of Teaching and Research at Griffith University, Australia." *Studies in Higher Education* 32(2): 167–85.
- Grammatikopoulou, A. et al. 2019. 6 *Journal of Computers in Education An Adaptive Framework for the Creation of Exergames for Intangible Cultural Heritage (ICH) Education*. Springer Berlin Heidelberg. <https://doi.org/10.1007/s40692-018-0115-z>.
- Gómez-ruiz, María Luisa, Francisco José Morales-yago, and María Luisa de Lázaro-Torres. 2021. "Outdoor Education, the Enhancement and Sustainability of Cultural Heritage: Medieval Madrid." *Sustainability (Switzerland)* 13(3): 1–21.
- Grangeia, T.d. A. G., Jorge, B. de, Cecílio-Fernandes, D., Tio, R. A., & Carvalho-Filho, M. A. de (2019). LearnFun! Social media and gamification sum up to foster a community of practice during an emergency medicine rotation. *Health Professions Education*, 5(4), 321–335. <https://doi.org/10.1016/j.hpe.2018.11.001>.
- Groh, Fabian. 2012. "Gamification: State of the Art Definition and Utilization." *Proceedings of the 4th Seminar on Research Trends in Media Informatics*

- (RTMI'12): 39–46. http://vts.uni-ulm.de/docs/2012/7866/vts_7866_11380.pdf.
- Hakulinen, Lasse, Tapio Auvinen, and Ari Korhonen. 2013. “Empirical Study on the Effect of Achievement Badges in TRAKLA2 Online Learning Environment.” *Proceedings - 2013 Learning and Teaching in Computing and Engineering, LaTiCE 2013*: 47–54.
- Hakulinen, Lasse, Tapio Auvinen, and Ari Korhonen. 2015. “The Effect of Achievement Badges on Students’ Behavior: An Empirical Study in a University-Level Computer Science Course.” *International Journal of Emerging Technologies in Learning* 10(1): 18–29.
- Hamari, Juho. 2013. “Transforming Homo Economicus into Homo Ludens: A Field Experiment on Gamification in a Utilitarian Peer-to-Peer Trading Service.” *Electronic Commerce Research and Applications* 12(4): 236–45. <http://dx.doi.org/10.1016/j.elerap.2013.01.004>.
- Hamari, Juho. 2016. “Challenging Games Help Students Learn: An Empirical Study on Engagement, Flow and Immersion in Game-Based Learning.” *Computers in Human Behavior* 54: 170–79. <http://dx.doi.org/10.1016/j.chb.2015.07.045>
- Hamari, Juho. 2017. “Do Badges Increase User Activity? A Field Experiment on the Effects of Gamification.” *Computers in Human Behavior* 71: 469–78.
- Hamari, Juho, and Jonna Koivisto. 2015a. “Why Do People Use Gamification Services?” *International Journal of Information Management* 35(4): 419–31. <http://dx.doi.org/10.1016/j.ijinfomgt.2015.04.006>.
- Hamari, Juho, and Jonna Koivisto. 2015b. “‘Working out for Likes’: An Empirical Study on Social Influence in Exercise Gamification.” *Computers in Human Behavior* 50: 333–47.
- Hamari, Juho, Jonna Koivisto, and Harri Sarsa. 2014. “Does Gamification Work? - A Literature Review of Empirical Studies on Gamification.” *Proceedings of the Annual Hawaii International Conference on System Sciences*: 3025–34.
- Hamari, Juho, and Veikko Eranti. 2011. “Framework for Designing and Evaluating Game Achievements.” *Proceedings of DiGRA 2011 Conference: Think Design*

Play.

- Hang, Yongxin et al. 2023. "The Impact of Mixed Reality Serious Games on Mortise and Tenon Learning in College Students." *Computers & Education: X Reality* 3(October): 100042.
- Hannewijk, Bas et al. 2020. "Capturing the City's Heritage on-the-Go: Design Requirements for Mobile Crowdsourced Cultural Heritage." *Sustainability (Switzerland)* 12(6).
- Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, 80, 152–161. <https://doi.org/10.1016/j.compedu.2014.08.019>
- Hassenzahl, Marc et al. 2015. "Experience-Oriented and Product-Oriented Evaluation: Psychological Need Fulfillment, Positive Affect, and Product Perception." *International Journal of Human-Computer Interaction* 31(8): 530–44.
- Hendrix, Maurice, and Per Backlung. 2013. "Educational Games – Are They Worth The Effort ?" *Games and Virtual Worlds for Serious Applications (VS-GAMES)* (December): 1 – 8.
[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6624226&sortType=asc_p_Sequence&filter=AND\(p_IS_Number:6623306\)](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6624226&sortType=asc_p_Sequence&filter=AND(p_IS_Number:6623306)).
- Hey, Jonathan. 2004. "The Data, Information, Knowledge, Wisdom Chain: The Metaphorical Link." *Intergovernmental Oceanographic Commission* 26(December): 1–18.
- Hiramatsu, Yuko et al. 2017. "Designing Mobile Application to Motivate Young People to Visit Cultural Heritage Sites." *International Journal of Social and Business Sciences* 11(1): 121–28.
- Hou, Yumeng et al. 2022. "Digitizing Intangible Cultural Heritage Embodied: State of the Art." *Journal on Computing and Cultural Heritage* 15(3): 1–19.
- Hung, Chi Sen, Tien Li Chen, and Yun Chi Lee. 2021. "From Cultural Heritage Preservation to Art Craft Education: A Study on Taiwan Traditional Lacquerware

- Art Preservation and Training.” *Education Sciences* 11(12).
- Huotari, Kai, and Juho Hamari. 2017. “A Definition for Gamification: Anchoring Gamification in the Service Marketing Literature.” *Electronic Markets* 27(1): 21–31. <http://dx.doi.org/10.1007/s12525-015-0212-z>.
- Jagielska-Burduk, Alicja, Mateusz Pszczyński, and Piotr Stec. 2021. “Cultural Heritage Education in Unesco Cultural Conventions.” *Sustainability (Switzerland)* 13(6).
- Jagtap, Santosh. 2019. “Design Creativity: Refined Method for Novelty Assessment.” *International Journal of Design Creativity and Innovation* 7(1–2): 99–115. <http://doi.org/10.1080/21650349.2018.1463176>.
- Jemmali, Chaima, Sara Bunian, Andrea Mambretti, and Magy Seif El-Nasr. 2018. “Educational Game Design: An Empirical Study of the Effects of Narrative.” *ACM International Conference Proceeding Series*.
- Johnson, Daniel et al. 2016. “Gamification for Health and Wellbeing: A Systematic Review of the Literature.” *Internet Interventions* 6: 89–106. <http://dx.doi.org/10.1016/j.invent.2016.10.002>.
- Jones, Brooke A., Gregory J. Madden, and Heidi J. Wengreen. 2014. “The FIT Game: Preliminary Evaluation of a Gamification Approach to Increasing Fruit and Vegetable Consumption in School.” *Preventive Medicine* 68: 76–79. <http://dx.doi.org/10.1016/j.ypmed.2014.04.015>.
- Kalogiannakis, Michail, Stamatios Papadakis, and Alkinoos Ioannis Zourmpakis. 2021. “Gamification in Science Education. A Systematic Review of the Literature.” *Education Sciences* 11(1): 1–36.
- Kara, Nuri. 2024. “A Mixed-Methods Study of Cultural Heritage Learning through Playing a Serious Game.” *International Journal of Human-Computer Interaction* 40(6): 1397–1408. <https://doi.org/10.1080/10447318.2022.2125627>.
- Kiili, Kristian, Antti Koskinen, and Manuel Ninaus. 2019. “Intrinsic Integration in Rational Number Games – A Systematic Literature Review.” *CEUR Workshop Proceedings* 2359: 35–46.
- Kim, Hayun et al. 2017. “Ontology-Based Mobile Augmented Reality in Cultural

- Heritage Sites: Information Modeling and User Study.” *Multimedia Tools and Applications* 76(24): 26001–29.
- Koivisto, Jonna, and Juho Hamari. 2014. “Demographic Differences in Perceived Benefits from Gamification.” *Computers in Human Behavior* 35: 179–88.
- Koivisto, Jonna, and Juho Hamari. 2019. “The Rise of Motivational Information Systems: A Review of Gamification Research.” *International Journal of Information Management* 45(October 2018): 191–210. <https://doi.org/10.1016/j.ijinfomgt.2018.10.013>.
- Kotsopoulos, Konstantinos I. et al. 2019. “An Authoring Platform for Developing Smart Apps Which Elevate Cultural Heritage Experiences: A System Dynamics Approach in Gamification.” *Journal of Ambient Intelligence and Humanized Computing* (0123456789). <https://doi.org/10.1007/s12652-019-01505-w>.
- Kuo, Ming Shiou, and Tsung Yen Chuang. 2016. “How Gamification Motivates Visits and Engagement for Online Academic Dissemination - An Empirical Study.” *Computers in Human Behavior* 55: 16–27. <http://dx.doi.org/10.1016/j.chb.2015.08.025>.
- Kuusk, Kristi, Ana Tajadura-Jiménez, and Aleksander Väljamäe. 2020. “A Transdisciplinary Collaborative Journey Leading to Sensorial Clothing.” *CoDesign* 16(4): 311–27. <https://doi.org/10.1080/15710882.2020.1833934>.
- Labrador, Angela M. 2022. “Integrating ICH and Education : A Review of Converging Theories and Methods.” : 18–36.
- Landers, Richard N., and Amy K. Landers. 2014. “An Empirical Test of the Theory of Gamified Learning: The Effect of Leaderboards on Time-on-Task and Academic Performance.” *Simulation and Gaming* 45(6): 769–85.
- Laureyssens, Thomas et al. 2014. “ZWERM: A Modular Component Network Approach for an Urban Participation Game.” *Conference on Human Factors in Computing Systems - Proceedings*: 3259–68.
- Lazzaro, N. 2004. *Why We Play Games: Four Keys to More Emotion Without Story*. XEODesign. Retrieved from: http://www.xeodesign.com/xeodesign_

whyweplaygames.pdf

- Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother?. *Academic exchange quarterly*, 15(2), 146.
- Lee, Joey J., Pinar Ceyhan, William Jordan-Cooley, and Woonhee Sung. 2013. "GREENIFY: A Real-World Action Game for Climate Change Education." *Simulation and Gaming* 44(2–3): 349–65.
- Lee, Lap Kei et al. 2021. "An Intelligent Augmented Reality Mobile Application for Heritage Conservation Education." *CEUR Workshop Proceedings* 3080: 0–1.
- Leitão, Rui et al. 2022. "Ocean Literacy Gamified: A Systematic Evaluation of the Effect of Game Elements on Students' Learning Experience." *Environmental Education Research* 28(2): 276–94. <https://doi.org/10.1080/13504622.2021.1986469>.
- Leong, Benny Ding, and Hazel Clark. 2003. "Culture-Based Knowledge Towards New Design Thinking and Practice—A Dialogue." *Design Issues* 19(3): 48–58.
- Le'vi-Strauss, Claude. 1965. Le triangle culinaire. *L'Arc* 26:19–29.
- Li, Jia. 2022. "Grounded Theory-Based Model of the Influence of Digital Communication on Handicraft Intangible Cultural Heritage." *Heritage Science* 10(1): 1–12. <https://doi.org/10.1186/s40494-022-00760-z>.
- Li, Xin Zhu, Chun Ching Chen, and Xin Kang. 2021. "The Design and Evaluation of Teaching Activities Combining Traditional Lantern Craftsmanship with Primary Education in the Perspective of Intangible Cultural Heritage." *Proceedings - 2021 3rd International Conference on Computer Science and Technologies in Education, CSTE 2021* (v): 53–57.
- Li, Zhaoqing, and Lin Xie. 2023. "A Probe into the Mutual Enhancement between Tertiary Education of Art and Intangible Cultural Heritage in China: A Case Study of Xiamen Bead Embroidery Course by Xiamen Academy of Arts and Design, Fuzhou University." *Sustainability (Switzerland)* 15(8).
- Liang, Hui, and Xiaohang Dong. 2022. "Enhancing Cognitive Ability through a VR Serious Game Training Model Mixing Piaget's Epistemological Methodology and

- Lumosity Concept.” *Visual Computer* 38(9–10): 3487–98.
<https://doi.org/10.1007/s00371-022-02552-9>.
- Liu, Zixiao, Shuo Yan, Yu Lu, and Yuetong Zhao. 2022. “Generating Embodied Storytelling and Interactive Experience of China Intangible Cultural Heritage ‘Hua’er’ in Virtual Reality.” *Conference on Human Factors in Computing Systems - Proceedings*.
- Loganathan, Parimalah et al. 2019. “Implementing Technology Infused Gamification in Science Classroom: A Systematic Review and Suggestions for Future Research.” *Learning Science and Mathematics* 2019(14): 60–70.
http://www.recsam.edu.my/sub_lsmjournal.
- Lu, Zhicong, Peng Tan, Yi Ji, and Xiaojuan Ma. 2022. “The Crafts+Fabrication Workshop: Engaging Students with Intangible Cultural Heritage-Oriented Creative Design.” *DIS 2022 - Proceedings of the 2022 ACM Designing Interactive Systems Conference: Digital Wellbeing (ii)*: 1071–84.
- Lumpoon, Pathathai Na, and Pree Thiengburanathum. 2016. “Effect of Integration a Mobile Game-Based Learning Framework in Cultural Tourism.” *Software, Knowledge, Information Management & Applications (SKIMA), 2016 10th International Conference*: 281–85.
- Ma, Chengxiang, Thawit Somrak, Suchita Manajit, and Chenglin Gao. 2024. “Exploring the Potential Synergy Between Disruptive Technology and Historical/Cultural Heritage in Thailand’s Tourism Industry for Achieving Sustainable Development in the Future.” *International Journal of Tourism Research* 26(5).
- Mantzou, Polyxeni, Xenofon Bitsikas, and Anastasios Floros. 2023. “Enriching Cultural Heritage through the Integration of Art and Digital Technologies.” *Social Sciences* 12(11).
- Marache-Francisco, Cathie, and Eric Brangier. 2012. “Redefining Gamification.” *Proceedings of the IADIS International Conference Interfaces and Human Computer Interaction 2012, IHCI 2012, Proceedings of the IADIS International*

- Conference Game and Entertainment Technologies 2012 2015: 227–31.
- Marangell, S. 2023. Exploring students' experiences of an internationalized university through a person-in-context lens. *J. Compar. Int. High. Educ.* 15, 134–165.
- Marczewski Andrzej. (2012), *Gamification: A Simple Introduction*, Raleigh, Lulu.
- Martín, M.J., and J.M. Cuenca. 2011. "Heritage Education and Learning in Museums: The Managers' Perspective | La Enseñanza y El Aprendizaje Del Patrimonio En Los Museos: La Perspectiva de Los Gestores." *Revista de Psicodidactica* 16(1): 99–122.
- McLinden, Mike. 2017. "Examining Proximal and Distal Influences on the Part-Time Student Experience through an Ecological Systems Theory." *Teaching in Higher Education* 22(3): 373–88.
- Mekler, Elisa D., Florian Brühlmann, Alexandre N. Tuch, and Klaus Opwis. 2017. "Towards Understanding the Effects of Individual Gamification Elements on Intrinsic Motivation and Performance." *Computers in Human Behavior* 71: 525–34. <http://dx.doi.org/10.1016/j.chb.2015.08.048>.
- Merillas, Olaia Fontal, and Marta Martínez Rodríguez. 2018. "An Analysis of Educational Designs in Intangible Cultural Heritage Programmes: The Case of Spain." *International Journal of Intangible Heritage* 13: 190–202.
- Montola, Markus et al. 2009. "Applying Game Achievement Systems to Enhance User Experience in a Photo Sharing Service." *MindTrek 2009 - 13th International Academic MindTrek Conference: Everyday Life in the Ubiquitous Era* 4(46): 94–97.
- Mortara, Michela et al. 2015. "Learning Cultural Heritage by Serious Games To Cite This Version : HAL Id : Hal-01120560." *Journal of Cultural Heritage* 15 (n° 3): 10.
- Muntean, C. I. 2011. Raising engagement in e-learning through gamification. In *Proc. 6th international conference on virtual learning ICVL (Vol. 1, pp. 323-329)*.
- Newell, William H. 1994. "Designing Interdisciplinary Courses." *New Directions for Teaching and Learning* 1994(58): 35–51.

- Ninaus, Manuel et al. 2023. "The Added Value of Game Elements: Better Training Performance but Comparable Learning Gains." *Educational Technology Research and Development* 71(5): 1917–39. <https://doi.org/10.1007/s11423-023-10263-8>.
- O'Donovan, Siobhan, James Gain, and Patrick Marais. 2013. "A Case Study in the Gamification of a University-Level Games Development Course." *ACM International Conference Proceeding Series*: 242–51.
- Ott, Michela, Francesca Maria Dagnino, and Francesca Pozzi. 2015a. "Intangible Cultural Heritage: Towards Collaborative Planning of Educational Interventions." *Computers in Human Behavior* 51: 1314–19.
- Ozer, Muammer. 2005. "Factors Which Influence Decision Making in New Product Evaluation." *European Journal of Operational Research* 163(3): 784–801.
- Pagán, Ester Alba et al. 2020. "From Silk to Digital Technologies: A Gateway to New Opportunities for Creative Industries, Traditional Crafts and Designers. The SILKNOW Case." *Sustainability (Switzerland)* 12(19).
- Papangelis, Konstantinos, Alan Chamberlain, and Hai Ning Liang. 2016. "New Directions for Preserving Intangible Cultural Heritage through the Use of Mobile Technologies." *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct, MobileHCI 2016*: 964–67.
- Payne, Malcolm. *Modern Social Work Theory*; Pmacmillan Education Ltd. Houndmills: Hampshire, UK, 1991.
- Patricia Bluteau , Lynn Clouder & Debra Cureton. 2017. Developing interprofessional education online: an ecological systems theory analysis. *J Interprof Care*. 2017, 31(4), 420-428. <http://www.scie-socialcareonline.org.uk/developing-interprofessional-education-online-an-ecological-systems-theory-analysis/r/a1C0f0000066Z06EAE>
- Peppler, Kylie, Heidi J. Davis-Soylu, and Maggie Dahn. 2023. "Artifact-Oriented Learning: A Theoretical Review of the Impact of the Arts on Learning." *Arts Education Policy Review* 124(1): 61–77.

<https://doi.org/10.1080/10632913.2021.1925609>.

- Perron, Nathan C. D. 2017. "Bronfenbrenner's Ecological Systems Theory." In *College Student Development*, New York, NY: Springer Publishing Company.
<http://connect.springerpub.com/lookup/doi/10.1891/9780826118165.0018>.
- Piaget, J. (1976). *Piaget's theory* (pp. 11-23). Springer Berlin Heidelberg.
- Piccialli, Francesco et al. 2020. "Unsupervised Learning on Multimedia Data: A Cultural Heritage Case Study." *Multimedia Tools and Applications* 79(45–46): 34429–42.
- Putz, Lisa Maria, Florian Hofbauer, and Horst Treiblmaier. 2020. "Can Gamification Help to Improve Education? Findings from a Longitudinal Study." *Computers in Human Behavior* 110(March): 106392. <https://doi.org/10.1016/j.chb.2020.106392>.
- Ri, M O, N I O Mun, and I T Ag. 1994. "World HERITAGE Education What Is The."
- Robson, Karen et al. 2015. "Is It All a Game? Understanding the Principles of Gamification." *Business Horizons* 58(4): 411–20.
<http://dx.doi.org/10.1016/j.bushor.2015.03.006>.
- Rocha Seixas, Luma, Alex Sandro Gomes, and Ivanildo José De Melo Filho. 2016. "Effectiveness of Gamification in the Engagement of Students." *Computers in Human Behavior* 58: 48–63.
- Rowley, Jennifer. 2007. "The Wisdom Hierarchy: Representations of the DIKW Hierarchy." *Journal of Information Science* 33(2): 163–80.
- Rughinis, Razvan. 2013. "Gamification for Productive Interaction: Reading and Working with the Gamification Debate in Education." *Iberian Conference on Information Systems and Technologies, CISTI*: 1–5.
- Ruiz-Calleja, Adolfo et al. 2023. "Orchestrating Ubiquitous Learning Situations about Cultural Heritage with Casual Learn Mobile Application." *International Journal of Human Computer Studies* 170(December 2021): 102959.
<https://doi.org/10.1016/j.ijhcs.2022.102959>.
- Ryan, Richard M., C. Scott Rigby, and Andrew Przybylski. 2006. "The Motivational Pull of Video Games: A Self-Determination Theory Approach." *Motivation and*

- Emotion 30(4): 347–63.
- Sailer, Michael, and Lisa Homner. 2020. “The Gamification of Learning: A Meta-Analysis.” *Educational Psychology Review* 32(1): 77–112.
- Salsabila, Firyal R, and Irena Y Maureen. 2022. “Infusing Storytelling and Game Elements in Designing Instructional Media.” : 78.
- Sardi, Lamyae, Ali Idri, and José Luis Fernández-Alemán. 2017. “A Systematic Review of Gamification in E-Health.” *Journal of Biomedical Informatics* 71: 31–48. <http://dx.doi.org/10.1016/j.jbi.2017.05.011>.
- Seaborn, Katie, and Deborah I. Fels. 2015. “Gamification in Theory and Action: A Survey.” *International Journal of Human Computer Studies* 74: 14–31.
- Sedig, Kamran, Paul Parsons, and Robert Haworth. 2017. “Player–Game Interaction and Cognitive Gameplay: A Taxonomic Framework for the Core Mechanic of Videogames.” *Informatics* 4(1).
- Sedig, Kamran, and Paul Parsons. 2013. “Interaction Design for Complex Cognitive Activities with Visual Representations: A Pattern-Based Approach.” *AIS Transactions on Human-Computer Interaction* 5(2): 84–133.
- Shang, Shanshan, and Nana Ni. 2023. “Understanding the Impacts of Storytelling and Player Perspective on Learning Outcomes: The Mediating Roles of Engagements.” *International Journal of Human-Computer Interaction* 0(0): 1–20. <https://doi.org/10.1080/10447318.2023.2288732>.
- Shen, Danni et al. 2022. “Sound Design of Guqin Culture: Interactive Art Promotes the Sustainable Development of Traditional Culture.” *Sustainability (Switzerland)* 14(4).
- Sigman, Mariano, Marcela Peña, Andrea P. Goldin, and Sidarta Ribeiro. 2014. “Neuroscience and Education: Prime Time to Build the Bridge.” *Nature Neuroscience* 17(4): 497–502.
- Simões, Jorge, Rebeca Díaz Redondo, and Ana Fernández Vilas. 2013. “A Social Gamification Framework for a K-6 Learning Platform.” *Computers in Human Behavior* 29(2): 345–53.

- Sinakou, Eleni, Vincent Donche, Jelle Boeve De Pauw, and Peter Van Petegem. 2019. "Designing Powerful Learning Environments in Education for Sustainable Development: A Conceptual Framework." *Sustainability (Switzerland)* 11(21).
- Slavec, Ana, Nežka Sajinčič, and Vesna Starman. 2021. "Use of Smartphone Cameras and Other Applications While Traveling to Sustain Outdoor Cultural Heritage." *Sustainability (Switzerland)* 13(13).
- Song, Xiaoting, Yongzhong Yang, Ruo Yang, and Mohsin Shafi. 2019. "Keeping Watch on Intangible Cultural Heritage: Live Transmission and Sustainable Development of Chinese Lacquer Art." *Sustainability (Switzerland)* 11(14).
- Sylaiou, Stella, Vlasios Kasapakis, Damianos Gavalas, and Elena Dzardanova. 2020. "Avatars as Storytellers: Affective Narratives in Virtual Museums." *Personal and Ubiquitous Computing* 24(6): 829–41.
- Tan, Peng., Ji, Yi., & Xu, Yuqing. 2021. "Rethinking of Intangible Cultural Heritage Teaching with Creative Programming in China." *Proceedings - 4th International Conference on Multimedia Information Processing and Retrieval, MIPR 2021* 9: 299–302.
- Tan, Song Ning, and Kher Hui Ng. 2024. "Gamified Mobile Sensing Storytelling Application for Enhancing Remote Cultural Experience and Engagement." *International Journal of Human-Computer Interaction* 40(6): 1383–96. <https://doi.org/10.1080/10447318.2022.2144121>.
- Thomas, Nibu John, and Rupashree Baral. 2023. "Mechanism of Gamification: Role of Flow in the Behavioral and Emotional Pathways of Engagement in Management Education." *International Journal of Management Education* 21(1): 100718. <https://doi.org/10.1016/j.ijme.2022.100718>.
- Toda, Armando M. et al. 2019 a. "Analysing Gamification Elements in Educational Environments Using an Existing Gamification Taxonomy." *Smart Learning Environments* 6(1): 1–14.
- Toda, Armando M. et al. 2019 b. "A Taxonomy of Game Elements for Gamification in Educational Contexts: Proposal and Evaluation." *Proceedings - IEEE 19th*

- International Conference on Advanced Learning Technologies, ICALT 2019 2161-377X: 84–88.
- Torsi, Silvia, Carmelo Ardito, and Cristina Rebek. 2020. “An Interactive Narrative to Improve Cultural Heritage Experience in Elementary School Children.” *Journal on Computing and Cultural Heritage* 13(3).
- UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage. 2003. Available online: <https://ich.unesco.org/en/convention> (accessed on 5 September 2022).
- UNESCO sustainable development and living heritage <https://ich.unesco.org/en/sustainable-development-and-living-heritage> (accessed on 9 June 2022)
- UNESCO ‘UNESCO Clearinghouse on Living Heritage and Education’. 2021, Available online: <https://ich.unesco.org/en/clearinghouse-education> (accessed on 13 September 2022).
- UNESCO Universal Declaration on Cultural Diversity. (2003) The text of the Declaration is available at: <http://orcp.hustoj.com/unesco-universal-declaration-on-cultural-diversity-2001/> (accessed on 13 September 2022).
- Van Roy, R., & Zaman, B. (2018). Need-supporting gamification in education: An assessment of motivational effects over time. *Computers & Education*, 127, 283–297. <https://doi.org/10.1016/j.compedu.2018.08.018>.
- Volet, Simone. 2001. “Understanding Learning and Motivation in Context: A Multi-Dimensional and Multi-Level Cognitive-Situative Perspective.” *Motivation in learning contexts: Theoretical advances and methodological implications*: 57–82.
- Wang, Ching Yi. 2019. “Building a Network for Preserving Intangible Cultural Heritage through Education: A Study of Indonesian Batik.” *International Journal of Art and Design Education* 38(2): 398–415.
- Weichbroth, Pawel. 2020. “Usability of Mobile Applications: A Systematic Literature Study.” *IEEE Access* 8: 55563–77.
- Xu, Ningning et al. 2024. “CubeMuseum AR: A Tangible Augmented Reality Interface

- for Cultural Heritage Learning and Museum Gifting.” *International Journal of Human-Computer Interaction* 40(6): 1409–37.
<https://doi.org/10.1080/10447318.2023.2171350>.
- Xu, Xing, and Tran, Ly. Thy. 2022. A qualitative investigation into Chinese International doctoral students’ navigation of a disrupted study trajectory during COVID-19. *J. Stud. Int. Educ.* 26, 553–571.
- Xu, Zhimin, and Daitie Zou. 2022. “Big Data Analysis Research on the Deep Integration of Intangible Cultural Heritage Inheritance and Art Design Education in Colleges and Universities.” *Mobile Information Systems* 2022.
- Yan, Wen-Jie, and Ke-Run Li. 2023. “Sustainable Cultural Innovation Practice: Heritage Education in Universities and Creative Inheritance of Intangible Cultural Heritage Craft.” *Sustainability* 15(2): 1194.
- Yan, Wen Jie, and Shang Chia Chiou. 2021. “The Safeguarding of Intangible Cultural Heritage from the Perspective of Civic Participation: The Informal Education of Chinese Embroidery Handicrafts.” *Sustainability (Switzerland)* 13(9).
- Yang, Ruixuan et al. 2024. “Enhancing the Sustainability of Intangible Cultural Heritage Projects: Obtaining Efficient Digital Skills Preservation through Binocular Half Panoramic VR Maps.” *Sustainability (Switzerland)* 16(13).
- Yi, J.; Tan, P. Chinese Traditional Handicraft Education Using AR Content. *Leonardo* 2020, 53, 199–200
- Yidan, Huang, Jinchi Yip, and Vickram Theavar. 2025. “Exploring the Potential of Mobile Phone Applications in the Transmission of Intangible Cultural Heritage among the Younger Generation.” *Preservation, Digital Technology and Culture* 54(1): 65–75. <https://doi.org/10.1515/pdte-2024-0058>.
- Yu, Lan. 2023. “Digital Sustainability of Intangible Cultural Heritage: The Example of the ‘Wu Leno’ Weaving Technique in Suzhou, China.” *Sustainability (Switzerland)* 15(12).
- Zaibon, Syamsul Bahrin, Ulka Chandini Pendit, and Juliana Aida Abu Bakar. 2015. “User Requirements on Mobile AR for Cultural Heritage Site towards Enjoyable

- Informal Learning.” Proceedings - APMediaCast: 2015 Asia Pacific Conference on Multimedia and Broadcasting (April): 61–67.
- Zdybel, Dorota. 2021. “Children’s Conceptions of Memory and Imagination - from Conceptual Knowledge to Metacognition. Phenomenographical Study.” *Thinking Skills and Creativity* 41(May): 100855. <https://doi.org/10.1016/j.tsc.2021.100855>.
- Zhang, Lekai et al. 2022. “MasterSu: The Sustainable Development of Su Embroidery Based on Digital Technology.” *Sustainability (Switzerland)* 14(12).
- Zhang, Lufang et al. 2023. “A Virtual Experience System of Bamboo Weaving for Sustainable Research on Intangible Cultural Heritage Based on VR Technology.” *Sustainability (Switzerland)* 15(4).
- Zhou, Jie, Ji Qi, and Xuefeng Shi. 2022. “The Innovation of Entrepreneurship Education for Intangible Cultural Heritage Inheritance From the Perspective of Entrepreneurial Psychology.” *Frontiers in Psychology* 13(March): 1–13.
- Zins, Chaim. 2007. “Conceptual approaches for defining data, information, and knowledge. ” *Journal of the American society for information science and technology*, 58(4), 479-493.

Appendix

Appendix A: Questionnaire data of study 1

Team1	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
X	6	6	7	6	7	6	6	7	6	6	7	6	7	6	7	7	6	7	7	6
H	7	7	7	7	7	7	6	7	7	7	7	6	6	6	7	7	6	7	6	6
G	6	6	6	6	6	7	7	6	6	7	7	6	7	7	6	6	6	7	6	7
Team2																				
X	7	7	4	7	6	7	7	4	7	7	5	7	5	7	6	6	7	4	6	7
H	6	6	4	6	6	6	7	4	6	6	6	7	4	7	5	5	7	4	7	7
G	5	7	4	7	7	5	6	4	7	6	4	7	5	6	7	7	7	4	7	6
Team3																				
X	4	5	6	4	5	5	5	6	5	5	6	5	6	4	5	4	5	6	5	5
H	4	5	6	5	5	4	5	5	5	5	4	5	7	5	6	4	5	6	5	5
G	4	5	7	5	5	6	5	7	5	5	6	5	6	5	5	4	5	6	5	5
Team4																				
X	5	4	5	3	3	4	4	5	4	3	4	4	4	3	4	5	4	5	4	4
H	5	4	5	4	4	5	4	6	4	4	5	4	5	4	4	6	4	5	4	4
G	7	4	5	4	4	4	4	5	4	4	5	4	4	4	4	5	4	5	4	4

Appendix B: Interview data of study 1

ID1	A001 VC students presented their ideas, shadow, enamel, etc. ISE students thought that technology could be combined with shadow, and we identified the topic of shadow play.	New ideas arise
	A002 During the group discussion, we share the more mature technologies with VC students, such as light modulation, motion capture, and gesture recognition.	Share knowledge in their respective fields
	A003 After talking with VC students, we felt that using motion capture technology to accomplish video interaction between the audience and the shadow theme would produce better results.	New ideas arise
	A004 Compared to other technologies, we have the foundation to do gesture recognition, as well as the dataset of character skeletons.	Reasons for choosing the technology
	A005 We let the AI learn new data, which allows the new model to improve on the previous model again.	Technology Experiment
	A006 Since motion capture is a mature technology, we finally chose motion capture and interaction with the audience to realize the shadow animation.	Reasons to choose this technology
	A007 Our previous work was a change of light effect and did not bring the audience a better display effect.	Disadvantages of single-discipline design
	A008 The interdisciplinary collaboration makes us think of the audience imitating the movements of the shadow as a better interactive experience.	New ideas arise
	A009 We built motion capture into the camera, and we can implement the whole process with complete OPCV computer vision.	Technology Implementation
	A010 Motion capture technology draws on open-source algorithms, and the implementation of motion capture technology needs to be optimized.	Technology Implementation
	A011 For this shadow motion capture implementation, we needed to rewrite the modeling and train the AI with a large dataset.	Technology Implementation
	A012 In the process of training the AI, we need to take a lot of photos of the same person with the same action at different angles and different distances under the same lighting conditions.	Technology Implementation
	A013 We took a total of 500 photos.	Technology Implementation
	A014 Based on these photos, we perform training in artificial intelligence.	Technology Implementation
	A015 After we tagged the individual photos, we started training the AI so that it could accurately recognize each required action.	Technology Implementation
	A016 The three actions we inserted in the animated short required more than 150 photos each to train the AI. The number of photos is related to the accuracy of the AI.	Technology Implementation

	A017 Photographs are the learning material for AI. It has an increasing grip on accurate model recognition.	Technology Implementation
	A018 As ISE students, communication with VC students and DHT students can enrich our knowledge of product presentation forms.	Benefits of interdisciplinary collaboration
	A019 Our work presentation may give the audience a rather dull feeling. Through communication with VC students, we found that technology ultimately serves people. With the help of VC students, we can present the technology better through art, so that the audience's experience can be further enhanced.	Advantages of interdisciplinary collaboration compared to single disciplines
	A020 I have a different feeling when I talk to ISE students. The VC students are thinking about how to add freshness to their design work from the visual aspect. But it is not enough. The work needs to be supported by technology to bring a new experience and add a multi-dimensional feeling to the design work. The design work is not only from the visual aspect but also through interaction to show the idea we want to express.	Interdisciplinary collaboration leads to a change in mindset
	A021 Our ideas cannot be realized without technology. The combination of art and technology can make physical design works.	Benefits of interdisciplinary collaboration
	A022 The motion capture we did in our previous works was simple light effect modulation. But after seeing the design work shown by the VC students, we had the idea of adding motion capture to the Shadow play animation short film, and we wanted to interact with the audience through this presentation.	New ideas arise
	A023 Our drawing skills were limited, and we were not able to make a beautiful presentation. The communication with VC students provided us with new ideas. I think we can present the technology in a more artistic and accessible way to the audience.	New ideas arise
ID2	B001 The idea is based on the title of intangible cultural heritage.	The initial idea
	B002 We need to understand which technologies ISE students are familiar with and build on that to be creative.	The initial idea
	B003 We wanted to make an art installation, and each person went to share an interesting art installation that they had seen. Each person said their ideas to give everyone some inspiration, and finally, we came up with the dancing machine.	Get ideas
	B004 Wang Wei suggested the dancing machine and proposed doing interactive design work.	Get ideas
	B005 I suggested making a design of Dalian ICH, and we all thought in this direction and finally decided on the Jinzhou Dragon Dance Dancing Machine project.	Get ideas

B006 ISE students mentioned a very interesting lighting device, we thought of light and shadow and used light and shadow as a starting point to think of creative ideas.	Different way of thinking
B007 We kept revising the design plan. The finalized design plan is the one Wang Wei said.	Get ideas
B008 I provide theoretical information, literature, and access to materials, as well as suggest my ideas.	DHT student works in teams
B009The students stated their ideas according to the previous ideas and went on to implement them. The VC students' design implementation included how the light and shadow changed and how the dragon's form needed to be designed.	Problems in design implementation and change of mindesign Implementation
B010 We followed the idea of light and shadow for the first experiment.	Technology Experiment
B011 We had some problems during the experiment, such as the limitation of light sources. We needed a lot of mechanical materials, and the art installation would be very large. Finally, we gave up the idea.	Problems in design implementation and change of mindesign Implementation
B012 I gained a lot from doing the project. VC students think differently from us, and they have more innovative ideas compared to us.	Different way of thinking
B013 We felt the collision of ideas in the process of combining art and technology, and we experienced different ideas in the design implementation.	Different way of thinking
B014 We had a lot of good ideas, but we found that they could not be accomplished in the design of experiments, and many of them were limited by	Findings in design experiments
B015 We were constrained by technology, money, time, etc. , and had to change our initial idea.	Change of mind in design implementation
B016 Our biggest takeaway was the experience of interdisciplinary design implementation. Previously, we had not done interdisciplinary design implementation, so we were not limited in our ideas.	Interdisciplinary collaboration leads to change of ideas
B017 For this project, because we had to collaborate with other majors in interdisciplinary collaboration and design implementation, we were considering more practical issues from the idea to the design implementation.	Interdisciplinary collaboration leads to change of ideas
B018 We follow the subject and consider how ICH needs to be promoted and presented.	Thinking process
B019 According to the cross-media theory, we want to pass on ICH and highlight its locality in a novel way. We intervene in more media in ICH to enhance the regional character of the Jinzhou Dragon Dance.	New ideas arise
B020 The starting point of our creativity is to make a physical design work from a practical point of view.	New ideas arise

VC1	B021 We learned a lot and improved ourselves by listening to the way of thinking of many DHT students and VC students during the discussion.	learned from interdisciplinary collaboration
	B022 First, we did experiments on light and shadow to give us a better understanding of light sources. We learned what kind of light source is needed for a specific light and shadow. During the experiment, we got guidance from the teacher and we learned more technical knowledge.	Learning through design experiments
	C001 Our initial idea was a mythological theme. We had a discussion in the classroom, and we all chose among several stories, and finally chose "The Legend of the White Snake", which was created with Bai Suzhen's love breaking through the shackles of the world.	Get ideas
	C002 Each student came up with a design, and we used the female figure designed by one student as the basis, and the other students followed this model.	
	C003 We pick the image design blind box that fits the topic.	Get ideas
	C004 Our team is different from the ID teams in working together as a team, the ID1 team is each painting dozens of frames, and we are required to unify the painting style and color scheme. The more members in the team, the worse it is to unify the painting style.	Difference of cooperation method
	C005 Because we were working in a team for the first time, our team had problems working together.	Teamwork
	C006 Each team member in the team has a different idea.	The advantages of teamwork in terms of creativity
	C007 In terms of creativity, teamwork gets better ideas than individual ideas. We all have different ideas, and we get a lot of ideas from listening to other team members' ideas.	The advantages of teamwork in terms of creativity
	D001 We came up with the idea through investigation.	Get ideas
VC2	D002 We decided to design a traditional festival through discussion, and after deciding on the topic, we all completed our work according to the division of labor.	Get ideas
	D003 We have identified several traditional festivals.	Define the topic
	D004 Zhang Yixiao was responsible for creating the main image, and others designed their parts based on the main image she created.	Design implementation
	D005 We need to unify the style of painting in the design process.	
	D006 I created the main image, but because I didn't use line drawing, I used color block stitching to draw it, which led to a different drawing style when everyone was drawing. (Because a line drawing is a drawing with extractable contour lines, while a color block is a drawing without extractable contour lines)	Problems encountered in the design process

D007 If the design of individual team members, it will be created according to their preferred style.	individual work
D008 If the team is collectively designed, we need to integrate.	Teamwork
D009 Male students proposed ideas such as colored eggs and blind boxes, and male and female students had different ideas.	The difference between male and female students

Appendix C: Questionnaire of study 2

这是一份关于非物质文化遗产移动 App 中使用游戏元素是否对参与者接受非物质文化遗产相关知识有影响的调查问卷。你对研究的参与是自愿的，你可以在任何时候选择不参与或停止。本问卷调查的结果可能会被公布，但你的身份将保持私密和匿名。请使用非物质文化遗产移动 APP 后对每一款 App 进行评分。

This is a questionnaire about whether the use of gaming elements in ICH mobile apps has an impact on participants' acceptance of ICH-related knowledge. Your participation in the study is voluntary and you may choose not to participate or stop at any time. The results of this questionnaire may be published, but your identity will remain private and anonymous. Please rate each app after using the ICH mobile app.

APP	适合非物质文化遗产 ICH fitness	易用性 Usability	享受与愉悦 Enjoyment and pleasure	兴趣 Interesting	感知有用性 Perceived usefulness
The Forbidden City 365					
Dougong					
Han Xizai's Night Banquet					
Crafted wood					
Chinaware					
Folding fan					
Fantastic Traditional Festivals					
The Everlasting Regret					
A Day in the Life of an Emperor					

评分为 5 分制，最好为 5，最差为 1。

The rating is on a 5-point scale, with the best being 5 and the worst being 1.

Appendix D: Questionnaire data of study 2

APP-Functional appropriateness	A	AB	ABC	B	BC	BA	C	CB	CAB
1Female	5	3	4	3	5	5	3	5	4
2Female	2	4	4	4	5	5	2	4	4
3Female	3	3	4	2	4	4	3	3	4
4Female	3	4	5	5	4	4	4	5	3
5Male	3	4	3	4	4	3	3	3	2
6Male	3	3	3	4	4	3	3	3	3
7Female	3	3	3	4	4	3	3	3	3
8Female	3	3	3	3	4	4	3	4	3
9Female	3	4	3	3	4	4	3	4	4
10Female	3	4	4	3	4	4	2	5	3
11Female	4	4	3	3	4	4	3	4	3
12Female	4	3	3	3	4	3	3	4	3
13Female	4	4	3	3	4	4	3	4	3
14Female	3	4	3	4	4	3	3	5	2
15Female	3	3	4	3	4	3	5	5	3
16Female	5	5	5	5	5	4	4	5	4
17Female	4	3	4	3	5	5	3	5	4
18Female	3	4	2	3	3	3	4	4	3
19Female	4	3	3	4	4	4	4	4	4
20Female	5	4	4	4	4	4	4	5	4
21Female	3	5	4	3	5	5	4	4	4
22Female	5	5	4	5	5	5	5	5	5
23Female	4	3	2	3	4	3	4	4	5
24Female	4	4	3	3	3	3	2	4	4
25Female	4	4	5	4	5	3	4	5	3
26Female	5	5	2	3	4	4	2	5	4
27Female	3	4	5	4	5	5	5	4	2
28male	4	5	5	5	5	3	3	4	3
29Female	4	3	4	3	3	4	3	4	3
30Female	4	4	5	3	4	3	4	5	4
31Female	4	4	3	5	5	3	2	4	4
32Female	3	5	4	4	5	4	2	5	5
33Female	3	4	2	4	3	3	2	3	2
34Female	1	5	4	4	5	3	1	3	5
35Male	5	5	5	5	5	5	5	5	5
36Male	3	3	3	4	3	4	3	3	2
37Male	3	4	3	4	5	4	4	3	3
38Male	3	3	4	4	4	3	4	4	3
39Male	4	5	3	5	5	5	3	3	3
40Male	3	4	3	3	4	4	3	3	2