

The Effect of Mobile Serious Games on Learning Intangible Cultural Heritage

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Abstract

This study focuses on exploring the usage of mobile serious games in supporting the transmission of intangible cultural heritage (ICH). Specifically, it examines the effectiveness of *the 5th Great Invention* (game app) and *SunMao* (non-game app) on raising awareness and promoting skills learning regarding Mortise-Tenon joint, which is a traditional craftsmanship classified as Chinese ICH.

The research methods involve interviews, questionnaires, and observations. The result of this study shows that both apps can raise cultural awareness, however there is no significant difference shown when comparing both apps. On the other hand, *the game app* can improve craft skills more than the non-game app. This study also gives further suggestions for future potential research.

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Declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Chapter 1: Introduction

1.1 Research Motivation and Rationale

This research aims to explore the usage of serious games in supporting the transmission of intangible cultural heritage. Specifically, it examines the effectiveness of serious games on raising awareness and promoting skills learning regarding traditional craftsmanship.

In recent two decades, the intangible cultural heritage and its safeguarding have been given increasing concern and attention on the global scale, particularly since the *Convention for the Safeguarding of the Intangible Cultural Heritage* introduced by UNESCO in 2003 and widely ratified by nations around the world. This 2003 Convention showed that UNESCO acknowledges that cultural heritage does not end at monuments and collections of objects (i.e. tangible cultural heritage), but also includes traditions or living expressions that inherited from our past generation to our future generation, such as oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe, or traditional craftsmanship (UNESCO, 2003), namely intangible cultural heritage. Along with the growth of globalization and social transformation, however, more and more young people are losing their interest in traditions and living expressions, which is bringing the threats of disappearance and destruction to the existing intangible cultural heritage. In order to ensure the viability of intangible cultural heritage, the ongoing transmission of its special knowledge and skills is important.

One of the most promising means that has potential for supporting the transmission of intangible cultural heritage could be serious games. Serious games emerged from the rapid development of digital games. A digital game is an interactive program for one or more players and provides entertainment at the least. It can be played on the various platforms including computers, consoles, and mobile devices such as smartphones or tablets. It used to be played by children and teenagers, but now it is popular among all ages. Serious games are digital games that use entertainment to facilitate learning for education, government or corporate training, public policy, and strategic communication objectives (Zyda, 2005; Susi, Johannesson, and Backlund, 2007), which means they are used for achieving certain purposes that go beyond pure entertainment (Djaouti, Alvarez, and Jessel, 2011). Currently, the usage of serious games is increasingly widespread in the cultural heritage field. Many related studies have shown that serious games not only can provide some cultural education, but also can support the preservation, reproduction, and appreciation of cultural

heritage as well as promote cultural awareness (Laamarti, Eid, and Saddik, 2014). So far, however, there has been little work done on the serious games for intangible cultural heritage, which is the main goal of this research. In addition, many studies showed evidence regarding the effects of cultural heritage serious games, however they are more focused on evaluating the entertainment factor rather than the learning aspects of the games, as well as there are limited studies on measuring the extent of their learning effectiveness (Tsita and Satratzemi, 2019).

As a consequence, this research seeks to address these lacunas by focusing on *The Fifth Great Invention* — a mobile game with 3D features and designed for the mortise-tenon joint which is a Chinese intangible cultural heritage. In order to measure the extent of this game's learning effectiveness, I will use SunMao — a mobile application also about the joint with 3D visuals but has no game features, as comparison.

1.2 Research Aims and Objectives

This research aims to explore the adoption of serious games in supporting the transmission of intangible cultural heritage. In order to examine the research question, the following objectives and hypotheses have been developed.

Objective 1: to determine if *the Fifth Great Invention* can raise cultural awareness better than the *SunMao*

Hypothesis: *The Fifth Great Invention* is better at raising cultural awareness than *SunMao*

Objective 2: to determine if *the Fifth Great Invention* can teach craft skills better than the *SunMao*

Hypothesis: *The Fifth Great Invention* is better at teaching craft skills than *SunMao*

Chapter 2: Literature Review

2.1 Introduction

Conducting literature review aims:(1) to understand the research questions in the light of previous studies and develop arguments about the research topic, while focusing on conceptual and theoretical frameworks for research questions, and appropriate research methods to answer the questions; (2) to show the understanding of current background and knowledge about the research topic; and finally (3) to highlight the importance of the research (Polit and Beck, 2004; Feak and Swales, 2009).

2.2 The Importance of Intangible Cultural Heritage

Cultural heritage is a human creation that gives us the information and knowledge about our identity, our history, and our bond to the past, the present, and the future (Feather, 2006; Rouhi, 2017), which means it is what we value and we pass on from the last generation to the next generation, including objects, practices, customs, places, artistic expressions and values, which is normally expressed as either tangible or intangible (ICOMOS, 2002).

Since the adoption of *the Venice Charter* in 1964, varied heritage conservation instruments in the form of charters, principles, guidelines, resolutions and recommendations have been continually drafted and instituted by international institutions such as UNESCO or ICOMOS to define the scope of cultural heritage and propose appropriate approaches its safeguarding (Ahmad, 2006). In the meanwhile, the concept of cultural heritage has been considerably changed. Cultural heritage does no longer end at the tangible cultural heritage which manifested through material forms such as monuments and collections of objects, buildings or sites. It also includes the intangible cultural heritage which manifested through immaterial forms such as traditional music, dance, languages, knowledge, skills, or practices (Singer, 2011). Such expansion happened is because, firstly, the selection of what qualified as cultural heritage was no longer based on the intrinsic qualities of the object (i.e. the values and authenticity of the materials), but rather on our ability to recognise their values and build our own identity linked with them (Munjeri, 2004; Vecco, 2010). In other words, anything that expresses the value of society can become a heritage, which enables people to recognise to include intangible cultural heritage. Secondly, they found out that there is a symbiotic relationship between tangible and intangible heritage, which the intangible could be regarded as the larger framework within which the tangible takes on shape and significance

(Bouchenaki, 2003). Bouchenaki (2003) states that cultural heritage is a conjunction of society (which is the interaction system that connects people), norms and values (that is the ideas or beliefs that attributes relative importance). If intangible heritage represents norms and values, then symbols, objects, and technologies such tangible heritage are the evidence of underlying them. As Arjun Appadurai (cited in Munjeri, 2004, p. 18) puts it,

“intangible heritage because of its very nature as a map through which humanity interprets, selects, reproduces and disseminates cultural heritage was an important partner of tangible heritage. More important it is a tool through which the tangible heritage could be defined and expressed [thus] transforming inert landscapes of objects and monuments turning them into living archives of cultural values”.

For example, the Shrine of Ise, as one of the greatest temples, contains everlasting wisdom and spirit values. This building is made of wood but remains the same for more than a thousand years, as it is reconstructed every 20 years in a custom. The whole reconstruction keeps using the same types of wood as new building materials. Trained craftsmen use the techniques inherited from the last generation to renew the whole building as well as produce and install its furniture and decorations for it. There is also a work plan that contains creation knowledge of this building which looks hundred and hundred years into the future. It can be argued that the value of the Ise Shrine is not defined by the criteria of the materials, whereas by the workmanship, design and setting, which are seen as the intangibles (Munjeri, 2004).

In this setting, the importance of safeguarding intangible heritage is increasingly highlighted, especially by UNESCO's 2003 *Convention for the Safeguarding of the Intangible Cultural Heritage*. In this Convention, UNESCO appeals for recognising the decline, destruction and disappearance of intangible heritage due to the growth of globalisation and the process of social transformation. In order to maintain cultural diversity and sustain intercultural dialogue with different communities, intangible cultural heritage is an important factor that needs to be understood and safeguarded (Signer, 2011). According to the 2003 Convention, UNESCO defined the intangible as:

“the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity.”

(UNESCO, 2003)

Considering different cultures more or less vary in defining the manifestations of intangible cultural heritage, UNESCO (2003) provides a general framework which grouped them into five main domains:

- “(a) oral traditions and expressions, including language as a vehicle of the intangible cultural heritage;
- (b) performing arts;
- (c) social practices, rituals and festive events;
- (d) knowledge and practices concerning nature and the universe;
- (e) traditional craftsmanship.”

2.2 Traditional Craftsmanship: The Mortise-Tenon Joint

The People's Republic of China is a strong supporter of the UNESCO 2003 Convention, although it is a latecomer to the safeguarding of ICH (Cros, 2012; Tan, 2017). So far, China has 41 elements presented on UNESCO's *Lists of Intangible Cultural Heritage and the Register of good safeguarding practices*, especially has 7 elements registered on *the List of Intangible Cultural Heritage in Need of Urgent Safeguarding*, which includes traditional design and practices for building Chinese wooden arch bridges, and Chinese traditional architectural craftsmanship for timber-framed structures. The mortise-tenon joint is the core technology of it. The mortise-tenon joint is the main link from a structure made of timber. No nails were used in the ancient buildings in China. Instead, mortise and tenon joints were extensively used in the process. This is a sort of convex-concave connection, that could effectively join two timber pieces. In this kind of architecture, mortise-tenon joints had been used to connect strong frames, in which the purlins, beams, columns, bracket sets and lintels were installed. The frames were resistant to earthquakes. Besides, they were flexible and could be assembled very fast. It lasts around 7,000 years and symbolizes great wisdom of our ancestors (Chen and Song, 2017).

2.2 Safeguarding and Transmission

Safeguarding intangible cultural heritage means to ensure its viability among the present generation and its continued transmission to the future. Singer (2011) states that “the importance of intangible cultural heritage is not the cultural manifestation itself but rather the wealth of knowledge and skills that is transmitted through it from one generation to the next.” Take traditional craftsmanship as an example, rather than focusing on preserving the craft objects, the safeguarding should concentrate on passing the skills and knowledge regarding how to produce craft objects onto others. As guru on monumental heritage of ICOMOS stressed, “physical heritage can only attain its true significance when it sheds light on its

underlying values. Conversely, intangible heritage must be made incarnate in tangible manifestation” (cited in Munjeri, 2004: 18). Bouchenaki (2003) proposed a threefold approach which points out the same direction: (1) tangible heritage should be put in its wider context in order to give greater weight to its values, which to avoid the situation that most of the attention are paid to its physical form, while the intangible elements hidden in it are overlooked (Papathanassiou-Zuhrt, 2015); whereas (2) intangible heritage can be translated from oral forms into the materials such as documents, archives or film records, as well as (3) support the transmission of its skills and knowledge, which is ‘know-how’.

Intangible cultural heritage transmission is a dynamic, interactive and creative process, and education is playing a key role in its safeguarding. The classic approach such as identification or documentation that is identifying a cultural heritage and making a plan to safeguard it will not go so far due the ‘living’ nature of intangible cultural heritage, whereas the border approach especially the education that can reach more communities, strengthen the modes and methods of transmission that are recognised by communities and make a greater contribution to intangible cultural heritage safeguarding, because the transmission itself is education (UNESCO, 2017; UNESCO, 2019). As UNESCO (2003) highlighted in its Convention, safeguarding measures including “transmission, particularly through formal and non-formal education”.

2.3 Serious games and Its characteristics

People usually do not need further explanations when mentioning games in the playtime. As Oxford Dictionary defines, game is an activity that people engage in for amusement or fun (Game, 2019). Thanks to technological advances, games can be played by electronically manipulating images produced by computer programs on the monitors or other displays (Video game, 2019), which are named as video games. Perhaps, video games are similar to other mediums (such as books, television or movies) that they both can offer entertainment, but the games can provide more than that.

Marc Prensky writes what makes games engaging and believes that “...video games are potentially the most engaging pastime in the history of mankind” (Prensky, 2001, pp.106). Prensky (2001) lists 12 structural game elements to explain why games engage us and have more potentials, which are shown in Table 1.

WHY GAMES ENGAGE US

Games are a form of **fun**. That gives us *enjoyment and pleasure*.
Games are a form of **play**. That gives us *intense and passionate involvement*.
Games have **rules**. That gives us *structure*.
Games have **goals**. That gives us *motivation*.
Games are **interactive**. That gives us *doing*.
Games have **outcomes and feedback**. That gives us *learning*.
Games are **adaptive**. That gives us *flow*.
Games have **win states**. That gives us *ego gratification*.
Games have **conflict/competition/challenge/opposition**. That gives us *adrenaline*.
Games have **problem solving**. That sparks our *creativity*.
Games have **interaction**. That gives us *social groups*.
Games have **representation and story**. That gives us *emotion*.

Table 1. Why Games Engage Us, in Digital Game-Based Learning by Prensky (2001, pp. 106)

Based on Prensky (2001) and other studies on the video games characteristics including Malone (1981), Garris et al. (2002) and Vogel et al. (2006), Wounters et al. (2013) seek out the key game characteristics and provide an integrated structure of all types of video games, that it is being interactive, based on a set of agreed rules and constraints to a clear goal which sets by a challenge, and alongside with sustaining feedback such as scores, awards or changes in the game world.

Video games used to be rejected as a form of culture, and their abilities and possibilities had been underestimated as well. It is probably because people perceived video games as an entertaining medium of children only for leisure; and as a distraction or moral baseness with no benefits for the human culture and society (Newman, 2004). Indeed, there are many of the studies out there about the effects of playing video games that indicate the negative impacts including the potential harm associated with violence (Ferguson, 2007; Ferguson, 2013), aggression (Anderson et al., 2010), addiction (Hafeez, Idrees, and Kim, 2015) and depression (Lemola et al., 2011). More researchers, however, do believe in the good side of playing video games as they found out positive impacts both inside and outside gaming contexts, which have a great effect on learning.

A fairly recent research (Granic, Lobel and Engels, 2013) has summarized many studies of advantages of playing video games and classified them into four categories as following: (1) cognitive advantages: players obtained fast and accurate attention allocation, high spatial resolution in visual processing, and strong mental rotation abilities, especially when playing

action games (Green and Bavelier, 2012). Problem-solving are also indicated as the cognitive skills that players obtained through gaming, notably when playing puzzle or role-playing games, players might need to do some actions before game proceeding further such as gather information, consider various options, or plan or change strategies and goals, which could reflect the skill (Prensky, 2012); (2) motivational advantages: the failure and rewards are the key motivational elements lead players to persist and continue to complete the tasks during the video gaming and become the winners. Rewards such as points or coins provide continual effort and keep players to proceed further (Sweetser and Wyeth, 2005), and the experiences of failure could highly motivate players to return to the task for reaching goals and winning games (McGonigal, 2011); (3) emotional advantages: playing video games can produce positive emotional feelings such as happiness, confidence, or self-control, as well as can allow players to be good at mood management when they are having negative emotions; and (4) social advantages: as video games can be played by individual or/and multiplayer, and most of them prefer to play with friends, family members or other players who have the same interests, players can acquire essential prosocial skills including the effective cooperation, organization, support, and assist (Gentile et al., 2009; Ewoldsen et al., 2012).

Wouters et al. (2013) propose that the influence of games on learning that depends upon the change of cognitive processes and the effect on motivation, and they explain that the (inter)active nature of digital games “active cognitive processing of educational materials is a prerequisite for effective and sustainable learning”, digital games can “simulate tasks games in such a way that performing them in the game involves the same cognitive processes that are required for task performance in the real world”, and the games’ immediate feedback “provides players information regarding the correctness of their actions and decisions and thus gives them the opportunity to correct inaccurate information”.

Video games attract a great amount of attention from various domains including cultural heritage, which intends to utilize them by introducing the concept of serious games for achieving various purposes that go beyond pure entertainment. Prior to offering further discussion of how serious games are used for cultural heritage, it is necessary to define what a serious game is. The concept of serious games first appeared in *Serious Games*, a book written by Clark Abt (1970). Through examining the positive influences of games and simulations on formal or informal education and training, the author coined the term ‘serious games’ and concerned them in the sense that “these games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement”

(Abt, 1970: 9). Although Abt's understanding of serious games was built on the examples of mainframe computer games and pen-and-paper based games, it cannot be denied that this concept has influenced a wide range of subsequent studies on the serious games in various fields, and has laid the foundation of many follow-up definitions that made for serious games (Hakulinen, 2011; Taylor and Backlund, 2011; Stokes, 2012).

The modern definition of the term 'serious games' seems to be built on the basis of the original concept but more closely follows the lead by the understanding of Sawyer and Rejeski (2002) and Sawyer (2009), who inspired a great interest in the idea of importing serious purposes into video games including those run by technology platforms which raised in the new digital era, such as high-end graphic game consoles (i.e. electronic games), the Internet (i.e. online games), or mobile computing (i.e. mobile games), and ultimately shaped the current Serious Games field. Many recent definitions are created in this setting, such as those of Zyda (2005), Chen and Michael (2005), and Djaouti, Alvarez, and Jessel (2011). However, as Corti (2007) stressed, the Serious Games field gathers many researchers, practitioners and related personnel who come from various domains and who always have different opinions about what does and what does not belong(s) to the serious games. Hence, a broader description might be more appropriate to define current serious games for all fields as a serious game is "any piece of software that merges a no-entertaining purpose (serious) with a video game structure (game)" (Djaouti, Alvarez, and Jessel, 2011: 120).

Djaouti, Alvarez, and Jessel (2011)'s research further provides a concrete analysis of the nature of serious games by discussing the differences between video games, serious games, and serious gaming. In the first place, their research found out that a commercial entertainment video game can be used directly for supporting a serious purpose, especially in education and healthcare. These games offered the possibility for allowing teachers or therapists to create their own serious scenario where they introduce the play sessions of their participants and influence the way their participants might play (Gee, 2003; Shaffer, 2006; Stora, 2005). For example, the game Pokémon originally aims at creature collection, exchange, and fighting, but the players have to know and master the natures or characteristics of their collected Pokémon creatures in order to increase the odds of success during the fighting as well as in exchange for needed creatures. As these creatures are designed on the basis of real-world living beings, the game is commonly used as teaching materials for inspiring children's learning interest in real native wildlife and facilitating the knowledge construction about it (Balmford et al., 2002).

However, Djaouti, Alvarez, and Jessel (2011) prefer to perceive these video games as a 'purpose-shifting' game rather than a serious game. One possible reason is that these video games can shift their original purposes from entertainment to seriousness, but they are designed for purely entertainment, which is against the concept of serious games that the games do not take entertainment as their primary and only purpose (Chen and Michael, 2005). Besides, not all video games can be used to serve a serious purpose, unless the 'serious' content can be added into them.

In terms of Djaouti, Alvarez, and Jessel (2011), some software modifications of video games have been created in this setting, which means these games attempt to fit seriousness into a pre-existing video game. As illustrated with Scape from Woomera (software modification) that built on Half-Life (video game) in their research, the game referenced the original game scenario —fighting an alien invasion, and transformed it to a serious scenario —infusing the awareness of the difficult living conditions from the people who stay in an Australian immigration centre.

In contrast to purpose-shifted or software-modified video games, serious games should be in the sense that a video game is crafted from the beginning by integrating both 'serious' and 'game' dimensions at the same time (Djaouti, Alvarez, and Jessel, 2011). Such games are considered as the real serious games. To be specific, on the one side, a serious game is created on designers' own terms which often alongside with explicit serious purposes at first. Take PeaceMaker as an example, this game designed by the university students who primarily aim to enable the players to better understand the plight of different races through allowing Palestinians and Israelis to switch their roles (ImpactGames, 2010 cited in Sanford, et al., 2015).

On the other side, a serious game should be entertaining which can compete with commercial entertainment video games. As Abt (1970: 9) stated, they are played primarily for serious purposes but "this does not mean that serious games are not, or should not be, entertaining". Some researchers argued that entertaining could be too intense to hinder serious content which issues in the situation that players try to avoid the serious mode in order to return to the gaming mode as fast as possible (Kerres et al., 2009), but without entertainment, serious games will lead to failure to work. As the concerns expressed by Granic, Lobel and Engels (2013), the majority of failed serious games are lack of the 'fun' —most essential nature characteristic of entertainment video games and the dynamics of

engagement, flow, and immersion, and merely pulling together a series of serious contents in the games which attempt to makes them look great and good for the players.

2.4 The Use of Serious Games in Cultural Heritage

During the past two decades, lots of cultural heritage research contributions are directed towards taking the strengths of serious games and using them to support people-centred cultural purposes, in particular to encourage the interaction between cultural heritage and users and thus promote their cultural learning (Mortara et al, 2014).

Mobile applications as burgeoning technological tools have been valued in the cultural heritage field. Mobile applications — also known as mobile apps— a computer program or software that runs on a mobile device such as an audio guide, PDA, smartphone or tablet. Among others, Smartphone-based mobile applications are popularly developed and used for supporting the interaction between cultural heritage and users.

Technically, smartphones as the main personal mobile devices that are on the leading edge of mobile technologies at present, who have powerful and composite capabilities that combined the features of computers and other mobile devices including PDAs, cell phones, digital cameras, media players, and GPS navigations, and even be further added with some new functions such as touchscreen, high-speed networks, wireless fidelity connectivity, motion sensor, augmented reality, and virtual reality (Tomiuc, 2014). In other words, smartphone-based mobile applications (1) allow ubiquitous access that enable the cultural learning to take place no longer only in the cultural context such as cultural institutions or heritage sites, but in everywhere and anytime; and (2) provide rich interaction and usage experience to facilitate the cultural learning.

On the one side, smartphone adoption and mobile app penetration are universal and striking. According to the latest global report by Hootsuite and We Are Social (2019) — a world-leading social media platform and a global media agency respectively, almost 5.5 billion smartphones are in use around the world today, which grew nine percent (450 million) higher than last year; and meanwhile the mobile app market is booming, that application downloads and consumption reached nearly 200 billion in total and over \$100 billion respectively just for last whole year. It can be understood that smartphone-based mobile applications have a large number of users, which could promote cultural heritage to a wider audience.

As early as 2012, the potential of smartphones and mobile apps to the cultural heritage field has been aware of. A leading research company, Fusion Research and Analytics (2012), had conducted a survey in the Victoria and Albert Museum in the UK, and found out that most of the visitors were carrying their own smartphones and used it to interact with cultural heritage, including to take photos or videos of cultural objects, search exhibit-related information, share experiences to others via social media and download relevant mobile applications. In the following year, this company released a mobile survey with the Museums Association (2013) which further pointed out that mobile apps have a high adoption rate in the cultural heritage field.

The use and development of serious games run on mobile apps for cultural heritage are also on the rise. Besides the smartphone-based mobile games, games can be run on other mobile devices including institution-provided audio guides and Personal digital assistants (PDAs) or cell phones. It should be noted that the institution-provided audio guides, known as the early handheld mobile device which applied in the cultural institution such as museums and galleries, and still gained ground during a certain number of visitors (Museum Association, 2012). Visitors are allowed to access the exhibit or institution-related information and tour routes through multimedia digital systems and with new options, such as location awareness and free choice tour (Tallon, 2008). Game is also one of the options which runs on an audio guide, and it can be a single one or consists of several small games. This kind of mobile games is rare that normally appeared in a specific audio guide and targeted at one particular group. For example, British Museum (2009) as one of biggest national museums has launched various audio guides in different periods and for different groups, among them, however, only one game-contained audio guide is found so far, namely Children's Guide.

This guide contains small interactive games around some of the exhibits in the museum and enables children to understand those cultural objects in an interactive and interesting way. In fact, games are not quite suitable for running on institution-provided audio guides. In addition to the factors mentioned above, others probably could be that most of audio guides have rental charge so that restricting visitors who are not willing to pay for it for a visit; that audio guides only allowed to use inside cultural institutions so that limiting the active boundary; and that audio guide users are more accustomed to get information or knowledge about their interested exhibits through texts or audios.

PDA's or cell phones, as inchoate personal mobile devices, are also a kind of mobile devices that allow gameplay for supporting cultural purposes. The research from Yiannoutsou, Papadimitriou, Komis and Avouris (2009) has properly described how games are mediated by PDA's. They designed two mobile games, the Donation and the Museum Scrabble, for the Museum of Solomos and Eminent Zakynthians in Greece. Both mobile games offer some basic textual information about a set of specific exhibits as game clues which are stored in the PDA's. Based on the clues, players are encouraged to use their PDA's to scan the tags, to find the triggers of the clues, and to store the selected information as their point of view for searching for other relevant exhibits in the museum, so that the players can solve the given problems and get the game points.

A slightly different with PDA's, cell phones have additional functions such as surfing the Internet, phoning, sending emails, and texting messages. However, the gameplay escorted with cell phones is similar to it with PDA's. For example, the Ghosts of a Chance, a game that applied at the Smithsonian American Art Museum in the USA. Players use cell phones to get a series of clues and to play several types of puzzles about key exhibits around the museum through texting messages between the players, and further through other offered cell phone functions for getting more support in the game (Goodlander, 2009).

Nevertheless, such mobile games have unitary or similar game mode, game content is merely on the basis of textual information of physical exhibits inside cultural institutions, and the consoles are outmoded regardless of PDA's or cell phones. Compared to above, smartphone-based mobile games seem to become an inevitable trend.

Mobile games can be either a network-based or a stand-alone mobile application, which enable the context of game play to be various. It means that mobile games can be played in specific contexts at specific times (normally in a cultural context, such as a museum, an exhibition or a historical site, hereinafter referred as 'on-site' contexts), or in other diverse contexts (such as at home, school or other public places, hereinafter referred as 'off-site' contexts) with long periods of time.

In on-site contexts, mobile games are expected to build a link and allow the interplay between physical and virtual spaces, so that audiences are enabled to interact with the cultural content encountered along his or her visit. As such, some interactive functions, in particular, location awareness and augmented reality (AR) technology seem apt to be compatible with mobile games for cultural context settings.

Mobile games with location awareness function are designed into game activities that some actions need to be done in the physical space and other actions have to take place in the virtual space (Avouris and Yiannoutsou, 2012). For example, in *A Gift for Athena*, a mobile game for the Parthenon gallery in the British Museum, the ‘finding sculptures’ challenge allows the player to move to some specific locations to find a sculpture, point the camera on it to observe whether this sculpture is match the empty outline that displayed on the screen, and if the player found a match they can gain some rewards —an animation and an explanation of what the player has found or some clues for the next task; the game also has virtual challenges which encourages the player to generate information related to physical cultural objects in digital form through solving puzzles, playing mini-games, and interacting with game characters or other players (Museums and the Web, 2015).

AR technology is normally applied with location-based mobile games. Similarly, it aids to make connections across the physical and virtual environments, but more importantly, it enriches the experience and enhances learning motivation for audiences in cultural contexts. On the one side, mobile games with this function provide an interactive experience where the player can reference cultural objects on site and superimpose design elements onto images or objects in the real location, and also allow the player to bask in a real environment where the objects are enhanced by computer-generated perceptual information across multiple sensory modalities, such as visual, auditory, or haptic. A significant cultural mobile game can be represented by *Terracotta Warriors: The First Emperor and His Legacy*, which was designed for its corresponding special exhibition in Asian Civilisations Museum in Singapore. In this game, many cultural objects are featured as AR markers, for instance, the ancestral bell of Pre-Qin period is featured as a 3D virtual object which allows the player to active it by pointing the camera at the marker to ring the virtual bell on the screen and hear the actual sound of it); a coloured warrior displayed in AR to show what was the original look of the terracotta warriors before the disintegration of their decorative painting; AR warriors in alternating firing ranks in battle to show how the crossbow mechanism works; and so on (Thian, 2012). On the other side, players have a better motivation to learn about the cultural content within such interactive contexts. As one of the responses recorded in Thian (2012), “very creative and educational, fully integrated with the exhibits to bring out the best of history!”.

In these regards, mobile games in the genre of role-play and treasure hunt are the most popular for on-site settings, as they allow individuals or multi-players to find hidden objects,

locations or places by using a series of clues which obtain in the process of interaction with other players or cultural contents. According to some researchers, most of this genre of mobile games with interactive functions mentioned above is designed in narrative structure with game activities embedded in a larger story as the game background (Jenkins, 2004; Juul, 2005a; Juul, 2005b; Lombardo and Damiano, 2012). The story provides a framework that contains large amounts of information in a compact format which allows the audience more easily to understand the events, value the culture and assimilate the content (Bruner, 1991; Gershon and Page, 2001).

Moreover, characters and plots in the story motivate audiences to interact with and enable them to make the game advance (Spierling, 2005). Take *Terracotta Warriors* as an example again, this game gives a story that unfolded through a dialogue between Li Si, the prime minister and architect of the Qin Empire, and his son before they were going to be executed. The dialogue progresses through seven different locked parts, and each part highlights more than one cultural object displayed in the exhibition. As the story progresses, players are motivated to experience cultural objects or some mini-games in order to unlock all parts so that they can have a full understanding about ambitions and hidden agendas of the emperor in the period of Qin — the essential content or information related to the exhibition.

Although the story can make connections with players and breathe life into the cultural content, some game designers observed those game activities and indicated that players often focus on the story at first and not the actual exhibits in cultural contexts. More specifically, firstly, players just simply finding the exhibits to get the clues in order to make the story proceed but without carefully reading the descriptions of it, so that players cannot be encouraged to think deeply or have a good understanding about what they are reading and looking at (Klopfer et al., 2005; Yiannoutsou et al., 2009). Secondly, they seem to only go through the exhibits guided by the story, and other cultural objects in the exhibition may be ignored (Yiannoutsou and Avouris, 2012).

In fact, mobile games are more expected to be able to play away from the on-site context. As a player had commented to the *Tate Trumps*, a mobile game which merely could be played at Tate Modern, as follows: “Not everyone can get there immediately...why not...to play away regardless of location then when I am in the area I’m more likely to pop in!” (Downe, 2011). As required, there are indeed some mobile games designed for off-site settings, which with no limitations of time, spaces, and genres, but they are varied. Some of them just simply combined cultural heritage with superficial meanings. For instance, in the

Race Against Time released by Tate Modern, the player controls the chameleon to race through time in order to collect the colour power from as many major modern art movements; a variety of famous paintings such as The Starry Night by Vincent van Gogh and Water Lilies by Claude Monet are represented each period of time of modern art movements and showed as displaying background when the chameleon is running. Except the appreciation of those paintings and fun, almost no other significance from this game.

Some others are more detailed and complex. One Day Being Emperor can be an example, this mobile game involves various kinds of mini-games such as trivia, puzzles or actions, which allows the player to experience what was the life of a Qing emperor. Lots of relevant information and knowledge could be obtained through game playing as well. For instance, in one part of this game, four dresses are provided and allowed to wear, but the player (roles as the emperor) has to fit in the right dress in terms of the place. Through changing outfits and reading each description of it, the player can understand why and what kind of dress should be wearing in what type of occasion. At the same time, some cultural objects displayed in this game have a fine and elaborate appearance which nicely supports the reconstruction and appreciation of cultural heritage.

2.4.1 Mobile serious games and learning experience

The concept of active knowledge-acquisition experiences gets direct support from constructivism. This enables the learner to establish a connection with knowledge directly. In the process, the individual can create new knowledge and enhance the problem-solving and reasoning abilities (Huang et al., 2010). Digital games used in education can be engaging and efficient in this sense, as the interaction of the learner with the environment and activities construct knowledge. The process is continuous and takes place as a response to the external world. Presently, digital games are debated extensively. The opponents and defenders are emotionally involved and inflexible, with regard to their opinions. On both these sides, certain misunderstandings exist, while there are several attribution and terminology abuses Barrett and Long (2012).

Integration of games and education has several examples. Kaufmann (2004) presented a major project called Construct 3D. It was a geometric construction tool, that was designed particularly for the teaching of geometry and mathematics in tertiary and secondary education. The tool enables one to visualize 3D objects that had to be constructed and calculated using traditional methods in the past. AR was used as a means for enhancing the

interfaces for the generation in future, enabling students to work directly in a three-dimensional space. Morais et al. (2008) came up with GeoEspaçoPEC, which is relevant in the educational game context. It aims to stimulate the students to acquire knowledge on spatial geometry. It was developed to highlight the key ingredients of plane geometry. Structured as an RPG (Role Playing Game), it enables the aspirants to go on to the subsequent levels through the exploration of answers and solutions. In the process, they can gain knowledge on special geometry at the new levels. Previous studies mentioned in this section indicate that the mobile serious games can facilitate learning, but there is again gap of studies which indicate up to what extent mobile serious games can help in learning, transmitting and making aware people about intangible cultural heritage and thus this study would find this fact by using mortise tenon.

In order to evaluate the quality of the interaction between users and mobile applications, it is important to measure user experience. Prior to presenting further information, a definition of experience and user experience should be given. An appropriate definition of experience is proposed by Dewey (1938), that “experience is both the process and outcome of the interaction of a user with the environment at a given time” (cited in Calvillo-GameZ, 2010: 50). In the context of user experience, experience refers to the process and outcome of the interaction between user and software product. As ISO 9241-110 (2010) stated, user experience is an individual response and perception produced by the use and/or anticipated use of a system, product or service.

2.5 Evaluating Learning Effectiveness of Serious Games

The last few years have witnessed the development of particular models of evaluation for learning processes, based on games. Garris, Ahlers, and Driskell (2002) came up with a model involving input-process-output processes that fosters knowledge-acquisition through serious games. They perceive input as the instructional content and characteristics of the game. The process is therefore a learning mechanism that involves interest or enjoyment (330 E. Oprins et al.), along with user behaviour like increased perseverance at task. Output, on the other hand, refers to the learning and debriefing outcomes. One of the interesting aspects of this model is the effects on the perceptions of users, the following behaviour and the differences between the features of gaming design. Pavlas (2010) defines the game-oriented process of learning and differentiates between ‘game characteristics’ and ‘player traits’ as input variables. Here, ‘player in game states and behaviours’ has been considered as a type of process variable, considering that flow is a central theme. The

output is evident in the form of 'outcomes'. Connolly, Stansfield and Hainey (2009) have defined certain existing models for evaluating serious games. For example, they have defined the CRESST model (Baker and Mayer, 1999), game object model (GOM; Tan, Ling, and Ting, 2007), and four-dimensional framework (De Freitas and Oliver, 2006). They have also proposed an integrated framework for evaluating game-oriented learning. This idea revolves around the fact that one can evaluate games in terms of motivation, learner performance, preferences, game environment, perceptions and collaboration between gamers. The common aspect between these models is that they present views of high-level on the analysis of game-oriented learning, focusing on the features of gaming design. However, they do not specify the indicators that should be gauged as per the generic evaluation models, proposed by Kirkpatrick and other researchers.

Mayer (2012) has presented these indicators with a greater degree of clarity. The conceptual model he proposed has different types of variables at the team or individual level, or the system or organizational level that can also be found in other models for generic evaluation (e.g., Kraiger et al., 1993; Tannenbaum et al., 1993). In Kirkpatrick's model, one can measure the outcome variables directly after the intervention of gaming and the effects measured are more indirect. In Mayer' model, a precondition is visible, along with the gaming intervention and a post-condition, through which one can derive experimental designs.

Mayer (2012) also laid the focus on the dilemmas between standardization and generalisation, involved in competitive research, the flexibility and specificity required for evaluating single cases. As a part of authenticated instruments for measurement, generic constructs can be used again for different studies related to various games, so as to carry out comprehensive studies as per the needs.

Therefore, the model proposed by Mayer (2012) is the most appropriate one, for analyzing serious games, among various models for analyzing game-oriented learning. This model falls in line with the general philosophies on the models for evaluation by Kirkpatrick and other researchers that can be applied to serious games.

2.5.1 The game-based learning evaluation model (GEM)

The proposed evaluation framework has some basic principles. These are based on the models that already exist, which were presented in the last section. This framework has

been presented as a model with input-process-output components, where both the outcome and process variables have been included (Alvarez et al., 2004; Kraiger et al., 1993; Tannenbaum et al., 1993, Mayer, 2012). The outcome variables are specific to the respective domains and one can measure that at different levels, as Kirkpatrick (1976, 1998) had proposed. This also includes training transfer (Baldwin and Ford, 1988). The process variables required for the learning process are generic. Therefore, it is possible to carry out a comparison between the serious games (Mayer, 2012). These have been divided into cognitive and emotional-motivational factors.

The emotional-motivational aspects have an influence on the processing of information and learning (Hockey, 1997; Richardson et al., 2012). In this framework of learning, the cognitive and emotional-motivational factors are together known as the learning indicators. The specific features of serious gaming of the intervention are accepted as the design indicators. Certain indicators (having *) are a part of the respective games, referred to as 'small games'. These may also be a part of the learning environment, where the games remain embedded. This is termed as the 'big game'. According to other models used in this respect (Cannon-Bowers, et al, 1995; Mayer, 2012), the learners' personal features determine the input. These may include the experiences, abilities and experiences of the learners (Roe, 2005).

Learning is also impacted by certain environmental factors at the organizational and personal levels. GEM specifies the nature of indicators, that are to be analyzed during the validation research, and the way they are associated with each other. The idea revolves around a validation study, that should gauge the learning outcomes, personal features, learning and design indicators and environmental influences. For each of the studies, one has to choose the indicators that have to be gauged, based on the hypothesis of the research.

Chapter 3: Methodologies

3.1 Introduction

This chapter describes the methodologies choices made for this research and presents the rationale for their inclusion. The research aims to examine the effectiveness of serious games on teaching craft skills and raising cultural awareness. In order to evaluate whether the serious games regarding the traditional craftsmanship can teach craft skills well and raise cultural awareness successfully, first, the researcher chose a serious game *The Fifth Great Invention* as a case study to provide in-depth research. Second, the research uses Bloom's taxonomy learning framework to match the learning objectives of the game. This framework involves three different domains which are Cognitive, Affective and Psychomotor. As the focus of this research is on skills learning and cultural awareness, thus the learning objectives are recognised in the Cognitive and Affective domains. The Cognitive domain is about the skills and knowledge acquisition of individuals, that consists of six levels from from the lowest to the highest level which include knowledge (the learner can recall the data or information), comprehension (the learner can understand the meaning of what is known), application (the learner can apply the learned knowledge in a new situation), analysis (the learner can differentiate the concept), synthesis (the learner can integrate different concepts to build structure), and evaluation (the learner can eventually makes judgments about the importance of concepts) (Anderson et al, 2011). The Affective domain is all about feelings, emotions and attitudes of the individual, which can be categorized into five levels including receiving phenomena, responding to phenomena, valuing, organization, and characterization (Anderson et al, 2011). Mortara et al. (2014, p. 280) suggest that the learner reflect the affection levels when they "show interest in the topic being taught; actively participate and show motivation; attach values to the educational messages; organise these values solving conflicts among contrasting ones into a unique values system; and finally internalize these values, behaving accordingly". Based on this framework, third, the researcher is able to apply observation and interview to find out which cognitive and affective level the users are at. In addition, in order to further examine the extent of the game effectiveness, a mobile application *SunMao* is adopted to be a comparison.

3.2 Case Study

With reference to the aim of this research, a case study approach is deemed to be a suitable method to how serious games can support the transmission of traditional craftsmanship, especially through raising cultural awareness and teaching craft skills. Crowe et al. (2011) states that a case study approach is particularly useful to generate an in-depth, multifaceted understanding of an issue or a phenomenon in its real-life context, which can be good at capturing information about more explanatory questions such as 'how', 'what' or 'why'. A case study is chosen in this research based on the decisions regarding the relevance and practical issues. This is what Stake (1995) characterized as an instrumental case. An instrumental case study is using a particular case that allows the researcher to investigate and gain a broader appreciation of an issue or a phenomenon, although some cases may be better than this one (Crowe et al., 2011). The interest in this research is the effect of serious games on learning traditional craftsmanship, and *The Fifth Great Invention* is regarded as the most appropriate case to be studied.

The Fifth Great Invention is a mobile game regarding mortise and tenon joints, which are the core technologies of Chinese traditional woodworking craftsmanship. It is a 3D spatial puzzle game that tests the abilities of players in spatial imagination as well as the construction of mortise and tenon joints. This game is developed not only for providing some entertainment but also for helping raise public awareness towards the importance of Chinese intangible cultural heritage in modern times. In order to examine the hypotheses, *SunMao* is introduced in this research as comparison. *SunMao* is a mobile application that also relates to mortise and tenon joints and has 3D visual settings. However, it only provides the presentation of different joints and their relevant information and knowledge, and has no game elements at all. By comparing these two mobile apps with 3D visual settings, the researcher can have more supporting evidence for examining the extent of the learning effectiveness of intangible cultural heritage serious games, as well as the researcher can limit some variables that may have otherwise affected results.

3.3 Interview

Interview is a qualitative technique that includes "conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program or situation" (Boyce and Neale, 2006). In a Game Studies standpoint, interviews provide "one of the only ways to understand players' motivations, their understanding of the

games” (Bromley, 2018). The interview can allow the researcher to understand users what and why they are thinking or doing, by asking the questions during or after an observation session of playtesting. In this research, the researcher uses a semi-structured interview. A semi-structured interview means some set of pre-decided questions, while some emerge from situations and answers of respondents. This method of interview helps in making the data analysis more straightforward, though the researcher may have problem to compare and contrast varied answers. The key benefit of using this method is that a direct control can be done by the researcher over the flow of process and interviewees may have a chance to clarify some issues at the time of process if required.

3.3.1 Process

Boyce and Neale (2006) criticized that there is a need for longer time in interviews and difficulties are related with arranging proper time with samples group members while conducting interviews. Accordingly, the researcher uses WeChat to contact potential interviewees first, then explains the purpose of this research, and asks them to sign the consent form when they agreed to participate in the interviews. In order to have an in-depth insight, the interview is conducted by one to one session, and the interviewees answer the questions during or after they experienced each mobile application. The interview has no time limitation but conducts in a quiet room so that the interviewees can concentrate to the participation. The whole interviews are recorded properly through videos. The conversation during the whole interview is set in Chinese, because it can make the researcher better concentrate on interviewees’ answers and ask for clarification instead of making notes while taking an interview. Once interviews are done, the researcher transcribes the conversation into word files, as well as translates the audio of respondents from Chinese to English.

3.3.2 Participants

There were ten people who participated in this interview. Certain criteria are used in the selection of interview participants. First, Chinese native speakers. As the two mobile apps are about Chinese culture and set in Chinese language, thus people who speak Chinese can experience these two mobile apps without language barriers. Second, students. Participants’ age can be a factor that inhibits the use of technology, which also has an effect on cognitive learning. Hence, in order to control the ‘age’ variable, students were selected as the participants. Third, the researcher chose equal numbers of participants split by gender, which are 5 female and 5 male.

3.3.3 Observations

Observation is adopted in this research in order to investigate user experience with these two mobile applications. There are many methods applied to collect and document data on user experience, which mainly can be put into two categories: behaviours and attitudes. The 'behaviours' refer to the actions that users take in the game, and the 'attitudes' refer to the opinions of users on what they use (Sangin, 2018). Observation is an extremely powerful research way for providing direct and objective insights into users' behaviour and making educated assumptions about the user's knowledge and intentions (Sangin, 2018). The observation can be less prone to subjective biases compared to the method of interviews, and will be helpful to support the conduction of interviews. The observation is set a time limitation, which is 30 minutes for each mobile app. The participants can stop at any time during their experience.

3.5 Questionnaires

Cooper and Schindler (2006) stated that a questionnaire contains a set of data which researchers use to collect and record needed information. Shiu et al. (2009) described the questionnaire as "a formalized framework consisting of a set of questions and scales designed to generate primary data" (p. 329). The questionnaire method makes it possible to obtain responses in standard manner and makes comparison easier between responses. The questionnaire also assists to prove the results in a scientific manner and more reliable. Use of digital technologies also makes this method easy by collecting responses in a fast manner through websites and apps locating in remote areas. Though, critics pointed out that if there is low sample size then reliability of results is assumed low. In addition to this, to design a questionnaire that would serve the purpose of research is very difficult (Bell, 2005). However, the sample size in this study is adequate and questionnaire has been approved by supervisor and designed based on theories so the reliability of questionnaire and results derived from it cannot be questioned. But there is a problem with questionnaire that is the low rate of response which is very common in this data collection method. People have the nature to avoid participation in filling questionnaire. However, this issue can be solved by explaining the significance of research and also by designing short questionnaire. In this study, the questions were related to *SunMao* and *The Fifth Great Invention*, so this can not be followed. The researcher explained respondents about the purpose and significance in a good manner. While sending questionnaires to respondents, the researcher was assured that these people have played both games. It increases credibility of this research.

3.5.1 Open ended and close ended questions

The three kinds of questions have been identified namely probing questions, specific or closed questions, and open questions (Saunders and Lewis, 2012). In this research, closed questions have also been used to make easy statistical tests. The close-ended questions have four options and the respondent needs to tick on one and in open-ended questions, the respondents have to reply subjectively. Close-ended questions have been used because this way is faster and simpler and comparison and coding them statistically is easier. Using close ended questions also serve advantages that the participants do not get distracted or influenced by the interviewer. Though, it is sometimes considered as a disadvantage as well because if there is no one they can ask. Using this type of questions limits the ability of participants to give a reply in detail (Neuman, 2014). In order to address this issue, use of open-ended questions have also been done. This questionnaire has questions related to nominal, ordinal and likert scale. Nominal and ordinal scale present demographic information of respondents whereas Likert scale presents information related to variables. In this study, using Likert scale is the best approach as this scale can represent perception, views, attitude in a better manner than any scale. In this study, the likert scale uses 7 points representing CD=Completely Disagree; D=Disagree; SD=Somewhat Disagree; N=Neutral; SA=Somewhat Agree; A=Agree; SA=Completely Agree (1 to 7) and CNH=Completely Not Helpful; NH=Not Helpful; SNH=Somewhat Not Helpful; N=Neutral; SH=Somewhat Helpful; H=Helpful; CH=Completely Helpful (1-7). In the first part, it includes an introduction that contains the topic and the aim of the study. In addition, some statements were written to make sure that respondent gave their consent. Then research related questions come. The questions in the questionnaire are put into consideration variables of the study and respondents complete those questions in presence or absence of researcher.

The researcher has also used open questions as these kinds of questions allow the participants to answer freely. Moreover, the participants are provided the opportunity to respond to the questions in detail as well as to clarify responses to complicated issues (Ely et al. 2003, p. 66). In addition, the logic and thinking process of a respondent can be revealed through open questions which is essential for sufficient interpretation of responses. If there is a need for more detailed information then probing questions are asked.

3.5.2 Questionnaire translation

In the questionnaire, Chinese as well as English languages have been used. To translate questions and information given in a questionnaire needs care so that translated questionnaire denotes what the researcher intends to do (Saunders et al, 2015). It is explained that it is very important that there should be the same meaning of both languages. The questionnaire which is translated is known as source questionnaire and translated one is known as target questionnaire. For easing of translation as well as comprehension, Malhotra (2010) suggested to put simple questions rather than having long complicated questions. This is the reason, the researcher has tried to keep the statements as simple as possible. (Malhotra and Birks, 2007) described that respondents should check that all questions are identical because some words may not be translated directly and have similar intended meaning because of differences in language (Malhora, 2010). This way, the design of the questionnaire seems so complete and clear.

3.5.3 Participants

The researcher intended to recruit around 300 participants to take part in the research. The participants were recruited through two places: (1) the QQ group —it is a community that organised by the game designer, everyone can join in and make suggestions about the game 5th Invention or other relevant contents; (2) TapTap — a platform where the game 5th Invention released, and people can post any comments or feedback about any games which released on the TapTap. A questionnaire is distributed through online or by contacting participants personally or sending it through posts stated by Bryman and Bell (2011). But, these two are very time consuming compared to sending it out online. Although, there are some pros and cons of this method, for example, via sending online, the reliability of answers is questioned as it is not known whether the same person is filling the questionnaire or not. But this method is very time saving and less expensive and convenient. The researcher has used Qualtrics in this study due to time and price benefit. Moreover, it is not possible to reach Chinese people physically. Thus, this is the best approach to fill the questionnaires.

3.5.4 Time Horizon

The opted time horizon for answering the research questions permits to differentiate between longitudinal and cross-sectional studies. According to Blumberg, Cooper and Schindler (2011), “cross-sectional studies are conducted only once and reveal a snapshot of

one point in time whereas longitudinal studies are repeated over an extended period of time which makes it possible to track changes in variables (e.g. panels or cohort groups)” (pp. 490-495). The current research is cross-sectional as data was collected within 4-5 weeks which is a very limited time for data collection for this level of study. And there was no permission to go beyond that fixed time. The university decides a limited time period for such studies and thus this study is kept cross-sectional.

3.6 Ethical issues

Bryman and Bell (2011) states that while conducting a research, there are a few ethical conducts which are required to be kept in mind. These conducts could be divided into four key areas. The first is that the researcher would not harm participants in any manner. It could be harm to the self-esteem of participants or physical harm. The second conduct is lack of informed consent that means to the fact that participants should be given as much as information required to make a decision if they want to participate in research or not. Invasion of privacy is third conduct that means keep maintaining the privacy of participants and it must not be disregarded. Fourth ethical conduct is deception that any kind of deception should not be involved. Deception takes place when researchers present their study as something other than what it is. In this research, the data collection was done via questionnaire online. Thus, the author was not in direct contact with participants. So largely, their anonymity could be maintained. Moreover, in files, the names of participants were shown as codes, so no one can recognize them. It was also ensured that any kind of data would not be shared to any third-party publication. All answers were filled on participants' wish only and the researcher did not try to influence anyone while taking the interview. After completing the research, the researcher would destroy the data. During the course of dissertation, data was kept secured in a password protected file.

Chapter 4: Findings and Analysis

4.1 Observation and Interview

There are 10 respondents who agreed to participate in the observation and interview. There are 5 males and 5 females. Nine of them are university students and one is working as a university lecturer. Most of the participants are young and lie between the 23 to 33 age range. They come from China and are studying in the UK currently. All participants are at the same beginning level, which means they do not know what the mortise and tenon joints are before using *SunMao* and *The Fifth Great Invention*. The demographic information of participants is given below:

Participant	Gender	Age	Profession	Present location	Hometown
Participant 1	Male	25	MA student	UK	Anhui
Participant2	Female	30	PhD Student	UK	Baoding
Participant3	Female	23	MSc student	UK	Ningbo
Participant4	Female	31	PhD student	UK	Hangzhou
Participant5	Male	27	PHD student	UK	Shanghai
Participant6	Male	24	MA student	UK	Hangzhou
Participant7	Female	28	PhD student	UK	Shanxi
Participant8	Female	29	MA student	UK	Shandong
Participant9	Male	28	MA student	UK	Maanshan
Participant10	Male	33	Lecturer	UK	Jinan

4.1.1 Before

Before the participants experienced two sessions which are *SunMao* and *The Fifth Great Invention*, they claimed that they did not know what is the mortise-tenon joint.

4.1.2 After SunMao

Most of the participants figured out what the mortise-tenon joint is. Among them, five of them (P1, P4, P5, P6 and P7) provided a further explanation of what they understood about the characteristics of the mortise-tenon joint by linking the past and the present. The researcher observed that most participants spoke about 'straight tenon' which is the most simple type of joint within all joints, when they answer the question of which joint they remembered through from the app. The participants were able to link their real life by recognizing the furniture they used or some well-known buildings constructed by the mortise-tenon joints.

4.1.3 After The Fifth Great Invention

All the participants knew what the mortise-tenon joint is. Among them, nine of them provided a further explanation of what they understood about the characteristics of the mortise-tenon joint by linking the past and the present. Among these, six participants would be able to construct the joints. The researcher observed that most participants spoke more generally about the joints. The participants were able to link their real life by recognizing the furniture they used or some well-known buildings constructed by the mortise-tenon joints.

-	Nothing	Remembering	Understanding	Applying
Before	100%	0%	0%	0%
SunMao	10%	40%	50%	0%
5th	0%	10%	30%	60%

4.2 Questionnaires

4.2.1 Reliability Test

A reliability test is utilized to test diverse statements regarding certain variables are finding out that specific variables. This could be better investigated by the statistical tool cronbach's alpha. It is a measure of internal reliability stated by Bryman and Bell (2011), The values of Cronbach alpha can vary from 0 to 1 and if the value is less than 0.6, it indicated low and unacceptable internal consistency (Malhotra, 2010). While more than .07 is considered good and reliable and kept in questionnaires. As acceptable values are mentioned, the values of all items are more than .70 and thus all items are accepted for 5th Great Invention and SunMao in the questionnaire.

Variable	Items	Value
SunMao independent variables	12	.948
Question 5	3	.871
Question 6	4	.735
Question 7	4	.785
Cultural awareness, transmission, learning	4	.801

Figure 1: Reliability test for SunMao

Variable	Items	Value
5thInvention variables	12	.954
Question 5	3	.810
Question 6	4	.721
Question 7	4	.882
Cultural awareness, transmission, learning	4	.914

Figure 2 : Reliability test for 5th Invention

4.2.2 Normality Test

There are some assumptions which need to be filled to perform some tests like correlation and regression, T-Test etc. and one of the crucial is the test of normality.

Statistics					
		Invention independent	Invention CA	enables me to recognise the importance of mortise-ten on transmissio n	enables me want to discover other ICHs
N	Valid	217	216	218	218
	Missing	1	2	0	0
Skewness		-.638	-1.171	-1.098	-1.231
Std. Error of Skewness		.165	.166	.165	.165
Kurtosis		.203	1.856	1.252	1.729
Std. Error of Kurtosis		.329	.330	.328	.328

Figure 3: Normality test for 5th Great Invention

Statistics					
		SunMao independent	SunMao CA	enables me to recognise the importance of mortise-ten on transmissio n	enables me want to discover other ICHs
N	Valid	212	218	217	218
	Missing	6	0	1	0

Skewness	.214	-.701	-.871	-1.256
Std. Error of Skewness	.167	.165	.165	.165
Kurtosis	1.419	-.331	-.090	1.993
Std. Error of Kurtosis	.333	.328	.329	.328

Figure 4: Normality test for SunMao

As per the rules mentioned in research methodology, values of Skewness and kurtosis lie between -1.231 and 1.856 and thus they can be considered normally distributed. In same way, the data set related to SunMao game normally distributed can be shown in below table, because the value lies between -.090 and 1.993.

4.2.3 Descriptive Statistics

The below tables present the demographic profile of respondents in the forms of tables and frequency analysis has been used for this.

Q1. Gender

Gender			
		Frequency	Percent
Valid	Male	99	45.4
	Female	118	54.1
	Total	217	99.5
Missing	System	1	.5
Total		218	100.0

Figure 5 : Gender profile of participants

From the above table, it is seen that around 45.4% of participants are males and 54.1 % of participants are females. The proportion of males and females are almost equal, and these little differences may not affect the overall results.

Q2. Age

age			
		Frequency	Percent
Valid	18-28	175	80.3

	29-39	41	18.8
	40-50	1	.5
	Total	217	99.5
Missing	System	1	.5
Total		218	100.0

Figure 6: Age of participants

There were four age groups in the questionnaire which were 18-28, 29-39, 40-50 and above 50. Approximately 80.3% of participants belong to 18-28 years old, while 18.8% of participants pertain to 29-39 age group. While, .5% of participant belongs to 40-50 and no participant pertains to above 50 age group. This may be considered as limitation of the study because the researcher could not get the responses from all age groups.

Q3. Education

Education			
		Frequency	Percent
Valid	Senior High school and below	55	25.2
	Undergraduate	124	56.9
	Postgraduate	34	15.6
	PhD and others	5	2.3
	Total	218	100.0

Figure 7: Education of respondents

Above table shows that around 25.2% participants have completed high school, while 56.9% have done undergraduate. A small percentage i.e. 15.4 % of participants have done post-graduation and only 2.3% of them did PhD or others degree.

Now the below answers are given in respect of characteristics of mobile serious games as this study focused on SunMao and 5thInvention game, thus the replies of participants have been presented in comparative manner so that it could be made more interesting for readers that what users think about SunMao and 5thInvention both.

Q4.1 The 5th Great Invention and SunMao raise my interest in the Mortise-Tenon

raises my interest in the mortise-tenon

		5 th Great Invention Percent	Sun Mao Percent
Valid	Completely Disagree	.5	0
	Disagree	.5	.9
	Somewhat disagree	.9	4.1
	Neutral	6.9	3.7
	Somewhat agree	22.0	20.6
	Agree	33.0	33.9
	Completely agree	36.2	36.2
	Missing	0.0	.5
	Total	100.0	100.0

Around 36%, 33% and 22% of participants completely agreed, agreed and somewhat agreed that that 5thInvention game raise their interest in the mortise tenon while 6.9% of them were neutral and .5%, .5% and .9% of them completely disagree, disagree and somewhat agree with this point consecutively. While another side, for Sunmao, the agreement level is almost same. Because 36%, 34% and 20.6% of participants completely agree, agree and somewhat agree consecutively that SunMao raises their interest in the mortise tenon while 3.7% were neutral on this. But around 4.1% disagreed and there is no one who completely disagreed with this.

Q4.2 The 5th Great Invention and SunMao improves my understanding about Mortise-Tenon

improves my understanding about mortise-tenon			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely disagree	.5	0
	Somewhat disagree	.9	0
	Neutral	4.6	9.2
	Somewhat agree	11.9	19.3
	Agree	30.7	38.5

	Completely agree	29.8	32.6
	Total	78.4	99.5
Missing	System	21.6	.5
Total		100.0	100

The above table shows the views on improvement in understanding about mortise tenon. In respect of 5th Great Invention, around 29.8% completely agree, while 30.7% show their agreement and 11.9% of them somewhat agreed on this. Approximately 4.6% of them neutral on this. Though, there are some proportion who disagreed with this point that SunMao improves understanding about mortise tenon but it is so minute so does not matter. Another side, in respect of SunMao, most of the people (32.6%, 38.5%, 19.3%) showed their agreement and only 9.2% were neutral on this.

Q4.3 The 5th Great Invention and SunMao are easy to operate

can easily to operate			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	.5	.9
	Disagree	2.3	.9
	Somewhat disagree	1.4	1.8
	Neutral	13.8	11.5
	Somewhat agree	23.9	19.4
	Agree	35.3	39.0
	Completely agree	22.9	26.6
	Total	100.0	100

In respect of SunMao and 5th Great Invention, the views were again same. A major proportion of respondents (22.9%, 35.3%, 23.9%) consecutively completely agree, agree and somewhat agree that 5th Great Invention is easy to operate. In comparison to this, 26.6% completely agree 39% of them agreed and 19.4% respondents somewhat agreed regarding the easiness to operate SunMao game. A very rare proportion of respondents 1.4% somewhat disagreed, 2.3% disagreed and .5 completely disagreed that 5th Great Invention is

easy to operate while .9%, another .9% and 1.8 % of them also did not agree this regarding SunMao.

Q4.4 The 5th Great Invention and SunMao are easy to use

can easily to use			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	.5	
	Disagree	2.3	.5
	Somewhat disagree	1.4	.9
	Neutral	11.5	9.4
	Somewhat agree	22.9	14.7
	Agree	35.3	44.0
	Completely agree	25.7	29.8
	Total	99.5	99.1
Missing	System	.5	.9
Total		100.0	100

The above table shows that how much serious games are easy to use. Around 29.8% of participants completely agreed for SunMao, while 25.7% completely agreed for 5th Great Invention that these are easy to use. Moreover, 44% of them agree for SunMao and 35.3% agree for 5th Great Invention for this and again a difference has been seen between “Somewhat agree” and 22.9% favour 5th Great Invention and 14.7% favour for SunMao. In respect of 5th Great Invention, 11.5% either not agree and disagree, while 1.4% somewhat disagree, 2.3% disagree and .5 were completely disagreed. Another side, there is no participant who completely disagree for SunMao, but .9% somewhat disagree and 9.4% of them neutral on this.

Q4.5 The 5th Great Invention and SunMao are the way to find out the information I Want

can easily find out the information that I want			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	.5	0

	Disagree	2.3	.5
	Somewhat disagree	3.7	.9
	Neutral	19.3	9.2
	Somewhat agree	26.6	14.7
	Agree	26.6	44.0
	Completely agree	20.6	29.8
	Total	99.5	99.1
Missing	System	.5	.9
Total		100.0	100

The above table shows that how much, respondents believe that they can find information easily whichever they want. A major proportion i.e. 44% of respondents agree on this in respect of SunMao while 26.6% respondents agree this for 5th Great Invention. Again, there is a considerable difference in respect of “completely agree” because for Sunmao, it is 29.8% and for 5th Great Invention, it is 20.6%. Around 26.6% of them somewhat agree that 5th Great Invention is the game through which, they can find expected information while 14.7% of them favour this for SunMao. The 19.3% of respondents were neutral on this for 5th Great Invention while 9.2% of them neither agree and disagree for SunMao. Around 3.7% and 2.3% somewhat disagree and disagree this for 5th Great Invention while .9% and .5% of respondents gave their negative views on SunMao. Overall, there are stronger positive views on SunMao for this statement.

Q4.6 I like the interface of mobile serious games

I like the interface			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	.5	0.0
	Disagree	1.4	0.0
	Somewhat disagree	1.8	0.0
	Neutral	9.2	7.3
	Somewhat agree	22.0	20.6
	Agree	30.3	33.5
	Completely agree	34.4	37.6
	Total	99.5	99.1

Missing	System	.5	.9
Total		100.0	100

This table exhibits that 34.4%, 30.3%, 22% completely agreed, agreed and somewhat agreed consecutively on the point that they like interface of 5thInvention. While, 37.6%, 33.5% and 22.6% of them state the same for SunMao. Around 9.2% either showed their agreement and disagreement for 5thInvention and for SunMao, it is 7.3%. In respect of SunMao, there is no disagreement while 1.8%, 1.4% and .5% somewhat disagree, disagree and completely disagree consecutively.

Q4.7 The 5th Great Invention and SunMao make my learning enjoyable

makes my learning is enjoyable			
		5 th Great Invention Percent	SunMao Percent
Valid	Neutral		11.0
	Somewhat agree		14.7
	Agree		34.9
	Completely agree		37.6
	Total		98.2
Missing	System		1.8
Total			100.0

Q4.8 The 5th Great Invention and SunMao make my learning interesting

makes my learning is interesting			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	.9	0
	Disagree	1.8	0
	Somewhat disagree	1.8	0
	Neutral	16.1	11.0
	Somewhat agree	18.3	13.8
	Agree	32.1	37.2
	Completely agree	28.4	36.7
	Total	99.5	99.1
Missing	System	.5	.9

Total	100.0	100
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The table shows that how much these serious games make the learning interesting. For 5th Great Invention, 28.4% of them completely agree, 32.1% agree and 18.3% somewhat agree on this point. While 1.8%, another 1.8% and .9% showed their disagreement on somewhat level, normal, and complete level on 5th Great Invention. While for SunMao, this statement is agreed by more people. 36.7% of them completely agree, 37.2% agree and 13.8% agree on this and 11% were neutral on this for SunMao and 16% of them neutral on this for 5th Great Invention.

Q4.9 The 5th Great Invention and SunMao make me feel immersive at a moment

makes me feel immersive at a moment			
		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	2.3	0
	Disagree	1.4	.5
	Somewhat disagree	5.0	4.1
	Neutral	13.8	6.0
	Somewhat agree	18.3	17.9
	Agree	29.8	34.4
	Completely agree	29.4	36.2
	Total	100.0	99.1

When the respondents asked at what level these serious games make them feel immersive at a moment. In respect of 5th Great Invention, 36.2% of them agree completely, 34.4% of them agreed, and 17.9% of them agreed at somewhat level with this point. In comparison to this, 29.4% agreed completely, 29.8% and 18.3% somewhat agreed. While 6.3% were neutral on this. For both games, a very little percentage of people showed their disagreement. At a somewhat disagreement level, 5% of them disagreed for 5th Great Invention and 4% for SunMao. For the 5th Great Invention, 2.3% of them completely disagreed but no one for SunMao.

Q4.10 The 5th Great Invention and SunMao is a good approach for learning mortise tenon

is a good approach for learning mortise-tenon
--

		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	1.4	0
	Disagree	2.3	0
	Somewhat disagree	1.8	.9
	Neutral	9.6	8.7
	Somewhat agree	16.5	14.7
	Agree	30.3	35.3
	Completely agree	38.1	40.4
	Total	100.0	100.0

The table explains how much respondents believe that 5th Great Invention and SunMao can be considered a good approach for learning mortise tenon. It has been seen that in respect of 5th Great Invention, 38.1% completely agree, 30.3% agree and 16.5% somewhat agree for this statement for 5th Great Invention and 8.7% were neutral on this. Around 1.4%, 2.3% and 1.8% participants showed their disagreement completely, generally and somewhat level consecutively. While 9.6% were neutral on this. It has been seen that people have stronger positive views for SunMao as no one disagreed at complete and general level and only .9% disagreed at somewhat level and rest all 99.1 % agreed that SunMao is a good approach for learning mortise tenon.

Q4.11 The 5th Great Invention and SunMao is a good tool for transmitting mortise tenon

is a good tool for transmitting mortise-tenon

		5 th Great Invention Percent	SunMao Percent
Valid	Completely Disagree	1.4	0
	Disagree	.9	0
	Somewhat disagree	2.3	2.3
	Neutral	8.3	6.4
	Somewhat agree	22.9	15.1
	Agree	24.8	34.9
	Completely agree	39.4	40.8
	Total	100.0	100.0

The table shows that 22.9%, 24.8% and 39.4% somewhat agreed, agreed and completely agreed for this for 5th Great Invention and around 1.4% of respondents completely disagreed that 5th Great Invention is a good tool for transmitting mortise-tenon while .9 and 2.3% disagreed and somewhat disagreed for this statement. While 8.3% did not agree or disagree. But another side, While for SunMao, only 2.3% showed their disagree views and 6.4% were neutral, rest 40.8%, 34.9%, and 15.1% completely agreed, agreed and somewhat agreed.

Q5. About mortise-tenon information presented in <SunMao>, do you agree or disagree the following:

Q5.1 I read the text information carefully

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely Disagree	2	.9	1.4	1.4
	Disagree	2	.9	1.4	2.8
	Somewhat disagree	5	2.3	3.4	6.2
	Neutral	14	6.4	9.7	15.9
	Somewhat agree	26	11.9	17.9	33.8
	Agree	57	26.1	39.3	73.1
	Completely agree	39	17.9	26.9	100.0
	Total	145	66.5	100.0	1.4
Missing System		73	33.5		
Total		218	100.0		

The researcher made sure that all participants have read the text information clearly or not then .9% and another .9% and 2.3% completely disagreed, disagreed and somewhat disagreed consecutively. While another side, 6.4% were neutral on this. On the other hand, a major share of people agreed that they read the text information. 17.9% and 26.1% and 11.9% completely agreed, agreed and somewhat agreed. It is necessary to mention that 33.5% did not fill the answers of this question so 66.5% is the total of respondents who replied.

Q5. 2 I appreciated the image information carefully

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely Disagree	2	.9	1.4	1.4
	Somewhat disagree	1	.5	.7	2.1
	Neutral	9	4.1	6.3	8.3
	Somewhat agree	13	6.0	9.0	17.4
	Agree	54	24.8	37.5	54.9
	Completely agree	65	29.8	45.1	100.0
	Total	144	66.1	100.0	
Missing System		74	74	33.9	
Total		218	218	100.0	

Major proportion of respondents 29.8%, 24.8% and 6.0% completely agreed, agreed and somewhat agreed that information on images are appreciable and have been seen carefully. Around .9% and .5% completely disagreed and somewhat disagreed for this while 4.1% were neutral for this.

Q5.3 I looked into the 3D structure of mortise-tenon carefully

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely Disagree	3	1.4	2.1	2.1
	Somewhat disagree	2	.9	1.4	3.5
	Neutral	4	1.8	2.8	6.3
	Somewhat agree	28	12.8	19.4	25.7
	Agree	41	18.8	28.5	54.2
	Completely agree	66	30.3	45.8	100.0
	Total	144	66.1	100.0	
Missing System		74	74	33.9	
Total		218	218	100.0	

As per this table, 30.3% agreed that they have seen 3D structure of mortise tenon carefully while 18.8% somewhat agreed for this while 1.8% were neutral. App. 12.8% somewhat

agreed for this point, 18.8% agreed and 30.3% completely agreed for this point. The people who disagreed with this point are very rate and the total percentage is 4% only.

Q6: In <SunMao>, do you think the following aspects help you to learn the mortise-tenon?

Q6.1 The text information about mortise-tenon

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	.5	.7	.7
	Neutral	15	6.9	10.6	11.3
	Somewhat agree	32	14.7	22.5	33.8
	Agree	56	25.7	39.4	73.2
	Completely agree	38	17.4	26.8	100.0
	Total	142	65.1	100.0	
Missing System		74	76	34.9	
Total		218	218	100.0	

Q6.2 The 3D structure of mortise-tenon

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	.9	1.4	1.4
	Neutral	9	4.1	6.4	7.8
	Somewhat agree	17	7.8	12.1	19.9
	Agree	41	18.8	29.1	48.9
	Completely agree	72	33.0	51.1	100.0
	Total	141	64.7	100.0	
Missing System		74	77	35.3	
Total		218	218	100.0	

Q6.3 The display of mortise-tenon furniture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	4	1.8	2.8	2.8

	Somewhat Disagree	2	.9	1.4	4.3
	Neutral	12	5.5	8.5	12.8
	Somewhat agree	22	10.1	15.6	28.4
	Agree	48	22.0	34.0	62.4
	Completely agree	53	24.3	37.6	100.0
	Total	141	64.7	100.0	
Missing System		74	77	35.3	
Total		218	218	100.0	

Q6.4 The background music

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely Disagree	6	2.8	4.3	4.3
	Disagree	5	2.3	3.5	7.8
	Somewhat disagree	3	1.4	2.1	9.9
	Neutral	33	15.1	23.4	33.3
	Somewhat agree	43	19.7	30.5	63.8
	Agree	28	12.8	19.9	83.7
	Completely agree	23	10.6	16.3	100.0
	Total	141	64.7	100.0	
Missing System		73	77	35.3	
Total		218	218	100.0	

After reviewing all information, it can be stated that the major agreement of respondents that which elements help in learning mortise-tenon. After aggregating all agreements, it has been found that 59.6% state that 3D structures of mortise tenon and 57.8% state text information about mortise tenon assist them the most to learn it. While only 41% state for background music, and 56.4% mention that displays for mortise tenon furniture also have been contributing to learning mortise tenon.

Q7: By experiencing <SunMao>, I want to:

			search relevant information	join activities related to mortise-tenon	in visit relevant museums	want to be the inheritor of mortise-tenon
Valid	Completely Not Helpful		.5	1.4	1.4	2.3
	Not Helpful		1.8	2.8	3.2	6.0
	Somewhat Not Helpful		1.4	2.3	1.8	3.2
	Neutral		13.3	12.8	7.8	25.2
	Somewhat Helpful		14.7	13.8	11.5	9.2
	Helpful		21.6	18.8	20.2	10.1
	Completely Helpful		10.6	12.4	17.9	7.8
	Total		63.8	64.2	63.8	63.8
	Completely Not Helpful		36.2	35.8	36.2	36.2
Missing System		73	.5	1.4	1.4	
Total						

When the respondents were asked that by experiencing SunMao, what they want to do then 49% of them state that they want to visit relevant museums, 46.90% of them want to search relevant information, 45% of them want to join activities related to mortise tenon. But very rarely 27.10% of them want to be the inheritor of mortise tenon.

Q12: About mortise-tenon information presented in <the 5th Invention>, do you agree or disagree the following:

		I read the text information carefully	I appreciated the image information carefully	I looked into the 3D structure of mortise-tenon carefully
Valid	Neutral	2.8	.9	.5
	Somewhat Agree	5.5	4.6	5.0
	Agree	13.8	12.8	9.6

	Completely Disagree	22.0	26.1	29.4
	Total	44.0	44.5	44.5
Missing System		56.0	55.0	55.5
Total		100.0	100.0	100

Q13: In <the 5th Invention>, do you think the following aspects help you to learn the mortise-tenon?

		The text information about mortise-tenon	The 3D structure of mortise-tenon	The display of mortise-tenon furniture	
Valid	Neutral	1.8	1.9	1.4	
	Somewhat Helpful	6.9	7.8	6.0	
	Helpful	10.1	9.2	12.8	
	Completely Helpful	25.2	26.1	24.3	
	Total	44.0	44	44.5	
Missing System		56.0	56	55.5	
Total		100.0	100	100.0	

When respondents are asked which following aspects help them to learn the mortise tenon 43% state the 3D structure of mortise tenon is more helpful, while another 43% again believe that the display of mortise tenon is more helpful. While 42% of them gave reasoning that text information about mortise tenon in 5th invention contributes more in learning mortise tenon.

6.4 The background music

Q13_4

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Completely Helpful	Not	1	.5	1.1	1.1
	Not Helpful		1	.5	1.1	2.1
	Somewhat Helpful	Not	1	.5	1.1	3.2
	Neutral		19	8.7	20.0	23.2
	Somewhat Helpful		19	8.7	20.0	43.2
	Helpful		22	10.1	23.2	66.3
	Completely Helpful		32	14.7	33.7	100.0
	Total		95	43.6	100.0	
Missing	System		123	56.4		
Total			218	100.0		

Compared to all, 33.1% of them state that background music is more helpful to make them learn mortise-tenon. While 8.7% of them are neutral and .5%, .5% and .5% did not believe that they are not helpful.

Q14: By experiencing < the 5th Invention >, I want to:

Q14_1

		search relevant information	join in activities related to mortise-tenon	visit relevant museums	want to be the inheritor of mortise-tenon
Valid	Somewhat Disagree	.9	.5	.5	1.4
	Neutral	3.7	4.1	9.3	16.5
	Somewhat Agree	8.3	10.1	19.6	8.3
	Agree	16.1	11.5	27.8	7.8
	Completely agree	15.6	17.4	41.2	9.6
	Total	44.5	44.0	89.1	43.6

Missing System	55.5	56.0	11.09	56.4
Total	100.0	100	100	100

This table shows the wishes that respondents want after experiencing 5th invention game, 40% of them mention that they want to search relevant information, 88% of them want to visit museums ,39% of want to activities related to mortise tenon and 25.7% want to be inheritor of mortise-tenon.

4.2.4 T Test

This test has been performed to observe whether there is difference between the males and females regarding the cultural awareness, cultural transmission and cultural learning of mortise tenon.

Group Statistics

Gender	N	Mean	Std. Deviation	Std. Error Mean
encourages me to know more about mortise-tenon				
Male	73	5.78	1.417	.166
Female	82	5.90	1.172	.129
enables me to recognise the value of mortise-tenon				
Male	73	5.86	1.316	.154
Female	80	5.89	1.125	.126
enables me to recognise the importance of mortise-tenon transmission				
Male	73	5.85	1.391	.163
Female	82	5.84	1.222	.135
enables me to want to discover other ICHs				
Male	73	5.70	1.488	.174
Female	82	5.60	1.369	.151

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means							
								95% Confidence Interval of the Difference		
	F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper	
encourages me to know more about mortise-tenon	Equal variances assumed	.745	.389	-.585	153	.560	-.122	.208	-.533	.289
	Equal variances not assumed			-.578	140.191	.564	-.122	.210	-.537	.294
enables me to recognise value mortise-tenon	Equal variances assumed	.317	.574	-.124	151	.901	-.024	.197	-.415	.366
	Equal variances not assumed			-.123	142.368	.902	-.024	.199	-.418	.369
enables me to recognise importance mortise-tenon transmission	Equal variances assumed	.332	.565	.037	153	.970	.008	.210	-.407	.422
	Equal variances not assumed			.037	144.342	.970	.008	.211	-.410	.426
enables me to discover ICHs	Equal variances assumed	.081	.776	.440	153	.660	.101	.229	-.352	.554

Equal			.438	147.1	.662	.101	.231	-.355	.55
variances not				24					7
assumed									

From the above table it has been found out that the number of males was 73 and females was 82. The number of males and females are similar in all cases. There is not much difference between the mean of males and females in respect of cultural awareness (males = 5.78/ females = 5.90), for cultural transmission (males =5.86 and females = 5.89) and cultural learning (males = 5.70/females = 5.60). However, It can be stated that the mean average for the statement that SunMao encourages me to want to know more about mortise-tenon is higher in females than males. Another statement that Sunmao enables me to recognise the value of mortise-tenon has higher mean for females than males. But the mean average for SUnMao enables me to recognise the importance of mortise-tenon transmission has been found higher in males than females. In the same case, SunMao enables me to discover other ICHs are more believed by males with mean scores 5.70 compared to 5.60. While standard deviation in case of females has been found relatively less than males in all cases. In the case of both items of cultural awareness, the standard deviation is 1.4 for males and 1.17 for females and 1.316 for males and 1.125 for females. In case of cultural transmission, the score of standard deviation is 1.39 for males and 1.22 for females. In the same way, the standard deviation for items of cultural learning for males is 1.488 and 1.39 for females.

The assumptions of homogeneity of variances have been tested by utilizing Levene's test of equality of variances. It is one method to decide whether the variance between groups for dependent variables are equal or not. In this test, the most important column is the "sig" column that denotes the significant value, which is the p value of the test. If the test of Levene's is significant statistically (i.e. $p < .05$), it does not have equal variance and has violated the assumptions of homogeneity of variances that means there are heterogeneous variances. Another side, if the test of Levene's is not significant statistically ($p > .05$), indicating there are equal variances and there is no violation of assumption of homogeneity of variances. In this study a significant value is .389, .574, .556, .776 showing that the variance is equal and the assumption of homogeneity is fulfilled.

4.2.5 ANOVA Test

In below tables, ANOVA test attempts to determine whether there is a significant difference between the demographic groups mainly age groups and education. In this study, the age groups are : 18-28, 29-39, 40-50, over 50. But, only people from 18-28 and 29-39 replied and only .5% replied from the age group of 40-50 which SPSS has not taken into consideration. From the below table, it is seen that the age group of 18-28 has higher mean value in all cases (cultural awareness, cultural transmission and cultural learning). The highest meaning is for the statement of “enables me to recognise the value of mortise-tenon” that reflects that these apps definitely increased cultural awareness more among people who are in younger age.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
encourages me to know more about mortise-tenon	18-28 140	5.87	1.302	.110	5.65	6.09	1	7
	29-39 12	5.58	1.311	.379	4.75	6.42	3	7
	Total 152	5.85	1.301	.106	5.64	6.06	1	7
enables me to recognise the value of mortise-tenon	18-28 139	5.93	1.177	.100	5.73	6.13	2	7
	29-39 11	5.18	1.601	.483	4.11	6.26	2	7
	Total 150	5.87	1.222	.100	5.68	6.07	2	7
enables me to recognise the importance of mortise-tenon transmission	18-28 140	5.89	1.270	.107	5.67	6.10	1	7
	29-39 12	5.33	1.670	.482	4.27	6.39	1	7
	Total 152	5.84	1.308	.106	5.63	6.05	1	7
enables me to discover other ICHs	18-28 140	5.68	1.380	.117	5.45	5.91	1	7
	29-39 12	5.33	2.015	.582	4.05	6.61	1	7
	Total 152	5.65	1.434	.116	5.42	5.88	1	7

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
encourages me to know more about mortise-tenon	.157	1	150	.693
enables me to recognise the value of mortise-tenon	2.620	1	148	.108
enables me to recognise the importance of	.469	1	150	.494

mortise-tenon transmission enables me want to discover other ICHs	3.890	1	150	.050
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ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
encourages me want to know more about mortise-tenon	Between Groups	1	.917	.540	.463
	Within Groups	150	1.697		
	Total	151			
enables me to recognise the value of mortise-tenon	Between Groups	1	5.676	3.873	.051
	Within Groups	148	1.466		
	Total	149			
enables me to recognise the importance of mortise-tenon transmission	Between Groups	1	3.372	1.985	.161
	Within Groups	150	1.699		
	Total	151			
enables me want to discover other ICHs	Between Groups	1	1.317	.639	.425
	Within Groups	150	2.061		
	Total	151			

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
encourages me want to know more about mortise-tenon	Senior High and below	42	6.02	1.239	.191	5.64	6.41	1	7
	Undergraduate	95	5.82	1.337	.137	5.55	6.09	2	7
	Post graduate	14	5.43	1.222	.327	4.72	6.13	3	7
	PHD and others	2	6.00	1.414	1.000	-6.71	18.71	5	7
	Total	153	5.84	1.298	.105	5.64	6.05	1	7
enables me to recognise the value of mortise-tenon	Senior High and below	42	6.14	1.221	.188	5.76	6.52	2	7
	Undergraduate	94	5.85	1.218	.126	5.60	6.10	2	7
	Post graduate	13	5.23	1.092	.303	4.57	5.89	4	7
	PHD and others	2	6.00	1.414	1.000	-6.71	18.71	5	7
	Total	151	5.88	1.222	.099	5.68	6.08	2	7
enables me to recognise the importance of mortise-tenon	Senior High and below	42	6.14	1.221	.188	5.76	6.52	2	7
	Undergraduate	95	5.81	1.315	.135	5.54	6.08	1	7

mortise-tenon transmission	Post graduate	14	5.29	1.383	.370	4.49	6.08	3	7
	PHD and others	2	6.00	1.414	1.000	-6.71	18.71	5	7
	Total	153	5.86	1.305	.105	5.65	6.06	1	7
enables me want to discover other ICHs	Senior High and below	42	5.93	1.276	.197	5.53	6.33	1	7
	Undergraduate	95	5.63	1.392	.143	5.35	5.92	1	7
	Post graduate	14	5.00	1.710	.457	4.01	5.99	2	7
	PHD and others	2	4.50	3.536	2.500	-27.27	36.27	2	7
	Total	153	5.64	1.431	.116	5.41	5.87	1	7

The assumptions of homogeneity of variances has been tested by utilizing Levene's test of equality of variances. Another side, if the test of Levene's is not significant statistically ($p > .05$), indicating there are equal variances and there is no violation of assumption of homogeneity of variances. In this study is significant value is .693, .108, .494 and .050 showing that the variance is equal and the assumption of homogeneity is fulfilled. As per ANOVA table, the significant value for cultural awareness is .463 and .051 which is more than .50($P > .05$). In the same way, the $p = .161$ for cultural transmission and .425 for cultural learning. It indicates that there is no statistical difference between the means of groups of ages.

Difference between the groups based on education

Under this test, the difference between the groups of education regarding cultural awareness, cultural transmission and cultural learning has been studied

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
encourages me want to know more about mortise-tenon	.911	3	149	.438
enables me to recognise the value of mortise-tenon	.048	3	147	.986
enables me to recognise the importance of mortise-tenon transmission	.258	3	149	.856
enables me want to discover other ICHs	2.393	3	149	.071

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
encourages me want to know more about mortise-tenon	3.873	3	1.291	.762	.517
Between Groups	252.363	149	1.694		
Within Groups	256.235	152			
Total					
enables me to recognise the value of mortise-tenon	8.489	3	2.830	1.931	.127
Between Groups	215.365	147	1.465		
Within Groups	223.854	150			
Total					
enables me to recognise the importance of mortise-tenon transmission	8.247	3	2.749	1.635	.184
Between Groups	250.589	149	1.682		
Within Groups	258.837	152			
Total					
enables me want to discover other ICHs	11.838	3	3.946	1.964	.122
Between Groups	299.391	149	2.009		
Within Groups	311.229	152			
Total					

As per above tables, the significant value for all groups of education has been found insignificant as they are more than .05 and therefore, it can be interpreted that there is no significant difference between the groups of education

There are some questions, which were opened ended and asked for SunMao and 5th Invention both.

What can you deduce from the content that you learnt in the <SunMao> about mortise-tenon?

For this question, 18 responses were found invalid. There were around 8 partial responses for this question. And 32 responses were fully relevant. Some relevant, meaningful and complete responses are given below

- The mortise-tenon has a very long history, and it's a very interesting technique that brings together the wisdom of craftsmen
- Mortise-tenon has workshops and organizations in China, which means there still have some people who are interested in it
- Mortise-tenon have played a positive role in the development of architecture
- Exquisite and delicate traditional culture
- We need to pay attention to the intangible cultural heritage
- Although the mortise-tenon is an antique way of connecting objects, it is still of great use and ornamental value in modern times. At the same time, it should raise our concern about it as well as to understand or inherit it.
- The mortise-tenon still can work in practice today

- The great wisdom of our ancient people
- Intangible cultural heritage needs to be inherited
- I learned the mortise-tenon's types, history, making tools, etc
- I learned the structures of mortise –tenon
- I felt the spirit of craftsmen in ancient China
- Mortise -tenon is very important in our life.

Would you experience this app again? Yes or No? Please state your reason:

This question was open-ended and with their agreements and disagreements, the respondents gave their varied opinions with this. Most of the respondents replied that they want to experience this app again. Some gave reasons for having the feature of fun, Chinese cultural tradition, to spend leisure time, learning mortise tenon, increase knowledge of intangible cultural heritage. While those who disagreed for this, had their own reasons such as dull content, weak interaction, not immersive and dry content, not being playable and entertaining.

Would you recommend this app to others? Yes or No? Please state your reason:

From this question, there are 28 responses invalid, 30 responses partial and 32 responses valid. Around 25 respondents mention that they would like to recommend this app to other people and around 7 respondents did not intend to share it and they have their own reasons.

No, the content is boring, and the interestingness is weak.

No, although the design of this app is good, it is not playable.

No, it is not a game.

Positive responses are given below

Yes, it can improve cultural self-confidence

Yes, because it is also a way of inheritance. It can let more people to understand and love mortise-tenon, so that to comprehend ancient wisdom.

Yes, the ancients' amazing wisdom is worth sharing.

Yes, I hope more people can realize the educational possibilities of games.

Yes, to spread Chinese traditional culture

When the same questions were asked in respect of 5th Great Invention, the answers are given below:

Q15: What can you deduce from the content that you learnt in the < the 5th Innovation> about mortise-tenon?

It can help others to understand the mortise-tenon, the game is fun and interesting.

Yes, it is an educational app.

Yes, I already recommended it to others. because I obtained a very good experience from this game, thus I would like to encourage the people who around me to know this ancient techniques and skills

Yes, cultural inheritance needs sharing.

Yes, let more and more people know and learn it, and safeguard its cultural value together.

Yes, this game is very special. The way of gameplay is different from the others. Meanwhile, I hope people around me can have a better understanding about this intangible cultural heritage

Yes, because this is the most interesting way to learn about mortise-tenon.

Q16: Would you experience this game again? Yes or No? Please state your reason:

Most of the people again responded that they will experience the game 5th Great Invention and gave almost the same reasons. While people who gave negative answers, said simply no.

Yes, because of its interesting

Yes, it can increase my understanding about traditional culture.

Yes, because I hope to know more about mortise-tenon and experience more combination of its structures through this game

Yes, I can't wait to try the next open beta test of this game.

Yes, the playability is very high, I am also interested in this aspect

Yes! I love it, it has high playability. The knowledge of mortise-tenon has infiltrated into this game.

Q17: Would you recommend this game to others? Yes or No? Please state your reason:

Again, the proportion of respondents saying yes is more than negative responses and most of responses are again the same.

Yes, it promotes public understanding of traditional culture

Yes, I already recommended it to others. because I obtained a very good experience from this game, thus I would like to encourage the people who are around me to know these ancient techniques and skills.

Yes, cultural inheritance needs sharing.

Yes, this game is very special. The way of gameplay is different from the others. Meanwhile, I hope people around me can have a better understanding about this intangible cultural heritage.

Yes, the game design is great. It contains both knowledge and joy. Nice !

While the respondents who state "NO" did not give much reasons and said merely

Chapter 5: Discussion

5.1 Hypothesis 1

The first hypothesis is that *The Fifth Great Invention* is better at raising cultural awareness than *SunMao*. In order to confirm this hypothesis, the researcher looked at the data gathered from the interview and the questionnaires. Before using any of the two apps, none of the interview participants displayed any interests towards the mortise-tenon joints, or the general intangible cultural heritage. After using *SunMao*, only four of the participants showed their interest by saying they would experience the app again and share the app with others. After using *The Fifth Great Invention*, nine of the participants said they would continue playing the game after the session and recommend it to the others. If we assume that time spent using these apps will increase cultural awareness, this shows a significant increase in cultural awareness through the use of the game over the app, which supports the hypothesis.

Data from the questionnaires showed that 91% of participants agreed that the game raised their interest in mortise-tenon joints, whereas 90.7% of participants agreed that the app raised their interest in mortise-tenon joints. This shows a marginal benefit by using the game, however, due to the number of responses, this is not significant enough to support the hypothesis.

As per the below table, the relationship between the 5th Invention game and cultural awareness has been shown. The results reveal $r = .616$ and $p = .000$ which is less than $.05$ thus, there is a moderate to strong relationship between 5th invention and cultural awareness at significant level indicating that users are aware by using the game.

Correlations			
		Inventionindep endent	CAinvention
Inventionindependent	Pearson Correlation	1	.616**
	Sig. (2-tailed)		.000
	N	217	215
CAinvention	Pearson Correlation	.616**	1
	Sig. (2-tailed)	.000	
	N	215	216

Below table shows the correlation of SunMao and cultural awareness. It can be seen that there is positive and strong correlation between these two variables as $r = .691$ at significant level as $p = .000$ which is less than 0.05.

Correlations			
		SunMao independent	SunMao CA
SunMao independent	Pearson Correlation	1	.691**
	Sig. (2-tailed)		.000
	N	212	212
SunMao CA	Pearson Correlation	.691**	1
	Sig. (2-tailed)	.000	
	N	212	218

As Freire et al. (2016) the mobile serious games provide help by delivering knowledge of the past to the public in a very convenient and accessible manner. The game reconstructs digitally the ancient Chinese culture and tradition of mortise-tenon to enrich the experience by adding historically correct details. Mortara et al. (2014) in his research stated that the mobile serious games like Icura is an artistic heritage and cultural awareness game wherein the gamer is in contact with the legacy of physical artefacts of the ancient Chinese culture of wooden sticks assembling and connecting which is playing a very important role in creating a cultural awareness. Similar views are presented by Freire et al. (2016) stating that the game gives the opportunity to practice in first person behavioural codes as well as habits through in-game tasks which promote cultural awareness. Mortara et al (2014) mention that in this respect, SGs have the ability to provide a comprehensive experience that includes sounds like traditional music and spoken language, as well as aesthetic elements. It can bring religious and folkloristic events into life and provide the opportunity to practice the same in first person (Mortara et al, 2014). It makes people aware about the culture. The results of quantitative tests reveal that SunMao and 5th Great Invention both help in raising cultural awareness as the respondents replied that they could understand about the mortise tenon concept. Some of them were unaware about the term and some of them did not know much about it. However, both applications made them understand about the mortise tenon. It is quite clear that SunMao is the application that has more theoretical explanation of

technique and its wooden structures, while 5th Great Invention is the game which focuses more on giving experience to make wooden objects instead of educating them. In respect of qualitative data, the respondents in interviews replied quite similar in this respect. Some of them responded that they could understand what is mortise tenon and related it with the Chinese intangible cultural heritage. Therefore, it can be stated that SunMao and the 5th Great Invention can raise cultural awareness for Mortise-tenon. In this case, there is not enough evidence to support the hypothesis.

5.2 Hypothesis 2

The second hypothesis is that *The Fifth Great Invention* is better at teaching craft skills than *SunMao*. In order to confirm this hypothesis, the researcher looked at the data gathered from the observation, interview and the questionnaires. Before using any of the two apps, none of the interview participants displayed any knowledge of the mortise-tenon joints, or the general intangible cultural heritage. After using SunMao, five of the participants showed a basic understanding of mortise-tenon. After using *The Fifth Great Invention*, nine of the participants showed a basic understanding of mortise-tenon, six of which were able to demonstrate their knowledge of how it can be applied. This shows that the game can improve craft skills more than the app, which supports the hypothesis.

This table shows that the 5th Great Invention game is positively correlated with cultural learning and r value = .352 and p = .000 which is less than .05 and correlated at significant level. It indicates that the 5th invention game may help in learning culture but at a low level.

Correlations			
		5th Great Invention independent	cultural learning
5th Great Invention independent	Pearson Correlation	1	.352**
	Sig. (2-tailed)		.000
	N	217	217
cultural learning	Pearson Correlation	.352**	1
	Sig. (2-tailed)	.000	
	N	217	218

** . Correlation is significant at the 0.01 level (2-tailed).

In respect of cultural learning and attributes of SunMao, it can be stated that correlation is again at moderate level as $r = .541$, $p = .000$. Thus, playing SunMao is positively associated with cultural learning.

Correlations			
		SunMao independent	cultural learning
SunMao independent	Pearson Correlation	1	.541**
	Sig. (2-tailed)		.000
	N	212	212
cultural learning	Pearson Correlation	.541**	1
	Sig. (2-tailed)	.000	
	N	212	218

Hafeez, Idrees, and Kim (2015) stated the good side of playing video games as they found out positive impacts both inside and outside gaming contexts, which have a great effect on learning. In the case of questionnaire as well as interview, it has been found that mobile serious games SunMao and 5th great invention both influence the cultural learning as the respondents could understand about mortise tenon, its structure, names of many techniques, functioning and how wooden pieces are combined etc. Though, results of quantitative (questionnaire) and qualitative study (interview) are almost similar in respect of impact of mobile serious games in cultural learning. In the case of the questionnaire, the impact of both games on cultural learning was found little and when both of them are compared the impact of 5th Invention on cultural learning is more compared to SunMao. In the same way, the interview suggests that respondents are more interested and impressed with the 5th Innovation game as it is more practical while SunMao is less interactive and full of theoretical explanations of structure that make users bored. While the 5th innovation game more affects cultural learning. Thus, both apps contribute to cultural learning. Gaitatzes, Christopoulos, Papaioann (2004) claimed that smartphone-based mobile applications allow ubiquitous access that enable the cultural learning to take place no longer only in the cultural context such as cultural institutions or heritage sites, but in everywhere and anytime; and provide rich interaction and usage experience to facilitate the cultural learning. They simply offer access to information for the users. Through digital games, one

can gain more engagement. From the pedagogical perspective, they can experience an advanced interaction, customizing the learning process. The study of these findings in respect of questionnaire and interview have been matched with the findings of Gaitatzes, Christopoulos, Papaioann (2004). This data and information confirms the hypothesis that *The Fifth Great Invention* is better at teaching craft skills than *SunMao*.

5.3 Assumptions, Limitations, and Further Investigations

One limitation of this study was that each participant tested both apps. This poses a potential issue when testing retained knowledge due to the order that the apps were used. As we are attempting to measure and compare the amount of retained knowledge after using these apps more reliable results may have been obtained by having more participants which only use one of the two apps chosen at random. In addition, some responses to the questionnaire had to be discarded as participants misunderstood which app they should be answering questions for. This would not have been an issue had participants only tested one app.

An additional issue was that some open ended questions during interviews meant participants spoke about the attributes of the apps rather than the educational content. This information made it difficult to accurately determine how to score the participants' learning level.

Two of the questions on the questionnaire used uncommon language which may have resulted in respondents not understanding what was being asked. This was an oversight when designing the questionnaire and meant that answers to these questions could not be analysed with any level of significance or reliability.

This study did not investigate the potential reasons behind why one application may be better than the other at raising cultural awareness or teaching craft skills. Further investigations could be done to show how elements such as music, colors, UI navigation, and other design elements may affect how a user's cultural awareness or ability to learn craft skills. By understanding how these elements of game design affect learning, game developers would be able to make improvements which may significantly increase how effectively serious games can teach intangible cultural heritage.

This study only tested users with little to no prior experience with the subject of mortise-tenon. Further studies could investigate to what level serious games are useful in

teaching craft skills and if they are of use to users with prior knowledge of the subject. It is expected that high skill level techniques would be less effectively taught using serious games and additional methods may need to be used to protect and preserve these parts of intangible cultural heritage.

In order to make additional improvements to serious games, it would be useful for further investigations into the optimal amount of information that can be provided to a user per game level. This may be affected by factors such as time needed per level, amount of reading per level, and complexity of the game. By finding the optimal knowledge saturation of levels game designers would be able to develop games that teach intangible cultural heritage more effectively.

Chapter 6: Conclusions

6.1 Summary

The objective of this research is to determine the impact of 5th Great Invention and SunMao both on cultural awareness, and craft skills learning of mortise-tenon. Mortise-tenon is an intangible cultural heritage of China and this culture is vanishing day by day. The results have been derived from two methods, qualitative as well as quantitative. The results of quantitative study reveal that SunMao and 5th Great Invention affect the cultural awareness, cultural transmission and cultural learning. While interviews reveal that 5th great invention is more helpful in raising awareness and teaching craft skills for Mortise-tenon than SunMao. Most participants state that their willingness to share these apps with others depends on their interest in the subject. This study further revealed which one is better SunMao and 5th Invention and has revealed new facts which will guide future research. From the interviews, it has been found out that the 5th Great Invention game app is better than SunMao for the teaching of craft skills. According to participants, it has more fun features, more practical, lots of content, is more exciting and challenging, and it motivates users to play it more than SunMao. The study also reveals that there is no significant difference between the demographic groups and their perception for culture awareness, and craft skills learning for mortise tenon from mobile serious games.

6.1 Practical Implications and suggestions for this game in the future development

There are many suggestions from respondents to improve these apps so that they can be played and used by more users and help in learning, transmitting and making aware people about intangible cultural heritage. It has been suggested that:

- The design needs some improvements, such as the cutting lines function should be simply identified and manipulated.
- The game can allow the players to design their own furniture on it.
- Some tasks can be added to make use of various mortise-tenon structures to assemble a whole object, and so that the players can have an intuitive experience about the different use of these structures.
- The game should be more flexible and the zoom functions would able the users to see the structures more clearly
- The element of more entertainment can be added else the users would be bored after using it. E.g the social advantage of video games can be added. The reason for the suggestion is also based on the findings. The social advantage is missing in both apps. So, the game as well as the app should be designed in such a way that can invite friends or colleagues to give the challenge to make the wooden structure fast. Or the user may make the group and then work on the game app in groups and all should suggest making any wooden object online like other online games are being launched in the market on a daily basis.
- It has been found in the study that the participants state that introduction of the apps is not clear so the introduction should be added that explain about mortise tenon, its significance and link with culture and history so that users who more like traditional and culture would be attracted towards it.
- Consultants can be hired to enhance the game's historical text and innovative content
- Hope can add more complex objects, and provide more difficult levels, so that allows the player to have self-selection for the difficulty.
- I hope that more mortise-tenon structures can be added in the game. I also hope it can add independent custom patterns. Hope to produce peripheral products about mortise-tenon
- It is suggested that the learning process can be made customized. E.g. If any user wants to make a shoe rack for home within specific measures so, the SunMao app may guide the users that which kind of part with specific measures are needed and how they would be fixed should be shown in 5th Great Invention kind of games. To

enhance the experience of users, the app and game should be mixed. This has been suggested by many respondents in the interview as well

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