Multimodal Virtual Reality for Revitalizing Traditional Chinese Martial Arts – Visitors' Engagement and Learning Experience at the 300 Years of Hakka Kungfu Exhibition

Abstract

The core missions and functions of museums have fundamentally shifted over the past decade from mainly collecting, conserving, and displaying items for visitors to one of enhancing visitors' overall museum visiting experiences. As such, the themes of museums have evolved to telling the stories and knowledge behind the artifacts on display, and at the same time, putting increasing emphasis on enhancing the experience gained by the visitors. In examining the elements of visitor engagement, we have chosen *the 300 Years of Hakka Kungfu – Digital Vision of Its Legacy and Future, a Hakka Kungfu Exhibition* held at the Hong Kong Heritage Museum in 2016. We investigated how the use of 3-D virtual reality (VR) technologies in transforming a traditionally object-centered exhibition to a much more people-centered communal place for social networking and educational purposes. A questionnaire survey was used to measure visitors' overall experiences towards this Exhibition, with a total number of 209 responses collected. Our questionnaire results reveal an overall greater satisfaction of this VR approach compared to other traditional museum exhibitions, particularly with reference to how this approach enhances museum experiences of visitors' engagement and knowledge construction. Regression analyses confirmed that VR-related exhibits were more attractive than traditional multimedia.

Keywords: Museum education; Virtual Reality (VR); preserving culture; intangible cultural heritage.

Acknowledgment

Introduction

In recent years, there has been a significant increase in the use of virtual reality (VR) and motion-capture technologies amongst museums and galleries worldwide for a variety of purposes, ranging from purely educational to financial incentives. In particular, interaction and engagement between visitors and exhibitions aim at enhancing visitors' overall museum-visiting experiences. According to the International Council of Museums (ICOM) Code of Ethics for Museums (ICOM, 2013), a vital obligation of museums is to develop their educational role to disseminate and promote cultural information and knowledge to society. Rather than only collecting, conserving, and displaying artifacts to visitors, the core missions and functions of museums have shifted towards revealing the stories and knowledge behind the artifacts on display (Alexander & Alexander, 2008). Furthermore, museums increasingly emphasize on enhancing visitors' experiences, including cognitive, affective, reflective, and recreation, by engaging them in different levels of mindful (education and learning) activities, as well as other non-mindful (recreation and social) activities (Chan, 2009). The exhibitions have been thereby transformed from object-centered to people-centered and idea-oriented (Hein, 2000). In this new context, museums have become a communal place for both social networking and educational purposes, which demonstrate the visitors' engagement, as well as contributing to knowledge construction (Black, 2005; Jeffery-Clay, 1998).

In recent years, many museums in Hong Kong have become more visitor-oriented, in terms of setting up exhibitions that incorporate new forms of interactive storytelling and gaming components, with the aim of enriching experiences that could satisfy diversified visitor needs. This study was set out to examine how various emergent media technologies could be deployed for enhancing visitors' overall experiences at an exhibition entitled, ***300 Years of Hakka Kungfu – Digital Vision of Its Legacy and Future***, which was presented and co-organized by Intangible Cultural Heritage Office of Hong Kong (see Table 1), International Guoshu Association, and the City University of Hong Kong (CityU).

Table 1. Exhibition details.

	Exhibition Details
Exhibition Title	*300 Years Of Hakka Kungfu – Digital Vision of Its Legacy and Future*
Venues & Exhibition Periods	2016/09/02 to 2016/09/30 at Hong Kong Heritage Museum 2016/10/28 to 2017/02/28 at the City University of Hong Kong

Aims	Through the lens of traditional and new media to invite the audience to look into the Hakka Kungfu.
Website	http://www.hakkaKungfu.com/

Hakka, literally "Guest Families," refers to the descendants from central China who migrated to the Southern parts of China at a time of political unrest centuries ago (Chao, Shaw, & Kenderdine, 2016). They live today in a wide range of areas including the provinces of Guangdong, Jiangxi, Guangxi, Sichuan, Hunan, and Fujian, and have their own dialect and martial art systems. This Exhibition was regarded as a prime model of an emerging field of digital humanities pioneered in Hong Kong, as it employed a wide range of cutting-edge virtual reality (VR) technologies to present a form of traditional Chinese martial arts, Hakka Kungfu, in an animated, aesthetic, and interactive format. Such cutting-edge new media technology included the use of the latest holographic techniques, as an innovative strategy for documenting Hakka Kungfu as a form of intangible cultural heritage, with the aim of creating a compelling, and yet a tangible vision for the exhibition visitors of different age groups.

With reference to the technical aspects of this Exhibition, apart from grandmasters being projected on the hologram screens in 1:1 scale expertly performing their Hakka Kungfu art for viewers to admire (see Fig. 1), visitors could also get an idea of how each traditional weapon and training tool functioned (see Fig. 2). According to the Exhibition curator, Professor Jeffrey Shaw, they "tried to render the movements from different angles, forms, and approaches to spatialize the movements, and ultimately to present the motion in space through time" (Wang, 2016).
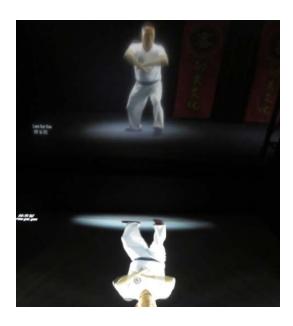
Fig. 1. A hologram of Hakka Kungfu performance in form of VR.

Fig. 2. The showroom of Hakka Kungfu weapons and training tools (left) and demonstration of their use with media technology (right).

By using diversified digital approaches, this Exhibition aimed at providing the visitors a well-rounded experience, in order to help them better appreciate the gracefulness and sophistication of this intangible cultural heritage. Digital media technologies deployed in this Exhibition included VR and augmented reality (AR), immersive visualization environments, navigable cinematic systems, and interactive narratives. Visitors could observe the trajectory of Hakka Kungfu movements, tracked and highlighted by colorful lines by wearing VR glasses, or seeing the movements in sculpture form, such as adding a haze of particles in the wake of the movements and using various colors in lightening streaks to represent the strength of each movement. In addition to the use of holographic technologies, this Exhibition was presented through a combination of archival materials, documentary videos (see Figure 3), photo archive

installations (see Figure 4), etc., to provide the visitors "a journey through time, to explore the origin, development and future of Hakka martial arts" (HKHM, 2016).

Fig. 3. Documentary videos.

Fig. 4. Photo zone showing archive of portraits and action photos of Hakka Kungfu masters.

Thus, the Hakka Kungfu Exhibition provided the researchers a valuable opportunity to develop a deeper understanding of how cutting-edge media technologies help enhance museum visitors' overall experiences (i.e., personal thoughts and feelings) in the local sociocultural context of Hong Kong. This study was guided by the following research questions (RQs):

RQ1: What is the visitors' collective experience during their visits to the Hakka Kungfu Exhibition? For this aspect, we want to examine whether the contents, setup, and presentation of this Exhibition are effective in enabling the visitors to develop an appreciation, as well as an understanding of the narratives of Chinese Kungfu in question, as a form intangible cultural heritage.

RQ2: For visitors' post-exhibition experience, to what extent is the Exhibition influential in shaping or even changing the visitors' overall attitudes, and perceptions towards values of traditional Chinese Kungfu as a whole?

RQ3: What roles can the latest digital media technologies (in particular, VR) play, in terms of influencing and fostering of the preservation of traditional Chinese Kungfu as a form of cultural heritage, in the context of the Hakka Kungfu Exhibition?

Values and significance of the study

Although it is already a global trend for the museums to integrate multimedia technologies into their exhibitions, research on the situation and feedback of emerging digital visual technology (such as VR) used in museum exhibitions in Hong Kong and Southeast Asia are scarce and scattered, in particular, related to the culture of Chinese Kungfu. Our findings are of interest to museum and gallery professionals who are considering to incorporate multimedia designs into their exhibitions, as a means of preserving intangible cultural heritage, and to educate and disseminate cultural knowledge to society in a more entertaining and engaging way. In addition, our findings could help identify various factors involved in audience participation, thereby exploring the possibility of building a platform for traditional Chinese Kungfu as an intangible cultural heritage (Chao, 2018), via the integration of the latest media technologies. In particular, the development of multimedia technologies has become increasingly important to museums, and museum professionals have been exploring how digital and communication technologies can be developed to offer visitors a more interactive, personalized museum experience. This growing emphasis on interactional and informal nature of museum experience provides a perfect opportunity to adopt digital interactive technologies for engaging visitors in exhibits and more generally in museums as a whole.

Literature Review

Prior research (Falk & Dierking, 2000) suggests that visitors' motivation and expectation of visiting museums are to learn and have fun. The study also divided the visitor motivations of going to museums into six categories, including education, entertainment, social event, life cycle, place, and practice issues. With the rapid development of information technology in the past three decades, information science researchers are interested in studying how information technology would affect the development of museum through the lens of socio-technological aspects (Marty, 1999). Obviously, integrating cutting-edge multimedia technologies could increase people's curiosity and appeal of the exhibitions to the public (Vom Lehn & Heath, 2005). Further, people's engagement and curiosity are important in enhancing learning

(DiPaola & Akai, 2006). Economou (1998) developed a prototype to examine the effectiveness of the multimedia application in an exhibition scenario. The results showed that the multimedia presence in the exhibition generally enriched the visitors' enjoyment and engagement, and motivated them to visit again. Interactive multimedia design also allowed visitors to engage in their own pace and increase their visual interest in absorbing knowledge in this kind of interactive environment (DiPaola & Akai, 2006), thereby encouraging self-learning and revisits.

Sparcino (2004) also examined an exhibition, "Puccini Set Designer," in 2003 to evaluate the interactivity and effective use of technologies implemented. The technologies used in that exhibition turned the museum's room into body-driven interactive multimedia narrative senor space. 3-D and audio-visual animation, VR glasses, reconstructed 3-D modeling of room and characters, immerse cinema interactive installation, and interactive documentary presentation table were integrated into the exhibition. Survey results revealed that the exhibits attracted people at all ages. The interactive technologies had possibly stimulated the visitors' exploration spirit and curiosity, and gave them a sense of interest and wonder in the object and information presented in the exhibition. Such interests may be grounded from the VR used, as it is an effective way for information exchange (Tan *et al.*, 2012).

Recently, cultural heritage projects have been regarded as a focus of the growing field of digital humanities. According to Pearce (1992) and Hooper-Greenhill (2000) , they have witnessed a major shift amongst museums' exhibition focus, that is moving away from the aesthetic value to the historical information behind the museum artifacts, as well as the ideas these artifacts represent and foster. This change of focus has led museums in general to concentrate on telling stories of the objects on display (Alexander & Alexander, 2008). In this context, culturally-centered VR systems plays an essential role in establishing the "connectedness" with the museum visitors – that is through active participation and interaction with the museum objects in VR, visitors are able to construct semantic meaning, thereby enhancing their cultural awareness.

Dawson and Joseph (2016) argued that although computer-based modeling has long been used in museums to support its exhibits, the integration of museum work into the digital humanities embraced the investigating of the knowledge process in the humanities domain. Ioannides *et al.* (2017) asserted that combining aesthetic and cultural heritage reconstructions with virtual

7

augmentations and adding dramatic tension has developed over the recent years into narrative patterns, which introduces exciting new virtual and augmented reality edutainment, as well as gamification medium for digital humanities projects. Marty (2007) also discovered the challenges faced by museum information professionals in how they need to cope with technology advancement, and how to incorporate these technologies into museum exhibitions.

Given the advantages brought by VR for enhancing visitors' museum-going experiences, this technology is not without limitations and shortcomings. According to Carrozzino and Bergamasco (2010), "Contemporary museums are much more than [just physical] places devoted to the placement and the exhibition of collections and artworks," as museums also "play a central role in making culture accessible to the mass audience… and one of the keys to approach the general public is the use of new technologies and novel interaction paradigms" (p. 452). Carrozzino and Bergamasco (2010) further explains that "VR is perhaps one of the most appealing and potentially effective technologies to serve this purpose, as this technology allows museum curators to modulate the cultural proposal by structuring different courses for different user profiles" (p. 452).

Given VR's potentials and effectiveness, VR is not without its inherent limitations. VR technology is still not widely adopted amongst museums worldwide mainly because VR is relatively expensive, and maintenance costs are commonly high. More importantly, VR systems are meant to create meaningful and pleasant experiences for museum visitors in a very limited amount of time. This condition in general has a tendency to prevent VR users in the museum setting to have slow learning curves, that is "to identify, at a glance, the context and the interaction modes without [much time] having to think too much" (Carrozzino & Bergamasco, 2010, p. 457). On the other hand, VR systems that could induce a deeper participation and involvement of users (i.e., increasing their ability to absorb concepts and information) are usually more expensive, more complex to setup, maintain and master, and require large dedicated spaces (Carrozzino & Bergamasco, 2010; Osberg, 1995).

Further, Lepouras et al. (2004) discovered a number of other challenges when creating a virtual reality environment open to the public inside a museum, through an experiment with a total number of 25 subjects (14 male and 11 female, mostly students and researchers of the University of Athens). Findings of this experiment indicate that the VR system "designer has to develop an intuitive, consistent, user-friendly, stimulating virtual environment, with rigid

In summary, related literature has provided much evidence that multimedia technologies and applications would be a useful tool for presenting and interpreting objects and knowledge if they have been properly designed and implemented based on specific contexts. However, research on the situation and feedback of multimedia technology used in the museum in Hong Kong, in particular, those related to Kungfu is still scarce. Our study aims to understand how emerging multimedia tools (such as VR) perform in facilitating visitors in the museums in Hong Kong, and thus understand how well such technologies could achieve the education role of a museum.

Methodology

A questionnaire survey was designed to identify the visitors' expectations and experiences, about the Hakka Kungfu Exhibition, particularly their interaction experiences with various multimedia technologies. Since this Exhibition was about presenting a centuries-old Chinese cultural heritage, Hakka Kungfu, via the use emerging multimedia technologies, in the context of establishing a dialogue between the past and present, the researchers included items that were devoted to enquire about the level of understanding, knowledge, and enjoyment, visitors' new knowledge about Hong Kong history, and how culture was successfully disseminated to the respondents. During the exhibition periods at the two venues (see Table 1), a total number of 209 completed questionnaires were collected, of which 100 were from the Hong Kong Heritage Museum (HKHM), and 109 were from the CityU. While the Exhibition is considered as a success with high attendance rate (with 7,015 visitors visited just in the first week), the low response rate was partly because of HKHM's policy that did not allow us to conduct a survey on site. In examining the question of whether this type of exhibition can be used in local schools for allowing the younger generations to learn more about their local culture and history in the liberal studies course of local high schools, as well as achieving the purpose of creating their sense of belonging to Hong Kong, our project ultimately explored the possibilities of whether the public agrees with the Hong Kong Government's establishment of a new museum dedicated to Kungfu in the future as an ongoing effort or even as a permanent way to preserve this vanishing traditional art.

Data Analysis

Demographic

The survey results indicate that this Exhibition successfully attracted a large number of visitors who had never been trained for Kungfu or any kind of martial arts. Since martial arts and Kungfu are predominantly a male sport globally, it is surprising that this Exhibition had attracted a large number of female visitors. In fact, the number of female survey respondents was higher than their male counterparts, with a ratio of 1:1.2 (see Tables 2 and 3), despite only 19.3% of female respondents had experiences in martial arts training.

Table 2. Demographic (N = 209)

Demographic	N	%
Gender		
Male	95	45.5%
Female	114	54.4%
Ethnic background		
Hakka	27	12.9%
Not Hakka	172	82.3%
Don't know	10	4.8%
Age		
8-16 years old	11	5.3%
17-24 years old	68	32.5%
25-34 years old	42	20.1%
35-44 years old	39	18.7%
45-54 years old	32	15.3%
55-64 years old	10	4.8%
65-74 years old	7	3.3%
Education level (see note)		
Elementary school	7	3.4%
High school / Secondary School	26	12.5%
Certificate / Diploma	5	2.4%
Associate degree /Pre-Associate degree	5	2.4%
Bachelor's degree	96	46.2%
Master's degree	62	29.8%
Doctoral degree / Ph.D. or above	7	3.4%
Note: One respondent did not indicate his/her education level.		

Table 3. Backgrounds & Respondents' Interests in Kungfu or Martial Arts

	Trained in Kungfu or martial arts		Interested in Kungfu or martial arts	
	Yes	No	Yes	No
Male	51	44	91	4
Female	22	92	88	26
Total	73	136	179	30

Ratings of exhibition installations

We also asked the visitors a series of questions related to their perceptions, attitudes, and their level of enjoyment towards the Exhibition. Our results are presented in Tables 4 and 5, which reveal that all of the major installations were well received amongst the respondents and had mean values > 3.0 (i.e., mid-point of the scale) for all five cases, with $p < 0.001$. Amongst the five major installations, those installations with VR media components, namely Hologram (see Fig. 1) and Re-Actor (see Fig. 5), and Motion Visualization (see Fig. 6) were well-received by our visitors and received highest ratings, followed by the display of traditional Kungfu weapon and tools as original artifacts (see Fig. 2). Furthermore, we can see that the correlation between VR exhibition installations and audience overall experience was strong, and the regression models support this as the elements of technology highlight the audience's overall positive attitude towards these particular installations, and components of this Exhibition (see Tables 7 to 10).

Fig. 5. Re-Actor presents the Hakka Kungfu performance using 3-D motion capture techniques on screen from six angles.

Fig. 6. Motion visualization videos demonstrating the Kungfu movements in 3-D format (left), and the video showing the use of motion capture technology for producing the 3-D video (MOCAP)(right).

Table 4. Exhibition Installations & Components

	Mean
Photo zone	3.94
Hologram and Re-Actor	4.26
Weapons and tools	4.08
Motion Visualization	4.25
Documentary videos	3.90
Note: 5-point Likert Scale is used. All values are higher than 3.0 (i.e., mid-point of scale), with $p < 0.001$.	

Visitors' perceptions, attitudes, and level of enjoyment towards the Exhibition

Our results for measuring the visitors' perceptions, and their level of enjoyment towards the exhibition are presented in Table 5. Our visitors agreed that the contents of this Exhibition were easy to understand. They also strongly agreed that this Exhibition enabled them to learn something new about the local history and culture of Hong Kong, as well as something new about traditional Chinese Kungfu.

Table 5. Attitudes and Perceptions towards the Exhibition

Items	Mean
Perceptions towards easiness of understanding the Exhibition.	3.97
Visitors' overall attitude & experience towards the Exhibition.	4.03
Overall rating of the 5 major high-tech installations of the Exhibition.	4.09
Learning something new about Hong Kong history and culture.	4.19

Learning something new about traditional Chinese Kungfu.	4.14
Using new media to capture Kungfu has made your experience more enjoyable/exciting/engaging.	4.34
Compare with other traditional martial arts exhibitions – how highly would you rate this exhibition (with 3-D motion capture).	3.97
Note: 5-point Likert Scale is used. All values are higher than 3.0 (i.e., mid-point of scale), with $p < 0.001$.	

With reference to the technical aspects of this Exhibition, visitors strongly agreed that using VR-based new media to capture Kungfu made their experience more enjoyable, exciting, and engaging. A relatively high rating was given when visitors were asked to compare this Exhibition against traditional ones with only physical artifacts. Although visitors only moderately agreed that this Exhibition could help establish a collective cultural identity for Hong Kong, they strongly agreed that the local Hong Kong Government should establish a permanent on Chinese Kungfu (see Table 6), for the purpose of preservation, as well as for educating the general public about Kungfu being an important part of the local cultural heritage.

Table 6. Perceptions & Attitudes towards the Overall Exhibition & its Cultural Influence

Items	Mean
Do you agree this exhibition helps establish a collective cultural identity for Hong Kong?	3.44
Do you agree the Hong Kong Government should establish a permanent on Chinese Kungfu?	4.13
Note: 5-point Likert Scale is used. All values are higher than 3.0 (i.e., mid-point of scale), with $p < 0.001$.	

Factors Affecting Overall Attitude towards the Exhibition

Based on the stepwise regression at Table 7, results reveal that the five main installation features, i.e., (1) Photo Zone, (2) Hologram and Re-Actor, (3) Weapons and Tools, (4) Motion Visualization, and (5) Documentary Videos, had significant and direct impacts on the visitors' overall attitude towards the Exhibition. Gender was also found to have a significant impact, of which female had a less positive attitude towards the Exhibition, in comparison to male. We also noted that gender interacted with Documentary Videos, of which female had a lower level of interest in it.

Table 7. Regression Analysis on Factors Affecting Overall Attitude Towards the Exhibition

Predictors	Regression	Stepwise regression without the interaction terms	Stepwise regression with interaction terms
Photo Zone	1.33	1.38 *	
Hologram and Re-Actor	2.98 ***	3.02 ***	3.04 ***
Weapons and Tools	1.78 *	1.79 *	2.03 **
Motion Visualization	2.20 **	2.18 **	2.11 **
Documentary Videos	2.13 **	2.23 ***	3.51 ***
Gender	–1.71	–2.08 *	
Age	0.17		
Kungfu training	3.20 **	3.24 **	
Interested in Kungfu	1.15		
Kungfu Training × Photo Zone			3.89 ***
Kungfu Training × Documentary Videos			–3.10 **
Gender × Documentary Videos			–0.53 *
Intercept	24.1 ***	25.0 ***	24.6 ***
R^2 (adj.)	0.53	0.53	0.55
F-value	26.0 ***	33.5 ***	35.9 ***
Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.			

We also note that visitors with Kungfu training had a more positive view, perhaps feeling more excited towards the Exhibition or possessing the knowledge that enabled them to better appreciate the contents of the Exhibition. Furthermore, visitors with Kungfu training were more interested in the Photo Zone, but less captivated by the Documentary Videos.

Use of Motion Capture Technologies

The stepwise regression model in Table 8 suggests that the following three high-tech VR installations had significant impacts, and contributed directly to creating a positive experience for the visitors. It is possible that the other traditional multimedia exhibition installations, i.e., Photo Zone and Documentary Videos, could be commonly found in other regular museum exhibitions or television documentary programs. Therefore, visitors were less impressed by them, when they were put side-by-side with high-tech VR installations at the Exhibition. However, there was no interaction effect between the factors from our stepwise regression with interaction terms.

Table 8. Regression Analysis of the Use of New Media and Visitors' Experience

Predictors	Regression	Stepwise regression without interaction terms
Photo Zone	–0.04	

Hologram and Re-Actor	0.19 *	0.18 *
Weapons and Tools	0.14	0.15 *
Motion Visualization	0.27 ***	0.30 ***
Documentary Videos	0.08	
Gender	–0.07	
Age	–0.04	
Kungfu Training	0.01	
Interested in Kungfu	–0.08	
Constant	1.85 ***	1.71 ***
R^2 (adj.)	0.26	0.27
F-value	8.79 ***	26.05 ***
Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.		

Hakka Kungfu Exhibition versus Traditional Exhibitions

From the stepwise regression as shown in Table 9, with the main effect, only four of the five installation features, i.e., Photo Zone, Hologram and Re-Actor, Weapons and Tools, Motion Visualization, had significant impacts on the visitors' overall attitude towards the Exhibition. Documentary Videos did not have an impact on the visitors, perhaps because they were commonly used in many other traditional exhibitions, and could not bring any surprise to the visitors.

Table 9. Regression Analysis on Factors Affecting Preferences on High-Tech Exhibition versus Traditional Ones

Predictors	Regression	Stepwise regression without interaction terms	Stepwise regression with interaction terms
Photo Zone	0.15 *	0.18 **	0.17 **
Hologram and Re-Actor	0.17 *	0.17 *	
Weapons and Tools	0.22 **	0.24 ***	0.37 ***
Motion Visualization	0.13	0.17 **	0.20 ***
Documentary Videos	0.10		
Gender	–0.06		
Age	–0.04		
Visitors with Kungfu training	0.26 **	0.28 **	
Visitors interested in Kungfu	–0.03		
Kungfu training × Hologram and Re-Actor			0.27 ***
Kungfu training × Weapons and Tools			–0.22 **
Constant	1.14 ***	1.02 ***	1.11 ***

15

R^2 (adj.)	0.43	0.42	0.43
F-value	16.6 ***	28.9 ***	29.9 ***
Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.			

From stepwise regression of the main effects, visitors with Kungfu training had more positive views towards the high-tech VR aspects of the Exhibition. This was probably because visitors with martial arts training possessed the ability to better understand the technical aspects of Hakka Kungfu being presented or highlighted via the use of 3-D technologies, as well as to better appreciate the aesthetics behind it. The stepwise regression with interaction effects shows that Kungfu Training interacts with Hologram positively. This indicated that the visitors with Kungfu training were more appreciative, and preferred to see this type of high-tech VR installations at the Exhibition. However, unexpectedly, the interaction between Kungfu Training and Weapons and Tools was found to be negative. In other words, people with Kungfu training did not prefer this technology to be used in the Exhibition. This can probably be explained by the fact that most Kungfu learners in Hong Kong are not trained in the martial arts using weapons, as a result they did not much attachment to these weapons.

Discussion

Enhancing visitors' experiences through multimedia technologies

Galleries and museums today recognize the need for creating a local, educational, intellectual, entertaining, and engaging experience for their visitors, as well as a collective cultural identity for the community. The ultimate goal of integrating new media technology (in particular VR) is to enhance visitors' overall museum-going experience by strengthening the impression the visitors from the original exhibition content, without causing significant distractions. Also beneficial was the technology-based components' potentials in attracting a much wider and more diverse audience group through various modes of exhibition contents presentation. This argument has become a necessary practice to incorporate multiple modes of content presentation in current exhibition presentation. Appropriate technology-based mode of presentation could contribute greatly to enhancing the overall museum-going experience, and create meaningful learning opportunities for the visitors. These notions supported our result that high-tech VR installations had more significant impacts than traditional multimedia installations like documentary video and photos.

To maximize the potential of technology to learning, it is important to go beyond the passive provision of information, and more towards 'active' learning approaches that could engage and impress the museum visitors emotionally, socially, physically, and intellectually. However, there is much to consider in the process of interpretation, understanding, and appreciation on the part of the museum visitors. According to Hein (1998), stimulating curiosity is crucial to the construction of a visitor's own understanding of a museum exhibition. At the same time, curators must make experience educational, fun, and engaging, while minimizing effort and inconvenience on the part of the visitors. The tacit nature of museum experience places emphasis the importance of understanding the "inner work" of imagination, reflection, and interpretation that take place during, and after, a visit to the museum. These notions supported our results that visitors with Kungfu training had more positive views towards the high-tech virtual reality aspects of the Exhibition.

Engagement via multimodal reality

Using new VR technologies, this Exhibition advocated the presentation of the central subject, Hakka Kungfu, in various ways and in different formats, thereby allowing the visitors to gather information to construct an intellectual repertoire of different bits of intelligence (Hopper & Hurry, 2000). Such intelligence could include bodily-kinesthetic, spatial (3-D), interpersonal, existential intelligence, and more. As explained by Hein (1998), active participation is required in learning and the acquisition of knowledge. Therefore, this Exhibition cultivated an atmosphere of virtual authenticity, at the same time allowing the visitors to harness various forms of digital media as a form of 'active' engagement with this intangible culture. That created an unparalleled museum experience that is beyond simple passive viewing of conventional means. As a result, visitors were exposed to a range of approaches or interactive activities (ranging from gamification to motional visualization, etc.) of representing central dimensions of the central topic, Hakka Kungfu, and each method of representation impressed the visitors with important and different insights for understanding (Cohen, 2001). In other words, this VR museum-going experience provided more 'active' multimodal learning approaches as the means of producing positive responses, and maybe even a better sense of cultural awareness far beyond the passive provision of conventional, static information presentations.

Towards a holistic understanding of the Exhibition contents

The Hakka Kungfu Exhibition was set up with the aim of engaging visual activities that could be enjoyed by visitors of various needs. In fact, our findings reveal that this Exhibition has successfully attracted a large number of female visitors, as well as those who have never taken any martial arts training. At this Exhibition, each installation or setup might be used to explain issues of cultural practices, traditions, history, geography, training and fighting techniques, theories of beauty, etc. By integrating VR technologies with traditional presentation media, this Exhibition offered visitors a more holistic understanding of Kungfu as an intangible cultural heritage in different dimensions, and also in varying sociocultural contexts. The careful layering of different installations helped the visitors create their 'individualized' learning experiences, as they navigated the different levels of the Exhibition's contents. The dimensions of visitor engagement described above has been successful in a variety of ways. For example, in terms of 'sociality,' this Exhibition could be experienced either individually or collectively, meaning that visitors could be engaged with the Exhibition installations individually, or together with other people as a group. The cross-referencing of various installations together worked well with one another. In fact, without the use of appropriate technologies such as VR, the complex subject matter of Hakka Kungfu would have been difficult to be understood or appreciated, especially to visitors who have never taken any training in martial arts.

Furthermore, encouraging interactivity and engagement in an environment featuring an intangible cultural heritage (like Chinese martial arts) that cannot be touched or stored in physical form is historically unconventional. Live Kungfu demonstrations could convey only limited amount of information as explanations and reference materials are often limited or only available separately. In short, VR technologies demonstrated the potential to enliven the Exhibition by promoting interactivity and engagement during the visits. Not only did interactivity draw visitor's attention to the exhibition (Pujol-Tost, 2011), but also it increased their willingness to learn and explore the Exhibition contents further, thereby enabling a more holistic understanding of the subject being presented.

Establishing a dialogue between past and present
Museums nowadays recognize the value of cultivating interest in younger generations and have implemented various multimedia technologies to attract them. Successful exhibitions must keep the audience's attention, enabling them to be fully engaged, and clearly, the Exhibition accomplished this, partially due to its interactive and entertaining components. In addition, a successful exhibit must appeal to a wide range of audience as far as possible. There can be little

argument that new media technologies is the popular medium through which children and young adults of this digital era communicate and entertain themselves. Based on our findings, visitors across various age groups, from different education levels and backgrounds, found ways to connect with the Exhibition and experienced high level of excitement and enjoyment. This may be in part due to the multiple modes of information presentation that appealed to a variety of learning styles, as well as recreational and entertainment preferences.

Another successful aspect of this Exhibition was its effectiveness in opening up more intense dialogues between the local communities and Hakka Kungfu, by preserving and exhibiting traditional Hakka Kungfu as a form of intangible cultural heritage in digital, and interactive format. We speculated that because a majority of the visitors were young university students, and many of them were far removed from the time, as the subject contents presented in this Exhibition were decades or centuries old. For this reason, it would normally require a leap of imagination for a majority of these young visitors. The contents of traditional Hakka Kungfu presented through media has become more accessible and comprehensible through the technological interface of VR.

Meanwhile, the Exhibition theme focused on the subject of Hakka Kungfu as a fading cultural practice or a tradition that comes with a long history. Via this Exhibition, the visitors could understand how these Hakka Kungfu masters used these artifacts, i.e., weapons and farming equipment, in the past on display, and the Documentary Videos and Photo Zone depicting these old masters' old ways of life, their feelings, hopes, and values, etc. Alternatively, the focus could be on the future, that is on what people could accomplish with Hakka Kungfu presented through Hologram and Re-Actor as well as Motion Visualization. This could shed light on what future chapters of Hakka Kungfu might hold. According to Kaptelinin (2011), modern technologies have some common features with crystal balls, Scrying pools, and other artifacts that are known to have the power of showing things that cannot be immediately discerned through 'ordinary' perception. In that sense, digital techniques did not just help preserve, but also help transmit this heritage across generations. In short, this Exhibition offered educational and cultural values of Kungfu as a slowing fading cultural practice amongst the young student visitors, as well as fostered public interest and awareness. Therefore, the visitors rated this Exhibition higher than other traditional exhibitions.

In summary, engagement in museum learning has been a natural result of appropriate uses of

interactive technologies (Harrison, 2011). The technology-enhanced exhibition dedicated to Hakka Kungfu is an example of successful use of new media for museums. Not only did VR technology provide additional depth to visitors' exhibition experience, it also allowed technology-supported transformative learning, especially considering the complex nature of Hakka Kungfu as the subject matter. When applied appropriately, the advantages of the integration of VR technologies include the ability to convey complex information in a more comprehensible, interactive, and meaningful manner. This Exhibition was successful on four levels:

(1) This Exhibition has successfully presented the Kungfu tradition as a form of digital humanities, at the intersection of history and technology. Also, the use of multimedia technologies has brought relevance back to a topic (Hakka Kungfu) that is deeply rooted in the long tradition and culture of the Chinese civilization that may seem to be abstract or outdated.

(2) The Holograms, Motion Visualization, and Re-Actor installations has promoted the appreciation of the beauty and wisdom of Chinese Kungfu in many varieties and dimensions. For example, the use of 3-D interactive visualization technology, and other value-added game-based elements have supported the visitors' understanding of unfolding temporal and logical sequences and narratives of using the Kungfu in questioning the past. Traditional Kungfu, which was once seen as losing its appeal to the young digital-generation in modern society, can look appeal again given the right presentation style and format, and with the help of VR and other new media technologies.

(3) By establishing best practices using digital humanities methods, arts and cultural administrators and conservators can use the results of this survey as evidence to request for further funding support for similar projects and exhibitions.

(4) This Exhibition supports the current and future research endeavors that scholars conduct to decode the wisdom behind traditional Kungfu culture and practices. In fact, increased engagement with the community via the use of the latest multimedia technologies will unarguably also lead to new sustainable approaches, processes, and methodologies towards the understanding of traditional Kungfu as a form of intangible cultural heritage.

Glimpse of the future

For thousands of years, traditional Kungfu has been an important and integral part of Chinese culture and society. Over the long history of its development, the functions and values of Kungfu have shifted from the practical military or self-defense techniques to personal wellness and enrichment. Traditional Chinese Kungfu in the modern context has also become a way of training of the mind, such as self-cultivation and moral education. Unfortunately, in our increasingly sedentary lifestyles in Hong Kong, people are moving away from a fishing and agricultural society into a highly globalized, commercial and materialistic one. In fact, the values of traditional Chinese Kungfu is gradually fading from the daily life of most people, especially with the young Net generation in many Chinese societies, particularly for fast-paced cities like Hong Kong. When modern combat sports like Muay Thai or mixed martial arts (MMA) are on the trend, Kungfu is slowly fading away from society, as it is often seen as an outdated form of training or fighting. As few grandmasters remain alive, the inheritance of this ancient art from China is facing a serious threat of being lost and forgotten (Cho, Lo & Chiu, 2017; Lo, 2015).

In the case of this *Hakka Kungfu Exhibition*, the use of new media technologies such as VR helped compensate for the limitations, and at the same time, enabling curators and Kungfu grandmasters to transmit this non-material cultural into VR, thereby does not only allowing it to continue to survive in different space and time. The new formats were demonstrated to be more appealing to the younger digital generation.

Conclusion

Museums and galleries have a long history of creating innovative and engaging ways of enriching visitor experiences. With social roles and functions similar to libraries, galleries, and archives, museums have always played an important role in our society. That is to serve as repositories of artifacts of knowledge, thereby bringing us closer to our own cultural roots, and making us aware of our own traditions and cultural past. At the same time, museums could open our minds and horizons about the issues around us. This provides us an ambitious vision for the future to be filled with new hopes and possibilities.

By using the latest 3-D motion capture and other virtual reality technologies, the Hakka Kungfu Exhibition has captured the seemingly isolated physics and outdated cultural heritage of

Kungfu, before everything should disappear. The diversity of digital media used in this Exhibition successfully created a completely new learning environment with impressive experiences that are fun, entertaining, engaging, interactive, as well as innovative. Via the use of the latest VR technologies, not only did this new format of multimodal content delivery contributes directly to the digital cultural heritage itself, it has also radically transformed how the visitors relate Kungfu to part of their traditions, and as an intangible cultural heritage.

Our findings indicated that visitors' exhibition experience was memorable, enjoyable, entertaining and educational. By creating a long-lasting impression on the minds of these exhibition visitors about the connections between and relevance of traditional Kungfu, their collective cultural identity, as well as the contemporary society we live in, this Exhibition exemplified a successful integration of the presentation of Kungfu as a form of cultural heritage with engagement-creating technology, in which technology is unobtrusive but effective.

The on-going development of advanced technology (Lo et al., 2017) triggers the experiments of exhibit design in the museums, for example, applying and integrating the multimedia technologies and tools into the exhibitions, such as AR, VR, 3-D animation, mobile guiding apps, and virtual museum. In other words, for our peers in other museums, archives, and libraries, digital technology (VR in particular) has created a golden age of opportunity.

As for our continuing work, we are planning to conduct similar studies for different heritage art forms, such as Chinese painting and calligraphy (Chen, Chiu, & Ho, 2018; Zhuang et al., 2014). Besides VR, we are especially interested in the use of mobile apps (Dukic, Chiu, & Lo, 2015; Ko et al., 2015; Lo et al., 2016) and social media (Kong et al., 2016) in the museum context to facilitate learning.

References

Alexander, E.P., & Alexander, M. (2008). Museums in motion: An introduction to the history and functions of museums (2 ed.). Lanham, MD: Rowman & Littlefield Publisher.

Black, G. (2005). The engaging museum: Developing museums for visitor involvement. New York, NY: Routledge.

Carrozzino, M. & Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums. *Journal of Cultural Heritage*, 11, 452-458.

Chao, H. (2018). *Lingnan Hung Kuen: Kung Fu in Cinema and Community*. City University of HK Press.

Chao, H., Shaw, J., & Kenderdine, S. (2016). *300 Years of Hakka Kung Fu: Digital Vision of its Legacy and Future*. International Guoshu Association.

Chan, J. (2009). The consumption of museum service experiences: Benefits and value of museum experiences. Journal of Hospitality Marketing and Management, 18(2/3), 173−196.

Cho, A, Lo, P. & Chiu, D. (2017). *Inside the World's Major East Asian Collections: One Belt, One Road, and Beyond.* Amsterdam: Elsevier.

Cohen, E.G. (2001). Book review: Intelligence reframes: Multiple intelligences for the 21st century. Teachers College Record 103(1), 47−49.

Dawson, B., & Joseph, P. (2016). Cultural heritage visualization: Using interactive multimedia in museum environments. In: International SERIES on Information Systems and Management in Creative eMedia (CreMedia), 2016/2, 1−10.

DiPaola, S., & Akai, C. (2006). Designing an adaptive multimedia interactive to support shared learning experiences. In: Proceedings from ACM SIGGRAPH 2006 educators program, Boston, MA.

Donald, J.G. (1991). The measurement of learning in the museum. Canadian Journal of Education, 16(3), 371−382.

Dukic, Z., Chiu, D. K., & Lo, P. (2015). How useful are smartphones for learning? Perceptions and practices of Library and Information Science students from Hong Kong and Japan. Library Hi Tech, 33(4), 545-561.

Economou, M. (1998). The evaluation of museum multimedia applications: Lessons from research. Museum Management and Curatorship, 17(2), 173−187.

Falk, J.H., & Dierking, L.D. (1992). *The Museum Experience*. Washington, D.C.: Whalesback Books.

Falk, J.H., & Dierking, L.D. (2000). Learning from museums: Visitor experiences and the making of meaning. Walnut Creek, CA: Alta Mira Press.

Hall, T., & Bannon, L. (2006). Designing ubiquitous computing to enhance children's learning in museums. Journal of Computer-Assisted Learning, 22(4), 231−243.

Harrison, L.A. (2011). Interactive Technology in Art Museum Exhibitions: A Case Study on Giuseppe Vasi's Rome: Lasting Impressions from the Age of the Grand Tour. Master's Thesis. University of Oregon.

Hein, G.E. (1998). Learning in the museum. New York, NY: Routledge.

Hein, H.S. (2000). The museum in transition: Philosophical perspectives. Washington, DC: Smithsonian Books.

Hong Kong Heritage Museum (HKHM). 300 years of Hakka Kung Fu – Digital vision of its legacy and future. Retrieved from http://www.heritagemuseum.gov.hk/en_US/web/hm/exhibitions/data/exid238.html

Hooper-Greenhill, E. (2000). Changing values in the art museum: rethinking communication and learning. *International Journal of Heritage Studies*, 6(1), 9−31.

Hopper, B., & Hurry, P. (2000). Learning the MI way: The effects on students' learning of using the theory of multiple intelligences. Pastoral Care in Education, 18(4), 26−32.

Ioannides, M., Magnenat-Thalmann, N., & Papagiannakis, G. (2017). Mixed Reality and Gamification for Cultural Heritage. Berlin, Germany: Springer.

International Council of Museums (2013). ICOM code of ethics for museums. Paris, France: ICOM. Retrieved from: http://icom.museum/fileadmin/user_upload/pdf/Codes/code_ethics2013_eng.pdf

Jeffery-Clay, K.R. (1998). Constructivism in museums: How museums create meaningful learning environments. Journal of Museum Education, 23(1), 3–7.

Kaptelinin, V. (2011). Designing technological support for meaning making in museum learning: A activity-theoretical framework. In: *Proceedings of the 44th Hawaii International Conference on System Sciences*.

Ko, E. H., Chiu, D. K., Lo, P., & Ho, K. K. (2015). Comparative study on m-learning usage among LIS students from Hong Kong, Japan and Taiwan. *The Journal of Academic Librarianship*, *41*(5), 567-577.

Kong, E. W., Chiu, D. K. W., & Ho, K. K. (2016). Applications of Social Media in Academic Library Services: A Case of the Hong Kong Polytechnic University Library. *International Journal of Systems and Service-Oriented Engineering (IJSSOE)*, *6*(2), 53-65.

Lo, P. (2015). Preserving Local Documentary Heritage: Conversations with Special Library Managers and Archivists in Hong Kong. Kowloon Tong, Hong Kong: City University of Hong Kong Press.

Lo, P., Cho, A., Leung, M. H.*, Chiu, D. K., Ko, E. H. T.*, & Ho, K. W. K. (2016). Use of smartphones by art and design students for accessing library services and learning. *Library Hi Tech*, *34*(2).

Lo, P., Cho, A., Law, B. K. K., Chiu, D. K., & Allard, B. (2017). Progressive trends in electronic resources management among academic libraries in Hong Kong. *Library Collections, Acquisitions, & Technical Services*, *40*(1-2), 28-37.

Lepouras, G., Katifori, A., Vassilakis, C. & Charitos, D. (2004). Real exhibitions in a virtual museum. *Virtual Reality*, 7, 120–128.

Liarokapis, F., Petridis, P., Andrews, D., & de Freitas, S. (2017). Multimodal serious games technologies for cultural heritage. In: Mixed Reality and Gamification for Cultural Heritage (pp. 371–392). Berlin, Germany: Springer.

Marty, P.F. (1999). Museum informatics and collaborative technologies: The emerging socio-technological dimension of information science in museum environments. Journal of the Association for Information Science and Technology, 50(12), 1083–1091.

Marty, P.F. (2007). The changing nature of information work in museums. Journal of the Association for Information Science and Technology, 58(1), 97–107.

Mayer, M. (2005). Bridging the theory-practice divide in contemporary art museum education. Art Education, 58(2), 13–17.

Pearce, S.M. (1992). *Museums, Objects and Collections: A Cultural Study.* Leicester and London: Leicester University Press.

Pujol-Tost, L. (2011). Integrating ICT in exhibitions. Museum Management and Curatorship, 26(1), 63–79.

Silverman, L. (1993). Making meaning together: Lessons from the field of American history. Journal of Museum Education, 18(3), 7–11.

Sparcino, F. (2004). Museum intelligence: Using interactive technologies for effective communication and storytelling in the "Puccini Set Designer" exhibit. In: Proceedings of the International Cultural Heritage Informatics Meeting (ICHIM 2004), Berlin, Germany.

Suthers, D.D. (2006). Technology affordances for inter-subjective meaning making: A research agenda for CSCL. International Journal of Computer-Supported Collaborative Learning, 1(3), 315–337.

Tan, W.-K., Tan, C.-H., & Teo, H.-H. (2012). Conveying information effectively in a virtual world: Insights from synthesized task closure and media richness. Journal of the Association for Information Science and Technology, 63(6), 1198–1112.

Vom Lehn, D., & Heath, C. (2005). Accounting for new technology in museum exhibitions. International Journal of Arts Management, 7(3), 11–21.

Wang, Y. (2016.09.01). Hakka kung fu meets digital art at Heritage Museum. China Daily Asia. Retrieved from http://www.chinadailyasia.com/hknews/2016-09/01/content_15488950.html

Zhuang, Y., Li, Q., Chiu, D. K., Wu, Z., & Hu, H. (2014). Efficient Personalized Probabilistic Retrieval of Chinese Calligraphic Manuscript Images in Mobile Cloud Environment. *ACM Transactions on Asian Language Information Processing (TALIP)*, *13*(4), 18.