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Effects of a Mobile Electronic Guidebook on Visitors' Attention and Visiting Behaviors

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ABSTRACT

Museums are one of the most important institutions providing students with the opportunity to gain knowledge, experience cultures, and develop different interests in an informal learning setting. As information and communication technology (ICT) has become more popular, many researchers have also become concerned with how to use mobile devices to support the museum's functions of lifelong learning. Although researchers have proposed several innovative types of mobile-device based electronic guidebooks, the effects of the most used audio-visual guidebooks have been rarely evaluated. This study explored the effect of a mobile electronic guidebook on visiting behaviors in a museum of history. Visitors' behaviors with two visiting modes (visiting with the electronic guidebook and visiting without supplementary tools) were compared. Forty-two college students were invited to visit the National Museum of History in Taiwan and were randomly assigned to one of the two visit modes. The results showed that the students with the electronic guidebook had a longer holding time with exhibits than the students without supplementary materials. The sequential analysis of visiting behaviors also showed that the students with the electronic guidebook displayed more inquisitive and structural behaviors when interacting with the exhibits.

Keywords

Mobile, Guidebook, Museum, Interaction, Informal learning

1. Introduction

Museums are one of the most important institutions providing students with the opportunity to gain knowledge, experience cultures, and develop different interests in an informal learning setting. As informal learning has become one of the most popular topics in the educational field, more and more research studies have emphasized museum learning as well (Paris & Hapgood, 2002). In the recent decades, issues of museum learning have minimally included how visitors' characteristics influence their visiting behavior (Falk & Adleman, 2003), how different characteristics of exhibits attract visitors' attention (Sandifer, 2003), how visitors' learning experiences are integrated in order to maximize learning effects (Anderson, Lucas, & Ginns, 2003; Hofstein & Rosenfeld, 1996), and interaction among visitors (Allen, 2002; Lienhardt & Gregg, 2002).

Technology also plays a significant role in museum learning. Due to the development of more advanced technology in wireless communication in recent years, wireless or mobile devices, such as personal digital assistant (PDAs), tablet PCs, and cell phones have been introduced into educational fields (Tatar, Roschelle, Vahey, & Penuel, 2003). The mobility and powerful computing functions of mobile devices provide an opportunity to allow each student to have his/her own device in an educational context (Virvou & Alepis, 2005; Lan, Sung, & Chang, in press; Hsi, 2003).

In museums, human resources are often limited so that individual tour guides might not always be available. As a result, personal electronic guidebooks, which might be mobile devices combined with e-learning content and an appropriate interface, have great potential to supplement museum learning. Different forms of technology have been incorporated into mobile guide systems. For instance, many mobile systems are equipped with wireless transmission tools (e.g., a wireless base station, infrared transmission, or radio frequency identification, RFID) or a global positioning system for visitors to access and gather information about the visited exhibits. Due to the different needs of exhibitions or visitors, mobile guide systems may have different content and formats.

Currently, there are two major approaches for designing mobile-device based guidebooks. The first approach, termed the audio-visual approach in this study, is embedding the exhibits' digitized images and descriptions in mobile devices. Equipped with other devices such as RFID or mechanisms of positioning (e.g., global positioning system), audio-visual guidebooks help visitors learn about specific exhibits. This may be the most popular approach for electronic guidebooks, and has been adopted by many public museums like the Exploratorium of San Francisco, the National Palace Museum of Taiwan, and the National Central Museum of Korea.

Another approach, called the scenario-based approach in this study, is focused on developing scenarios or implementing mechanisms which may be helpful for balancing visitors' attention between electronic guidebooks and exhibits, instead of planting digitized content and information into mobile devices. For example, Woodruff, Aoki, Hurst, & Szymanski (2001) implemented an electronic guidebook, SottoVoce, which enabled visitors to share audio information by eavesdropping on other visitors' guidebook activities. They found that eavesdropping audio provided more social and interactive learning resources than open air audio played through speakers. Additionally, Yatani, Sugimoto, and Kusunoki (2004) designed a problem-solving scenario, Musex, that increased young children's interest in exhibits in a museum of history and enhanced their interaction between peers. Klopfer, Perry, Squire, Jan, & Steinkuehler (2005) adopted a role-play approach to design the Mystery at the Museum (M@M) scenario that facilitated children's interaction with exhibits. Finally, Sung, Chang, Cheng, and Hou (in press) proposed a human-computer-context interaction (HCCI) framework and implemented an interface for enhancing the depth of college students' interaction with tri-color glazed pottery in the National Museum of History, Taiwan.

Despite the increasing applications of mobile devices in museums, research investigating the effects of the electronic guidebooks on the visitors' experience with exhibits is rare. Questions such as what the basic affordances of guidebook systems are, how the guidebook affects visitors' attention paid to artifacts, how a visitor's attention is shuttled between the virtual content in the guidebook and the physical exhibits, and how visitors interact with their peers when equipped with a guidebook still remain unanswered. Though some pioneering research has been conducted (e.g., Hsi, 2003; Woodruff, Aoki, Hurst, & Szymanski, 2001; Yatani et al., 2004; Sung et al., 2007), there are at least two limitations of the aforementioned studies. Firstly, most of the currently available empirical research has emphasized the scenario-based approach of guidebook design and has ignored investigation of the effects of the first approach. Although the design of audio-visual guidebooks with visiting maps and digital information may not be as elaborate as the scenario-based approach, it remains the most common type of guidebook used in most museums. The basic information of using the audio-visual guidebooks (i.e., if the visitors with audio-visual guidebooks are more engaged with exhibits than the visitors without such devices, if audio-visual guidebooks are helpful for guiding visitors' visiting path, or the difference between the behavior patterns of visitors with and without guidebooks) will be of great help for further design and use of similar devices in museums. The second limitation is that most of the studies mentioned above adopted observation and interviews in their research methodologies. Anecdotal records were used to describe the visitors' behaviors and attitude toward the mobile guide systems. Although these methods might offer feedback to the designs of mobile guidebooks, they provide little evidence for understanding the concrete effects of the guide systems on visitors.

To bridge the research gap and to explore the effect of audio-visual guidebooks, the first objective of this study was to investigate if an audio-visual guidebook, designed by the researchers in this study, would be beneficial to a visitor's engagement with exhibits; in other words, if those visitors would spend a longer period of time observing the exhibits compared to those without the guidebooks. The second objective of this study was to explore if the audio-visual guidebook would be helpful for guiding visitors' visiting in a museum. To achieve this objective, this study investigated if the visitors with the audio-visual guidebooks would demonstrate a more directional and structural pattern of visiting behaviors than those without the guidebooks. We also adopted a different methodology compared with that used in previous research. In this study, the mixed method approach was employed to gather not only quantitative data (e.g., visitors' attention and holding time to each exhibit) but also qualitative data (e.g., visiting

process recorded in video tapes and interview data about visiting experiences) to obtain a more complete and comprehensive understanding of the effects of the mobile guidebook on museum learning.

2. Method

2.1 Participants

Forty-two college students (19 males and 23 females, average age of 20) were invited to visit the Tang Dynasty's Tri-Color Glazed Pottery exhibition at the National Museum of History (NMH) in Taiwan. These students voluntarily participated in the experiment. They were randomly assigned to two different visit modes, and each mode had 21 participants. The first visit mode (guided mode) was the experimental group in which the students used an electronic guidebook during their visit in the museum. The second visit mode (unguided mode) was a control group in which the students did not use any tools during their visit. Due to data loss during the experimental process, the analysis of the results was based on complete data from 35 participants: 19 in the experimental group (8 males and 11 females) and 16 in the control group (7 males and 9 females).

2.2 Design

This study adopted a concurrent triangulation design of mixed methodology (Creswell, Plano Clark, Gutmann, & Hanson, 2003). During the experiment, qualitative and quantitative data was concurrently gathered. For the quantitative data, this study collected the time each participant spent at every exhibit and each participant's frequency and sequence of visiting behaviors. The visiting behaviors were transcribed and categorized by the coding scheme developed by the researchers (details in next section). These categorized visiting behavioral frequencies and sequences were subsequently analyzed by lag sequential analyses (Bakeman & Gottman, 1997; Erkens, Kanselaar, Prangsma, & Jaspers, 2003) to determine the differences in the behavioral patterns of the two visit modes. For the qualitative data, the researchers conducted interviews at the final stage of the experiment. The content of the interviews was recorded and transcribed. The transcribed data was also categorized and coded, and several themes were then identified. The themes also were used as supporting evidence for the quantitative analyses.

2.3 Procedure

The experiment took place in the Tang tri-color glazed pottery exhibition at the National Museum of History (NMH) in Taiwan. There were 61 objects in the exhibition room. The duration of the whole experiment ranged from 40 to 70 minutes (depending on the visitors' pace): 10 minutes for orientation, 10 to 40 minutes for visiting the exhibition, and 20 minutes for interviews. No time limits were imposed on the visitors during any portion of the study. During orientation, the visitors received brief instruction from research associates about the use of the electronic guidebook. They were also introduced to the devices that would be used during the experiment (including headphones, and tablet PCs, and spy cameras). The participants were told that the research associates would answer any questions about the use of the device if needed. For each visitor, the following data were videotaped or recorded: the path taken through the exhibition, visiting behaviors in different categories, and the time spent on each exhibit. The participants were allowed to end visiting the exhibition at any time they thought they had finished viewing the exhibits. Throughout the visit to the exhibition, the experimental group used the guidebook, whereas the free-visit mode was asked to visit the exhibition without any supplemental tools except the spy video camera.

2.4 Experimental Tools

2.4.1 Tablet PCs

During the visiting, each participant in the experimental group used a tablet PC (Acer TravelMate C110) and a headset. The guide system was loaded onto the tablet PCs.

2.4.2 The electronic guide system

The guide system provided both audio and visual outputs to the users. The visitors had the options of either seeing a picture coupled with a text description of an object or hearing an audio clip with identical content read by a male voice. While observing visual characteristics of the exhibits, the participants could listen to the audio descriptions at the same time. In the guide system, the homepage was the map of the exhibition room (see Figure 1). The map was drawn according to the layout of the actual exhibits in the exhibition room, with the numbers representing the exhibit numbers. All the operations in the guidebook could be performed by clicking with the EMR (electromagnetic resonance) stylus. After clicking on an exhibit number, the system would open a page providing the relevant information of the exhibit (See Figure 2). The guide system contained background information on 20 exhibits and gave the users information such as the photos, years, feature description, and cultural context of the exhibits. The visitors' actions in the electronic guidebook were also logged by the system database. The information of the exhibits was provided by NMH.

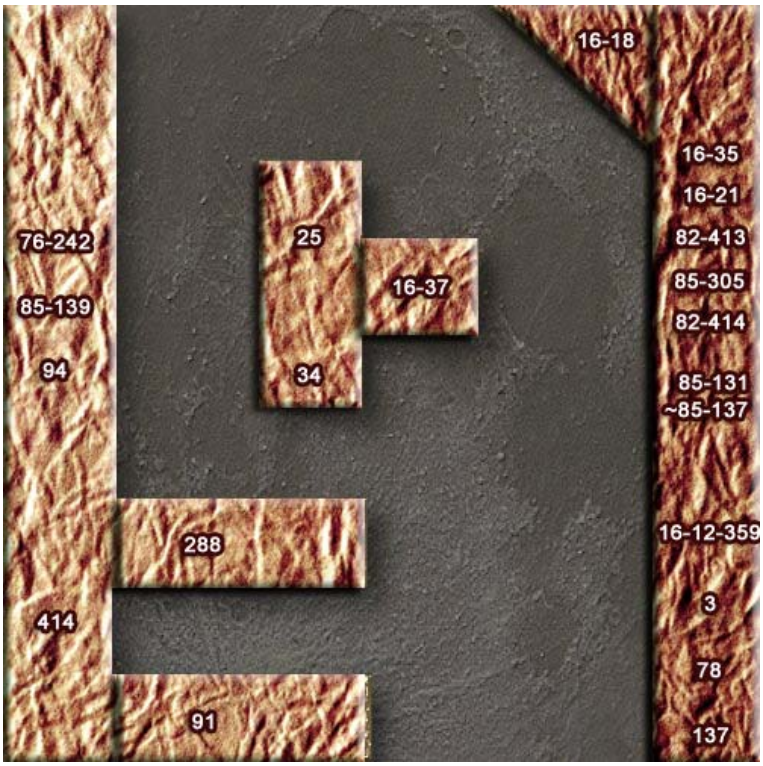

Figure 1. The exhibition map in the mobile guide system

2.4.3 Spy video camera

During the visit, all participants were asked to wear a spy video camera, which was attached to the front edge of a cap worn by the participants during their visit. The lens of the video camera was adjusted to each participant's eye level so that the researchers were able to see what the participants saw, and therefore were able to precisely code the participants' behaviors. This spy camera was a color video camera with 290000 pixels and a maximum wireless transmission range of 500 meters, which covered the entire experiment site. The spy camera recorded all the objects, people, sounds, and movements during the visiting process. The recorded data included the duration each student spent visiting the exhibition, each student's visiting behavior sequence, and the duration of each behavior. A sample photograph of the experimental tools is shown in Figure 3.

Figure 2. The description page of an exhibit

Figure 3. The experimental tools

2.4.4 Semi-structured interview

Every participant was interviewed immediately following their visit. This semi-structured interview was intended to elicit spontaneous responses, and the interview questions were aimed at understanding the students' feedback about the experiment and their visit experience. The interviews did not press each visitor for a direct answer. The interviews were recorded by sound recorders. Sample questions of the interview are included in Appendix A.

2.4.5 Coding Schemes

Using the spy video camera, the participants' visiting behavioral sequences and duration were recorded and transcribed. Figure 4 shows a sample participant's behavioral sequences after it was transcribed into a Microsoft Excel file. Each participant's video was viewed and coded using the coding scheme constructed by the researchers.

From the videos, all behaviors observed could be coded into one of the five categories including staring at an exhibit (S), browsing exhibits (B), referencing (R), walking (W), and other behaviors (O). When a participant stopped walking and observed a single exhibit for more than two seconds, this behavior was coded as staring at an exhibit. The definition of browsing exhibits meant the visitor was looking at a series of exhibits without stopping to look at a single exhibit for more than one second. Referencing was defined as when the participants lowered their heads and used the tablet PCs or read the description boards hung on the wall in the exhibition room. When a participant moved from one point to another without looking at any specific exhibit, using the computer, or reading the description boards, the behavior was categorized as walking behavior. Any other behavior that could be observed in the videos but could not be categorized to any of the above codes would be coded as other behaviors. Examples included looking at other visitors in the same exhibition room, talking to the research associates, or looking around and searching for directions.

Microsoft Excel - Case1.xls

檔案(F) 編輯(E) 檢視(V) 插入(I) 格式(O) 工具(T) 資料(D) 視窗(W) 說明(H) Adobe PDF 輸入需要解答的問題

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	A	B	C	D	E	F	G	H	I
1	Timeline	Behaviors	Exhibit number	Duration(sec.)					
2	15:08:10	(B)Browsing		8					
3	15:08:18	(R)Referencing		2					
4	15:08:20	(W)Walking		10					
5	15:08:30	(R)Referencing		16					
6	15:08:46	(W)Walking		1					
7	15:08:47	(B)Browsing		6					
8	15:08:53	(R)Referencing		38					
9	15:09:31	(S)Staring at an exhibit	288	8					
10	15:09:39	(R)Referencing		3					
11	15:09:42	(W)Walking		4					
12	15:09:46	(S)Staring at an exhibit	34	2					
13	15:09:48	(R)Referencing		14					
14	15:10:02	(B)Browsing		2					
15	15:10:04	(R)Referencing		14					
16	15:10:18	(B)Browsing		5					
17	15:10:23	(S)Staring at an exhibit	25	4					
18	15:10:27	(R)Referencing		30					
19	15:10:57	(S)Staring at an exhibit	76-242	16					
20	15:11:13	(R)Referencing		3					
21	15:11:16	(S)Staring at an exhibit	76-242	4					
22	15:11:20	(B)Browsing		2					

Figure 4. A participants' behavioral sequence

3. Results

3.1 The Effects on the Visitors' Attention

From the 61 exhibits of the exhibition, only 20 of them were selected and incorporated into the electronic guidebook to provide further information about the exhibits. Using this classification scheme, this study was able to distinguish how the participants' interaction with these two groups of exhibits differed (20 guided exhibits vs. 41 unguided exhibits).

To determine the effects of the electronic guidebook on facilitating the interaction between the participants and the exhibits, this study focused on how long each participant spent visiting the exhibits. The spy video cameras recorded each participant's behavior of "staring at an exhibit" and the duration. By summing up the duration of all "staring at an exhibit" behavior displayed by a participant, this study was able to calculate the total time each participant spent staring at the exhibits in the two groups (guided exhibits and unguided exhibits). Table 1 shows that the experimental group spent a longer time visiting the exhibits (M=387.48 sec. for the experimental group and 150.16 sec. for the control group). The participants in the electronic guide mode spent an average of 232 seconds on visiting the guided exhibits and an average of 155 seconds on unguided exhibits. On the other hand, the participants of the free visiting mode spent only on average of 70 and 81 seconds on visiting the guided and unguided exhibits, respectively, much shorter than the experimental group. The Mann-Whitney U test indicated that there were significant differences between the two groups ($z= -3.22$, $p < .05$ in the 20 guided exhibits; $z= -2.97$, $p < .05$ in the 41 un-guided exhibits).

Table 1. Staring Time to the Exhibits

	Experimental (N=19)		Control (N=16)	
	M	*SD*	*M*	*SD*
Staring time to the 20[a] exhibits (sec.)	232.15	120.02	69.66	24.43
Staring time to the 41[b] exhibits (sec.)	155.32	66.45	80.50	25.08
Staring time to the 61 exhibits (sec.)	387.48	152.36	150.16	44.32
Total Visiting Time (sec.)	1355	275.03	684.80	121.89

[a]Guided exhibits
[b]Unguided exhibits

3.2 Visiting Behavior Patterns

To determine whether the audio-visual guidebook has triggered different visiting behaviors in museums, this study collected and coded five categories of visitor behavior, staring at an exhibit (S), browsing exhibits (B), referencing (R), walking (W), and other behaviors (O). The behaviors were coded and listed sequentially, as shown in Figure 4. We collected 3,634 and 1,151 behavior codes from the experimental and control groups, respectively, during the experimental period. The results are shown in Tables 2 and 3, and we used lag sequential analyses (Bakeman & Gottman, 1997; Erkens et al., 2003) to analyze the sequences of visitors' behaviors.

Table 2. Frequency Transition Table of the Experimental Group

	B	O	R	S	W	Total
B	4	36	308	214	30	592
O	33	9	87	42	24	195
R	326	92	223	702	62	1405
S	204	55	690	290	42	1281
W	40	7	70	44	0	161
Total	607	199	1378	1292	158	3634

The purpose of a sequential analysis is to observe the pattern of a certain behavior occurring immediately after another behavior had taken place. Therefore, the researchers compiled statistics of the frequencies of certain behaviors occurring immediately after other behaviors. The types of codes listed in the rows are the "starting behaviors," and the codes listed in the columns are the "subsequent behaviors" immediately following the starting behavior. The frequency values in the table are the total number of times a certain starting-behavior occurred right

after a subsequent behavior. Secondly, to test whether the continuities between behaviors was statistically significant, this study conducted a sequential analysis using the data listed in Tables 2 and 3, and the strength of the connection between the two behaviors are listed in Adjusted Residuals Tables (Table 4 and 5). In these tables, if a sequence's Z value is greater than +1.96, it means the level of continuity was statistically significant ($p < .05$), and a behavioral-transfer chart was then drawn based on this table.

Table 3. Frequency Transition Table of the Control Group

	B	O	R	S	W	Total
B	1	15	158	80	32	289
O	30	8	40	18	5	101
R	144	44	5	134	20	347
S	93	17	126	830	17	336
W	28	16	20	14	0	78
Total	296	100	349	329	77	1151

Table 4. Adjusted Residuals Table (Z-Scores) of the Experimental Group

	B	O	R	S	W
B	-11.40	0.75	6.66*	0.29	1.00
O	0.08	-0.54	1.60	-3.47	5.63*
R	9.72*	2.80*	-21.88	14.77*	0.19
S	-1.05	-2.79	14.31*	-11.97	-2.83
W	2.64*	-0.64	1.20	-1.83	-2.77

* $p<.05$

Table 5. Adjusted Residuals Table (Z-Scores) of the Control Group

	B	O	R	S	W
B	-11.28	-2.64	10.15*	-0.29	4.21*
O	0.85	-0.29	1.84	-2.23	-0.65
R	8.26*	3.59*	-14.02	4.97*	-0.72
S	0.97	-3.21	3.34*	-1.92	-1.42
W	1.89	3.79	-0.82	-1.90	-2.42

* $p<.05$

Figure 5 and Figure 6 show the behavioral transfer diagrams of the two visit modes. From the figures, we can see that there was a strong link between staring at an exhibit (S) and referencing (R) in the experimental group showing that the students using the electronic guidebook were more inquisitive when interacting with the exhibits. In contrast, the control group students displayed a stronger behavioral sequence between browsing exhibits (B) and referencing (R) rather than staring at an exhibit (S) and referencing (R). These results indicate that the experimental group displayed more in-depth interaction to the exhibits by referencing the guidebook, whereas the interaction of the control group with the exhibits only stayed on a surface level. Furthermore, the comparison between Figure6 and 7 shows that the visiting behavioral sequence of the experimental group was more directional and structured. For example, there is an obvious visiting sequence of O→W→(B→R→S)(the three behaviors form a cycle); while the sequence of the students without the guidebook was not as structured and directional. For example, though we still can find a behavior cycle of B→R→S, the connection between the behaviors is not as strong as that of the control group. Moreover, there is another behavior chain of B→W→O, which indicates that there is an obvious proportion of students who showed surface visiting behaviors bypassing most of the exhibits, then walked away from the exhibition. The results above indicate that an audio/visual guidebook was helpful for directing participant visiting behaviors and could promote a more engaging visiting process.

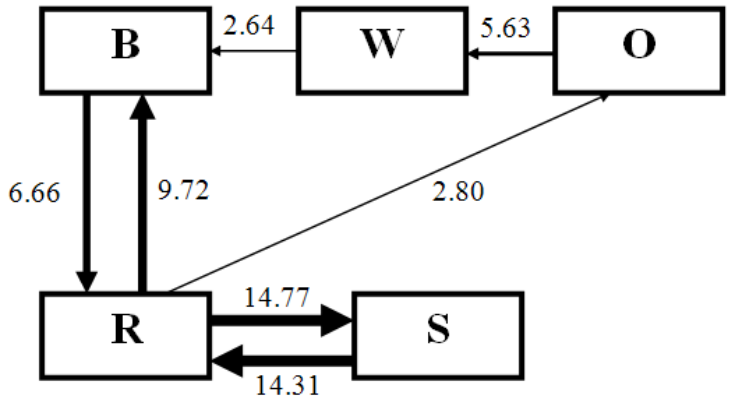

Figure 5. Behavioral transfer diagram of the experimental group

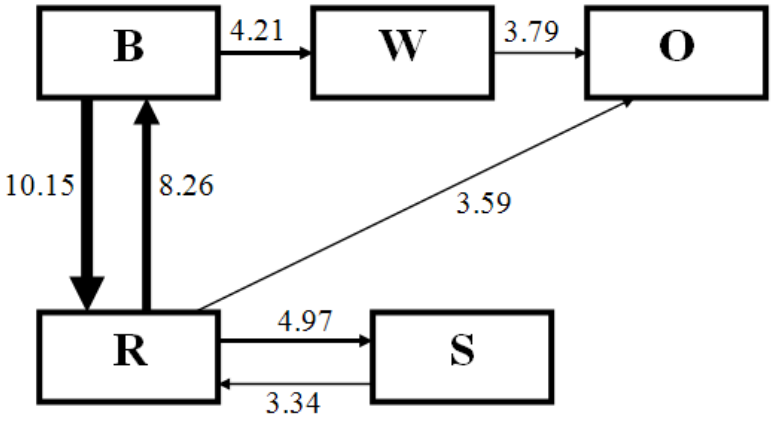

Figure 6. Behavioral transfer diagram of the control group

3.3 Themes Identified from Users' Feedback towards the Electronic Guidebook

The experimental group's interview data was transcribed. Then two rounds of review of the interview data were conducted. In the first round, one researcher reviewed the interview data and tried to identify the emergent themes. During the second round, another researcher along with the original researcher reviewed the interview data and identified the most common themes expressed by more than 50% of participants as the identified themes. Three themes were identified and reported as following.

3.3.1 Usefulness of the interface vs. feasibility of using the hardware

The participants had both positive and negative comments towards using the electronic guidebooks. One major negative comment expressed by several visitors was the weight of the tablet PCs and the complicated devices they had to put on during the experiment. In order to gather valid data, the participants were asked to wear a set of spy cameras (including a cap, a wireless transmitter, and the camera itself) and the electronic guidebook (including a tablet PC and a headset). Some participants discussed the feasibility of using such devices in museums:

> C: "The devices were too complicated. The weight of the computer was okay. But, I just felt a bit tired carrying them [devices] while I was visiting the exhibition. If the devices can be simplified or made lighter, I would be willing to use them."

W: “There was not much interaction between the computer and the users. Only audio and text information was provided. It was unnecessary to use such a big computer. It was a misuse of a good device for a minor purpose.”

Despite of the negative points discussed above, many participants also identified positive aspects of the content and design of the electronic guidebooks.

K: “When it [the NMH] uses computers, it’s more like introducing information. Last time, when I was visiting to another museum, they made it [the guide system] too fancy and the audio was very exaggerated. Although the audio clips used here were rather simple, I feel it’s easier to catch the main points.”

K: “I liked the audio clips. They were not too long. Most of us are not historians, so we might not want to examine the exhibits in such specific detail. During my previous visiting experience, many audio clips were too long. In many times, I often wanted to move on to the next item, but the clip was not finished, so I would have to wait for it.”

3.3.2 The visiting behavior patterns were influenced by the electronic guidebook

The previous section has indicated that the visitors with the guidebooks demonstrated a more structured and directional pattern of visiting than those who did not use the guidebooks. The map embedded in the guidebook, which served as a compass for visiting, was beneficial for visitors’ observation of the exhibits. For example, one participant who apparently had previous experiences with keypad-based audio guides mentioned that he liked the map selection mechanism of the electronic guidebook.

K: “Compared to keypad based [guide tools], it [the electronic guidebook] was more convenient. Using this [the electronic guidebook], I felt I was looking in the exhibition room directly. It was like following instructions as [the exhibits] was introduced one by one. It was quite systemized.”

W: “Unlike my previous experience, there was much more guidance this time. Compared to my own visit to museums without supplementary tools, I gained more knowledge. If the computer had more information, I would read every introduction pages.”

Another interesting finding is that though the guidebook helped visitors systematically interact with exhibits, their visit was not constrained by the guidebook. Instead, the visitors could autonomously choose their pace and path of visiting. For example, several participants valued being able to control the information retrieved from the guidebooks. Self-control allowed the visitors to construct experience with the desired balance of interaction with multiple entities (such as right amount and type of information from the guidebook and observation of the exhibits). Many participants said that they liked being able to control what the guidebook told them and the amount of information they received. As one visitor described his experience interacting to the electronic guidebook:

T: “When you visit an exhibition room…when there is a tour guide, he has to introduce the exhibits to a crowd of people at the same time. Then, you might not be able to hear what he said clearly. You might not want to follow his pace in visiting the exhibition. But, if I have a tool [electronic guidebook] like this, I can visit the exhibition by my own pace. It will be more interesting.”

3.3.3 Interacting with the exhibits through the guidebook

The most common comment the participants made about their visit to NMH was related to the interaction with the exhibits. The guidebook not only functioned as a role of docent, but it also engaged the visitors. The engaging functions of the guidebook were realized in two ways. Firstly, visitors with the guidebooks expressed that using the electronic guidebooks helped them to observe the exhibits in detail. In addition, the participants also mentioned that they visited more exhibits compared to their previous visiting experiences without using the electronic guidebooks. For example, three visitors shared their experiences:

C: “Because of the guidebook, my impression about the exhibits was more profound. I would select more [exhibits].”

K: “In many museums, when there is not much introduction, people might feel isolated. They don’t know what to look at, or only glance at the exhibits. Using the electronic guidebook, I would observe the exhibits in details. For example, there was an inkstone. I looked very closely. I even squatted down to take a closer look at the object.”

S: “I have been here before, but I gave only passing glances to exhibits. I just simply looked to see if the exhibits were pretty. I wouldn’t pay extra attention to see what the functions of the exhibits were and what meaning they represented. In today’s visit with explanation, I could understand what the exhibits were. Although I still didn’t really understand everything, but I got a better picture about the exhibits.”

The above statements illustrate one major reason why the visitors with the guidebooks demonstrated a stronger link between the behavior of staring at an exhibit (S) and referencing the guidebook (R). That is, when provided with appropriate information, visitors may be more willing to explore the nature of exhibits. As a result, the visitor, the information device, and the exhibits showed a more intense and closer pattern of interaction.

4. Discussion

This study was aimed at investigating how audio-visual guide systems alter visitors’ experiences in museums. The purpose was to examine the influence of the mobile electronic guidebook on visitors’ attention to the exhibits and visiting behavior. To achieve this goal, this study designated two different treatment groups. Regarding to the goal of investigating visitors’ attention, this study found that the visitors with the electronic guidebooks spent more time visiting the exhibits versus the visitors who did not use any supplementary tools during their visit to the exhibition of Tang Dynasty’s Tri-Color Glazed Pottery in the National Museum of History in Taiwan. This result demonstrates that using the audio-visual guidebook increases the visitors’ motivation to interact with the exhibits.

Scenario-based guide systems were generally considered a more effective tool, compared with audio-visual guidebooks, in facilitating visitors’ learning motivation to exhibits in museums. Due to this assumption, many previous studies conducted experiments to examine applications of scenario-based guide systems on visitors’ visiting behavior and attention to exhibits (Klopfer et al., 205; Sung et al., in press; Woodruff et al, 2002; Yatani et al, 2004). Though positive results were reported from these studies, investigation into audio-visual guidebooks, the most common type of guidebook applications in many museums, has been rather insufficient. The current research is helpful in bridging this research gap.

In regard to learning motivation, researchers have attempted to identify important factors that would influence learners’ motivation. According to Hidi and Baird (1986), if an article aims to be interesting and easy to be remembered, the content has to include surprising messages, goal-directed activities, and parts that can relate to readers. In addition, Anderson, Shirey, Wilson, and Fielding (1987) also proposed that situated interest, such as novelty, character identification, and life themes played significant roles in motivating learning. These aforementioned characteristics are often associated with affection factors which evoke readers’ emotions of being surprised, fresh, curious, and touched while they are reading the article. However, Kintsch (1980) argued that simply using these characteristics to stimulate learners’ emotional arousal might not enhance learning. On the other hand, if learners, after reading, are able to use the article content to find an appropriate position in their own knowledge structure, then they can acquire comprehension which might help the readers gain more interest. Kintsch called this type of interest “cognitive interest.”

To promote cognitive interest in museums, one can design a guide system which incorporates adjuncts such as abstract information about exhibits, outlines of exhibitions, or pictures to assist visitors in attaining deeper understanding about the exhibition being visited. By providing these adjuncts to visitors, electronic guidebooks will not only be able to increase visitors’ interaction with exhibits, but also will be able to facilitate the visitors’ cognitive interest- that is, by providing visitors with such an adjunct, they had the opportunity to explore related aspects of the exhibits. The electronic guidebook served as a referencing tool to stimulate the visitors’ cognitive interest. This might be the reason why visitors using the electronic guidebooks were more willing to interact with more exhibits for a longer time. They also displayed a more directional and structured visiting behavior patterns than those who did not use any supplementary tools. Moreover, the qualitative data of the interviews also corresponds to the findings of the

quantitative results. In the semi-structured interviews, the majority of the participants reported that, under the assistance of the electronic guidebook, they were better motivated and their learning was enhanced as well. Instead of surface browsing the exhibits, like most free visiting participants did, they were more engaged in their interaction with the exhibits.

5. Conclusion

Museums are important settings for informal learning. Due to limited human resources, mobile guide systems will play more significant roles in enhancing visitors' learning and visiting experiences in museums. Our study showed that although audio-visual guidebooks might not offer as many fancy functions as scenario-based guide systems, they still are effective in their initial application in a history museum. The findings indicated that the electronic guidebook may enhance visitors' attention and stimulate more inquisitive behaviors to the exhibits. Furthermore, we also provide concrete evidence that visitor's behavior patterns may become more directional and consistent with such assistance. On the other hand, this study has also stimulated some further concerns for designing a guidebook. For example, some participants complained about the weight of the tablet PCs. Thus, our future goal is to incorporate the guide system into a lighter device (such as PDAs). Another research concern has also arisen from the discussion of the experimental results. While organizing the feedback from the interviews, we found that most of the participants were first-time visitors to NHM. We wonder if this would be a factor influencing the visitors' motivation to use the electronic guidebook or to interact to the exhibits. Would previous visiting experience impact the behavior patterns of using electronic guidebooks? If so, what kind of information should be incorporated into the device for the visitors with prior experience or knowledge? Answering these questions will be helpful in attaining a more insightful understanding for designing a significant guidebook for enhancing museum learning.

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Appendix A

Sample Questions in Semi-Structured Interview

1. How would you describe today's visiting experience? How did you feel about it?
2. Compared to your previous visiting experience in other museums, did you learn more knowledge about the theme of the exhibition?
3. Compared to your previous visiting experience without using an electronic guidebook, did the electronic guidebook stimulate more learning motivation?
4. Compared to your previous visiting experience in other museums, did you visit more exhibits?