

A Self-Made Personal Explanation Aid for Museum Visitors

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Abstract—Explanation of museum exhibits must give useful and adequate information to museum visitors. However, good explanation costs a lot and is hard to be maintained by museum curators. This is the case with voice and/or video guidance, or smartphone applications. To cope with the issue, this paper proposes a novel personal support aid: Stamp-On Developers Toolkit (Stamp-On/DT) for visitors, developed by the visitors themselves. Stamp-On/DT consists of smart devices with explanation contents and 'stamp' devices attached to corresponding exhibits. The unique features of Stamp-On/DT are summarized as follows: (1) the digital contents of the corresponding explanation can be created by both visitors and curators, (2) the contents are easily described with conventional web tools such as HTML, CSS, or Java script, and (3) users are only required to save exhibited images in the same exhibited location with the same names. To validate the effectiveness of Stamp-On/DT system, we have conducted a workshop in a museum to let visitors create digital contents and then we have evaluated their performance.. From the workshop experiments, we conclude that Stamp-On/DT is an effective, easy and interesting aid in understanding museum exhibits.

Keywords- *tangible user interface; digital content; museum explanation*

I. INTRODUCTION

The purpose of museums is to collect, store, and educate people with different exhibits. In recent years, lifelong learning has become active and schools have created comprehensive classes. Therefore, demand for education in museums is increasing. With regard to the opportunity for visitors to learn about museum exhibitions, digital exhibition support systems and experiential exhibitions have increased. We have surveyed to identify the expectation of curators

from museum visitors. The participants of the survey have indicated that they hope for visitors to have interests in the exhibits, to observe the exhibits more comprehensively, and to feel familiar with the exhibits. Because most visitors often enjoy video games, museum exhibition support systems are required to be both interesting and enjoyable for visitors so that they can engage in observing the exhibits.

Based on such background, in this paper we propose a novel personal support aid: Stamp-On Developers Toolkit (Stamp-On/DT) for visitors, developed by the visitors themselves. The rest of the paper is organized as follows: In Section II, we present a literature survey to highlight the current problems; In Section III, we describe the system configuration and functions of the proposed system; In Section IV, we explain the usage of Stamp-On/DT; In Sections V and VI, in order to validate the effectiveness of Stamp-On/DT, we carry out workshop experiments, then give the findings and discussions; Finally, Section VII concludes the paper.

II. LITERATURE REVIEW

A. Study on Museum Exhibit Explanations

There are many studies on digital explanations for museum exhibits aimed at people accustomed to interactive stimuli, such as video games [1][2][3][4][5][6][7][8].

Such digital explanations have the same structure as video games. If visitors stand in front of a given exhibit, the digital explanation starts. There are interactive elements to push buttons for more details, but in general, visitors watch the exhibit passively. Experts on exhibits system developments (system experts) are responsible for creating such digital content. Therefore, to fix and/or modify these digital contents, hard work from system experts is required.

B. Authoring Tool for Museum Exhibit Explanation

Koleva et al. [9] developed an authoring tool that curators are able to use to connect 3D digital content and sounds for exhibits with a visual programming language. Even with this tool, however, system experts must prepare the 3D parts in advance. Roussou et al. [10] made a website to be used for museum learning, in which they use the pictures drawn by eleven years old children. In Roussou et al.'s study, they report that children made a paper prototype for the web contents. However, finally, a professional web designer created the actual website. Also they reported that the children's pictures required much time to digitize.

C. Digital Education Tools in Museums

Many museums, including the British Museum and the Louvre, have a digital presence on the Internet. People can watch exhibits remotely [11][12]. On the other hand, Google created a virtual museum for access on the Web in cooperation with different museums, including the National Museum of Western Art [13]. In addition to the Web, museum-display-support applications such as 'Tohaku Navi' [14] and 'e-Museum' [15] are employed. People can confirm the availability of certain exhibitions before visiting a given museum. Okumoto et al. [16] described that watching images and exhibit commentary on the Web before attending a museum was more effective for visitors than using the museum exhibit support system without watching the online commentary prior to visiting the museum. However, it is difficult for all visitors to learn information about exhibits in advance from a museum website. Furthermore, Okumoto et al. indicated that visitors only watched museum exhibits briefly because visitors were preoccupied with awareness of digital content.

D. Summary of the Survey and Research Statements

Currently, experts are required to make digital exhibition support systems. If only experts create the content, there is a limitation in that modifying existing content or adding new content requires considerable time. Although digital exhibition commentary has a level of interactivity because visitors can press a button, visitors mostly watch the exhibition support system passively. There is also a limitation in that visitors observe digital content more closely than the actual exhibits. Therefore, we believe that museum support systems require a mechanism that can help visitors interact more actively with museum exhibits.

From the literature survey, in an exhibition support system, the roles of visitors are considered very low. However, we believe digital contents should be generated by visitors themselves. It can be attained if the contents are easily developed and modified. Furthermore, if visitors are familiar with interactive video games, they are able to enjoy such digital contents interactively. In this paper, we would like to validate such visitor behaviors.

III. SYSTEM CONFIGURATION AND FUNCTIONS OF STAMP-ON/DT

Stamp-On/DT system is an extension of Stamp-On exhibition support tool [16]. The system configuration and functions are, thus, almost the same we have already reported. Based on the previous paper, we explain the outline.

A. Hardware

The Stamp-On/DT system hardware is composed of a Nexus 7 tablet, stamp, scanner, special paper, and stationary (Figure. 1).

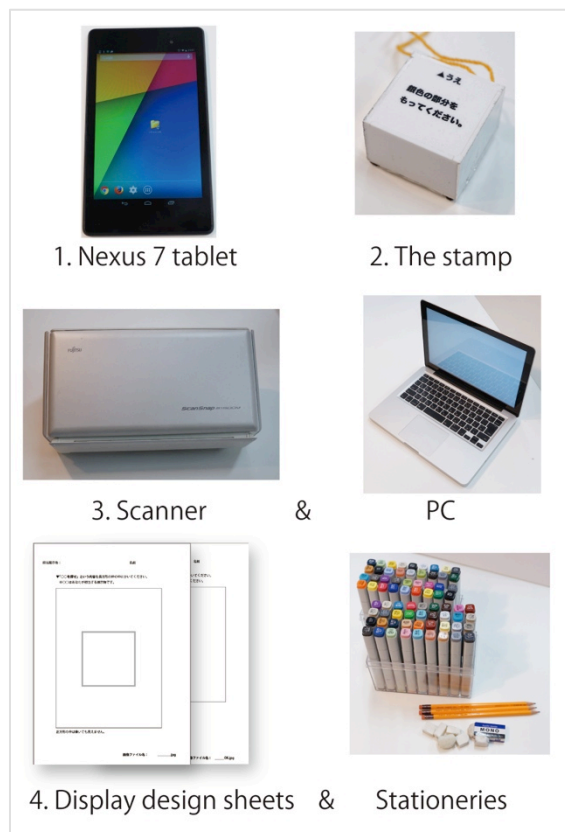


Figure 1. Stamp-On/DT system hardware.

1) Nexus 7 tablet: We need Chrome browser equipped on Nexus 7 tablet: Chrome. However, devices which satisfy the following conditions also run Stamp-On/DT systems:

- a) Device with a multi-touch screen, which is used to detect four or more point coordinates.
- b) Browser with JavaScript-compatible software.

2) The stamp: Aluminium tape is pasted on a stamp from the bottom of the stamp to the side of the stamp. The stamp has dot patterns on the bottom (Figure 2), on which the stamp has four convex points. When visitors press the Nexus 7 tablet with the stamp, the tablet reads the dot patterns of the bottom. Each of the stamp pattern identifies the corresponding information attached on the pattern. The

corresponding digital contents will change through this pattern (Figure. 3).

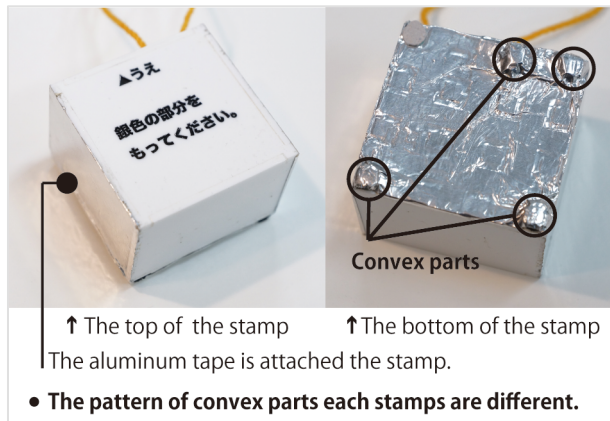


Figure 2. Stamp interface.

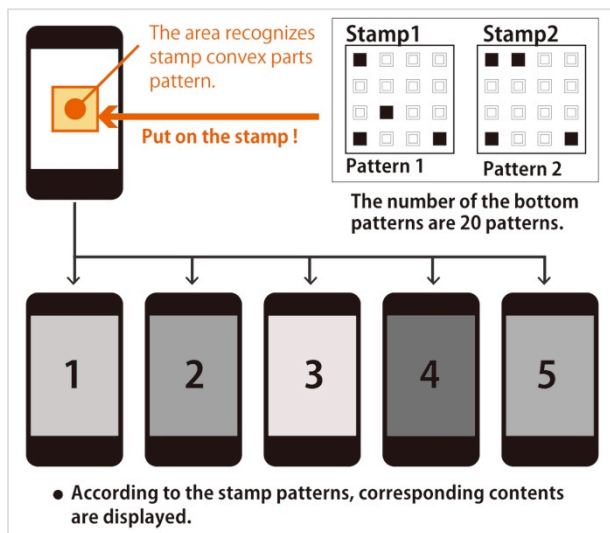


Figure 3. Mechanism to switch digital content.

3) PC and Scanner: A PC and a scanner are required in order to digitize the paper on which visitors write some information on the exhibited items in the form of a single quiz. After the sheet with the quiz is scanned and converted to an image file (jpg format), a support staff will cut unnecessary portions using an image processing software then save the file.

4) Display design sheets and stationeries: To convert digital data, the sheet pre-prints i) a frame in the same screen ratio as the Nexus 7 screen and ii) an area to press the stamp (Figure. 3). Stationeries are used by visitors to write the text and / or to draw the picture to be used.

B. Software

The software used for the proposed system is written in HTML, CSS, and JavaScript. The image file URLs are written in the HTML source file in advance. A new image file is displayed when the image file in the image folder is

overwritten. First, visitors bring their paper with the exhibit quiz and commentary to museum staff. Second, the staff overwrites the image file in the specified folder by scanning with the scanner and PC. Finally, the digital content is completed when the staff copies the folder to the Nexus 7 tablet. (If the PC and the Nexus 7 are connected to a web server, the folder is only required to be uploaded.)

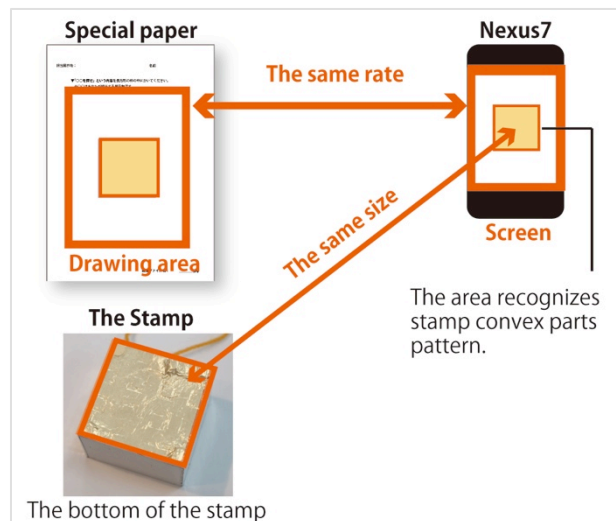


Figure 4. Method for digitizing paper on which visitors draw illustrations for museum exhibits. Method for uploading to Nexus 7 tablet.

IV. USAGE OF STAMP-ON/DT SYSTEM

Visitors who would like to use Stamp-On/DT are required to perform the following two tasks:

- 1) To create digital contents (Figure. 5).
- 2) To play with the digital contents (Figure. 6).

A. Task of the Content Creation Phase

At the first task, visitors are required to follow the steps:

- 1) Make a quiz regarding a given museum exhibit.
- 2) Learn about the exhibit while taking notes.
- 3) Write a quiz related to the exhibition on the sheet with texts and/or illustrations.
- 4) Scan the sheet then put them into the PC.
- 5) Put image files to HTML pages.
- 6) Transfer the image files and HTML files to Nexus7.

B. Task of the Playing Phase

At the second task, visitors are required to follow the steps:

- 1) Place a stamp in front of the museum exhibits.
- 2) Display the question on the screen of Nexus7.
- 3) Look for the answer stamp in front of the exhibits.
- 4) Put the stamp on screen of Nexus7 tablet.
- 5) Display corresponding contents according to the patterns of the stamp.
- 6) Display a correct or wrong image. If visitors choose a wrong answer, Nexus 7 displays 'try again'. If visitors choose a correct answer, Nexus7 displays the commentary image which visitors drew.

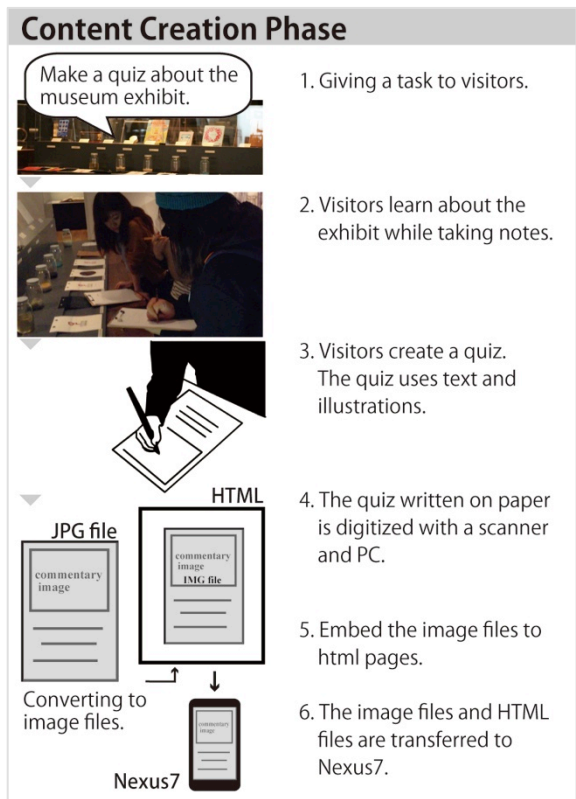


Figure 5. Content Creation Phase.

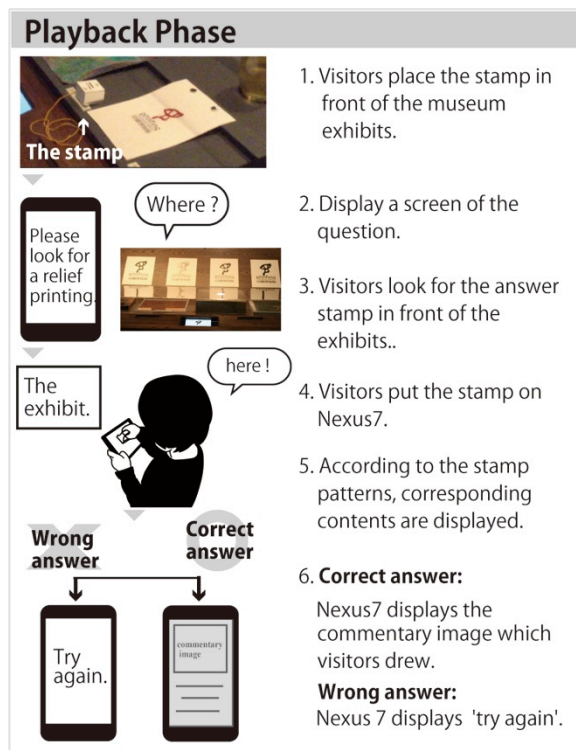


Figure 6. Playback Phase.

V. EXPERIMENT OF STAMP-ON/DT SYSTEM

A. Design of WorkShop

To evaluate the effectiveness of Stamp-ON/DT, we have organized a workshop in a museum where visitors were able to observe and enjoy the exhibits actively. Visitors to the workshop were instructed to create digital content to explain the museum exhibits.

When visitors create digital contents, we expect them to show the following behavior:

- Visitors will watch the exhibit more carefully than usual.
- Because visitors are required to create a sheet that explains the exhibit, they need to arrange exhibit information in a header and collect it. Therefore, visitors will understand the exhibit more comprehensively than usual.

B. Experimental Environment

We conducted an experiment to evaluate our system at the Printing Museum in Tokyo, on Saturday, September 27, 2014. The participants were nine female college students, and none of the participants had seen the exhibits previously.

Three days before the experiment, we trained two students for thirty minutes to assist with the activities of the participants to support digitizing, resizing, and saving the information collected during the experiments. Consequently, on the day of the experiment, the participants had no trouble because of the help provided by the student staff members.

Before the experimental workshop, all participants expressed an interest in printing and enjoyed drawing pictures. We divided the students into two groups (four and five people in each group), and the groups were labeled as Group A and Group B.

For both groups, the required task was to create several quizzes regarding the exhibition after observing their assigned exhibits (Figure. 7, Figure. 8). Each person was assigned one of two different exhibits randomly.

After a pre-test, Group A started to create digital contents immediately. On the other hand, after the pre-test, Group B observed the exhibits as usual and required to answer a mid-test. After the mid-test, Group B was required to start to create the corresponding digital contents. As indicated in Table 1, we gave the pre- and post-test to Group A as follows:

- T1. pre-test: the participants answered the test without seeing the exhibits in the museum in advance.
- T3. post-test: the participants answer the test after using the Stamp-On/DT system.

As indicated in Table 6, to Group B, we gave pre-, mid- and post-tests as follows:

- T1. pre-test: the participants answered the test without seeing the exhibits in the museum in advance.
- T2. mid-test: the participants answered the test just after watching the exhibits as regular visitors.

- T3. post-test: the participants answer the test after using the Stamp-On/DT system.

TABLE I. FLOW OF THE EXPERIMENTS

Group A		
Time	Action	States
10min	Pre questionnaire	T1
1h45min	Digital content creation (Watch Exhibits and production)	
30min	Playing with the digital content they made	
10min	Post questionnaire	T3

Group B		
Time	Action	States
10min	Pre questionnaire	T1
20min	Watch as usual	
10min	Intermediate questionnaire	T2
70min	Digital content creation (Watch Exhibits and production)	
30min	Playing with the digital content they made	
10min	Post questionnaire	T3



Figure 7. Experiment participants who observed exhibits.



Figure 8. Subjects drawing picture for exhibit commentary.



Figure 9. Staff digitizing exhibition commentary sheet drawn by participants.

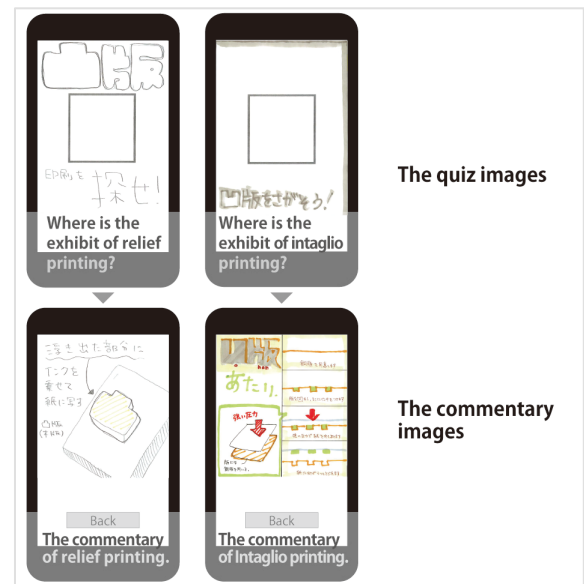


Figure 10. The pictures which subjects painted.

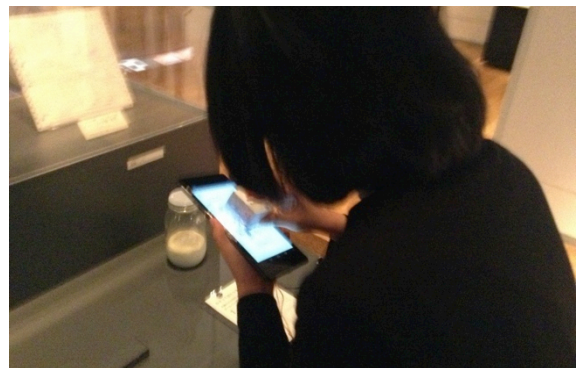


Figure 11. Subjects pressing stamp on Nexus 7 tablet.

C. The Objectives of the Evaluations

We specified the evaluation items of the experiments as follows:

- 1) How visitors learnt from the observations on exhibited items.

- Evaluate the difference in the observations and the learning effects of pre- and post-tests with Groups A and B between (T1) and (T3).
 - Evaluate the difference in the observations and the learning effects of pre-, mid-, and post-tests with Grope B among (T1), (T2), and (T3).
- 2) *How visitors enjoyed the experiences:*
- Evaluate how the visitors enjoyed the proposed systems through the questionnaire analyses.
 - Let visitors specify the enjoyable points of the proposed system through questionnaire analyses.

D. Evaluation Methods

We use the following methods to carry out the evaluation:

1) *Questionnaire Analysis*

a) *Viewing exhibits and learning effects: Multiple-choice and fill-in-the-blank questions were provided in order to determine how the participants learned from the exhibits. Group A answered two questionnaires, before and after the experiment. Group B answered three questionnaires: before, during, and after the experiment.*

For the post-test questionnaire, the participants answered five questions (Q1 to Q5) with five-grade relative estimation.

Q1 and Q2 are related to viewing the exhibits, and Q3, Q4, and Q5 are related to the enjoyability:

Q1. Did you observe the exhibit carefully?

Q2. After the experiment, did you become more careful in observing the general printed information familiar with you and your neighbours?

Q3. Was it interesting for you to make your own descriptions of the exhibited items?

Q4. Was it interesting for you to use the stamp interface?

Q5. Do you like to participate in another similar event, if we would provide the Stamp-On/DT system?

E. Interview

After the questionnaire sessions, we have made oral interview sessions against randomly selected participants.

1) *About viewing the exhibits: The interview consisted of the following questions: “Did you carefully observe the exhibits?”, ‘What were different points between your usual museum visits and this experimental observations on the museum exhibits?’, ‘What were different points between usual explanations of the exhibits and the digital contents you made?’*

2) *About enjoyment: The interview questions were as follows: ‘Was it interesting for you to play with Stamp-On?’, and ‘Was it fun to make your own digital contents?’*

VI. FINDINGS OF THE EXPERIMENT

A. Discussion of the Experiments

1) Questionnaire Survey Results.

The answers to the questionnaire survey for Groups A and B are summarized in Table 2. Table 2 depicts experimental results about pre- and post-tests. The sign

testing method is applied. The results suggest that there are statistical differences with the 95% reliability. To Group B, we apply the Freedman Testing to pre-, mid-, and post-testing. The results also suggest that there are statistical evidences (Table 3).

Table 4 summarizes the response distributions. Most participants responded positively to all questions. We investigated the response trends after separating the responses obtained from the questionnaire surveys into two groups: positive responses, including ‘completely agree’ and ‘agree’, and negative responses, including ‘somewhat disagree’ and ‘completely disagree’. Fisher’s exact tests (1×2) showed a statistical significance at 95% level for all items.

TABLE II. THE LEARNING EFFECT ON THE EXHIBIT

The fill-in-the-blank questions from related to the print.

Subjects No.	1	2	3	4	5	6	7	8	9
The pre-test (T1).	6	6	4	8	5	4	1	3	5
The post-test (T3).	15	14	16	18	13	10	8	9	7

p=0.003906, (p<.05). ↑ The number of correct answers
T1,T3 = states.

Four questions about the type of printing.

Subjects No.	1	2	3	4	5	6	7	8	9
The pre-test (T1).	1	0	1	0	0	0	1	0	2
The post-test (T3).	4	4	4	4	4	4	4	1	2

p=0.007812, (p<.05). ↑ The number of correct answers
T1,T3 = states.

TABLE III. ABOUT THE DIFFERENCES BETWEEN PRE-, MID-, AND POST-TESTING

The fill-in-the-blank questions from related to the print.

	The pre-test (T1).	The intermediate test (T2).	The post-test (T3).
SubjectsB1	6	8	15
SubjectsB2	6	10	14
SubjectsB3	4	6	16
SubjectsB4	8	9	18
SubjectsB5	5	10	13

Friedman chi-squared = 10, p=0.003906 (p<.05).
T1, T2, T3 = states.

Four questions about the type of printing.

	The pre-test (T1).	The intermediate test (T2).	The post-test (T3).
SubjectsB1	1	4	4
SubjectsB2	0	4	4
SubjectsB3	1	1	4
SubjectsB4	0	2	4
SubjectsB5	0	4	4

Friedman chi-squared = 8.375, p=0.01518 (p<.05).
T1, T2, T3 = states.

TABLE IV. RESULT OF OBSERVATION AND ENJOYABILITY

About Observation.	5	4	3	2	1
Q1. Do you think you carefully viewed the exhibit? **	3	5	1	0	0
Q2. Do you think that you tried to more carefully view a printed item that is more familiar to you? **	3	6	0	0	0

**p<.05, 5=completely agree, 1=completely disagree.

About enjoyability.	5	4	3	2	1
Q3. Do you think that it was fun for you to write a description of the exhibit? **	2	7	0	0	0
Q4. Did you think that it is fun to press a stamp? **	2	7	0	0	0
Q5. If there were another event of this type, do you think that you would want to participate? **	6	3	0	0	0

**p<.05, 5=completely agree, 1=completely disagree.

B. Results of Interview Survey

1) About viewing the exhibits.

- Participant A: I observed the exhibit carefully more than usual with the intention of preparing a quiz about it.
- Participant B: Commentary must be written to be easy to understand because it will immediately become the corresponding digital contents and will be shown to other participants. I observed the exhibit seriously to try to understand it properly in order to clearly make the contents.

2) Utterance of Enjoyable Aspects

- Participant A: I was impressed at the fact that just after making the quiz, it quickly became the corresponding digital content.
- Participant B: When I pressed the stamp, the immediate reactions the system made was quite interesting.
- Participant B: It was interesting to see the digital contents the other participants developed, because the contents gave me different others' perspectives on their focal points and explanations of the exhibits.

C. Summary and Discussion of Experiment Findings

Based on the questionnaire and interview results, the participants viewed exhibits more carefully with the proposed system than usual visits. All participants suggested that (i) it was pleasant to partake of the interview of the experiment, (ii) creating the digital content is much more interesting than making usual paper contents.

The experimental results have revealed that museum visitors would observe exhibits more carefully than usual visits, if the visitors could create quizzes about the exhibits. Furthermore, all participants have interests in the beautiful printing techniques, which curators of the museum usually use to make explanations of the exhibited items. Therefore, the participants have more interests in the various printings among them in the sense of color, styles, and materials.

When the nine participants used the Stamp-On/DT system at the same time, it was possible for them to produce 18 items of digital contents within 2 hours. These results have shown the superiority of the proposed system against prior digital contents research in the literature [10] on the points of the agility and non-professional support to produce the digital contents.

VII. CONCLUSIONS AND FUTURE CHALLENGES

This paper has described the design principles, functions, components, usages, and experiments on Stamp-On/DT system, which is a new extension of our Stamp-On [16]. Stamp-On/DT is a toolkit to let museum visitors develop digital contents. The unique features of Stamp-On/DT are summarized as follows: (1) the digital contents of the corresponding explanation can be created by both visitors and curators, (2) the contents are easily described with conventional web tools such as HTML, CSS or Java script, and (3) users are only required to save exhibited images in the same exhibited location with the same names. To validate the effectiveness of Stamp-On/DT system, we have conducted a workshop in a museum to let visitors create digital contents and to have their performance evaluated. From the workshop experiments, we conclude that Stamp-On/DT is an effective, easy and interesting aid in understanding museum exhibits.

From the experimental workshop, we have suggested that i) Stamp-On/DT system is successful to create digital contents in a short time without professional assistances; ii) the participants observed museum exhibits more carefully than usual, and iii) the learning effects on the exhibits observation was also attained.

The proposed system will be further enhanced so that more kinds of tablet devices other than a Nexus 7 can be used in the proposed system. Also, we will prepare manuals and videos, and improve the stamp shapes so that even naïve users can use the stamps.

The other future work includes 1) the improvement of stamp performance, 2) the introduction of the other kinds of hardware devices to assist the usage, and 3) the improvement of manufacture the stamp development.

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