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A STUDY ON COGNITION DESIGN IN INTERFACE USABILITY OF E-LEARNING WEBSITES

Jenn-Yang Lin
Department of Applied Arts and Design, NanHua University
design@mail.nhu.edu.tw

An-Sheng Lee
Department of Forest Products Science and Furniture Engineering, National Chiayi University
sheng1887@mail.ncyu.edu.tw

Chun-Wei Chen
Department of Industrial Design, National Cheng Chung University
willisnctu@gmail.com

H. H. (Buddy) Hooper Jr.
Department of Education Administration, Texas A&M University –Texarkana
buddy.hooper@tamut.edu

Abstract

This study aims to inspect cognition in interface usability of the e-Learning website of National Palace Museum (NPM). This study designs a questionnaire based on both structured and unstructured methods. Then, it invites experts to apply an unstructured heuristic evaluation to inspect interface usability. Finally, it collects opinions from the experts for a statistical analysis.

Substantial results of this study show that in the category of overall interface operation, “content descriptions through chapters and sections” is the most significant, showing that learning on SCORM™ platform is most influential to learners. In the category of visual communication design, “fonts” is the most significant, showing that word recognition is most influential to learners. The second most significant aspect is “pictures and animation". In the category of satisfaction with quality and service, “learning motive and attitude” is the most significant, showing that an active or passive attitude is affected by “content description through chapters and sections”, “navigator”, “technical issues”, and “colors”. Regarding this, the above-mentioned aspects affecting e-learning usability are proposed to interface designers as a reference for future planning and design of e-learning platforms.

Keywords: E-Learning, Usability, Heuristic Evaluation

Research Motive and Objective

Rapidly developing Internet, communication, and multimedia have brought a revolution to traditional learning methods and created an e-learning environment. In a world dominated by borderless learning and knowledge-based economy, learners really need to improve their competitiveness with the help of learning of various forms. E-Learning, which is based on Internet and information technology, provides more diverse and faster sources of knowledge. Moreover, it cuts educational costs, improves education quality and learning efficiency, and eventually achieves the goal of life-long learning.

Important e-Learning programs in effect in Taiwan are mainly initiated by the Ministry of Education, including "Learning Technology Programs of the Excellent Project" and "Standard Format for E-Learning Systems, Platforms, and Contents". Other related programs include "Taiwan E-Learning Program" by the National Science Council (NSC) and "E-Learning Park" by Institution for Information Industry. Led by these large scale programs, many schools and institutions have started planning e-Learning curriculum, making e-Learning a mainstream trend in the education community of Taiwan.

An interface is the part encountered by learners the most directly. A well or poorly designed interface is closely related to digital media usability, learners' enthusiasm, and learning effects. Therefore, it is usually a challenging task to integrate various teaching materials and learning management system (LMS), making reusing e-Learning materials or sharing teaching resources impossible or difficult.

In compliance to the e-Taiwan program in "Challenge 2008: Six-Year National Development Plan" promoted by the government, NPM has carried out three large scale

national programs, which are Taiwan E-Learning Program－National Palace Museum E-Learning, Taiwan Digital Archives Program－National Palace Museum Digital Archive Project, and Establishment and Value-added Program of National Palace Museum E-Learning. Among these programs, National Palace Museum E-Learning was initiated by NSC from 2003 to 2007. During this period, NSC established "demonstration of National Palace Museum e-Learning" in an attempt to set a museum e-learning model complying with international standards.

Course design of "NPM e-Learning" followed the widely recommended SCORM™ in domestic and overseas e-learning industries. SCORM™ is also known as sharable content object reference model. SCORM™ is characterized by its reusability of learning units. Learners can recombine teaching materials based on their needs and share materials on other SCORM™ based platforms, which helps to achieve the goal of saving costs.

Regarding this, this study has the following objectives:

1. Integrate essential evaluation guidelines for SCORM™ platforms.
2. Discuss influential aspects of an interface and select suitable functions for the e-Learning interface;
3. Provide a reference for the design of museum e-Learning interfaces and course interfaces.

Literature Review

E- Learning

E-learning is not a face-to-face type of learning; instead, it is an electric or computer-based interactive training opportunity. E-learning is a type of training that takes place through a network, such as the Internet or a company intranet. Harasim, Hiltz,

Teles, and Turoff (1995), Khan (1997), Porter (1997), and Windschitl (1998) described various forms of E-learning, such as virtual learning, online learning, distance learning, computer-assisted learning, and Web-based learning. Instructors have expressed considerable interest in blending several e-learning methods, especially synchronous and asynchronous learning, through the Web (Ravaglia, 2001). This is supported by the characteristics and resources of the Internet (Khan, 1997; Gillani & Relan, 1997) and is growing at a quick pace in universities across the country (Carr, 2000; Charp, 2002). Schrum (1998) spoke of the need for comprehensive, in-depth appraisals in the current study.

Rosenberg (2001) defined e-Learning as applying Internet technology to convey various digital contents in an attempt to gain knowledge and improve performance. E-Learning has three basic essentials.

1. E- learning is based on Internet: It updates, stores and accesses, conveys, and shares teaching materials or information in a real time manner;
2. E- learning applies computer and Internet technologies: It conveys digital courses to end users;
3. E- learning changes the ways of learning: It goes beyond traditional learning solutions.

E-Learning was a term firstly introduced by American scholar Jay Cross in 1999. “E” specifically stands for electronic, but it also speaks for the spirits of exploration, experience, engagement, excitement, empowerment, ease of use, and effective. American Society of Training and Education defines e-Learning as a learning method which conveys teaching materials or learning experiences through electronics technology. Electronics technology includes applications of computer based training, compact discs,

and various Internet applications. A more specific definition says that e-Learning is a process in which learners learn through digital media, including the Internet, enterprise networks, computers, satellite radio, tapes, videos, interactive televisions and compact discs. Its applications include Internet-based learning, computer-based learning, virtual classrooms, and digital cooperation (Zou, 2003).

SCORM™

SCORM™, also known as sharable content object reference model, was firstly introduced in the Advanced Distributed Learning Initiative by the United States Department of Defense. The purpose was to promote an international standard for e-Learning units which served as a guideline for designing and sharing reusable courses.

In Figure 1, learning objects in teaching materials are separated like building blocks and then regrouped into new courses. A common standard is essential to serve the purpose of combining learning objects smoothly.

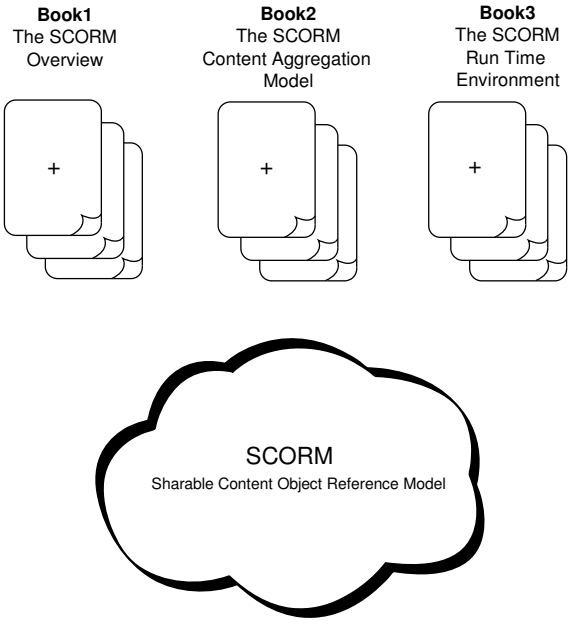

Figure 1. Configuration and Content of SCORM™

Cognitive Walkthrough

A cognitive walkthrough is an expert inspection of usability, and this process does not require user participation. This evaluation method tries to form a model for actions and opinions of the first interface use by an individual or a group of people.

Focus Group

A focus group is an analytical and evaluative diagnosis method which involves user participation. It is an informal evaluation applied to learn users' demands and perceptions before an interface is designed. In addition, it can learn the users' opinions after they use the interface for a period of time. It is one of the most frequently used methods in an exploratory research.

Questionnaires

Questionnaires and interviews are indirect inspection methods. Instead of directly examining a user interface, both methods review only users' opinions about using the interface. The questionnaire of this study aims to explore users' cognition in e-Learning website usability. The questionnaire applies principles of usability engineering to ensure that respondents comprehend questions correctly. However, a questionnaire may trouble users if it is too lengthy, difficult, or unprofessional (Nielsen, 1993).

Methodology

Prior to the formal research, a front-end research was conducted to select several representative e-Learning websites in effect through literature review and cognitive walkthrough. Members in a focus group then examined these websites and selected one

suitable for the study of e-Learning website usability. In this case, the focus group members selected NPM E-learning for case study. (http://elearning.npm.gov.tw).

Secondly, a questionnaire survey was designed based on structured and unstructured methods and then carried out a heuristic evaluation. Expert respondents were asked to operate the representative e-Learning websites and evaluate the usability of the interfaces based on their own expertise. Later, the experts' opinions were collected and analyzed for further planning and design of e-Learning platforms. Figure 2 shows the structure of this research.

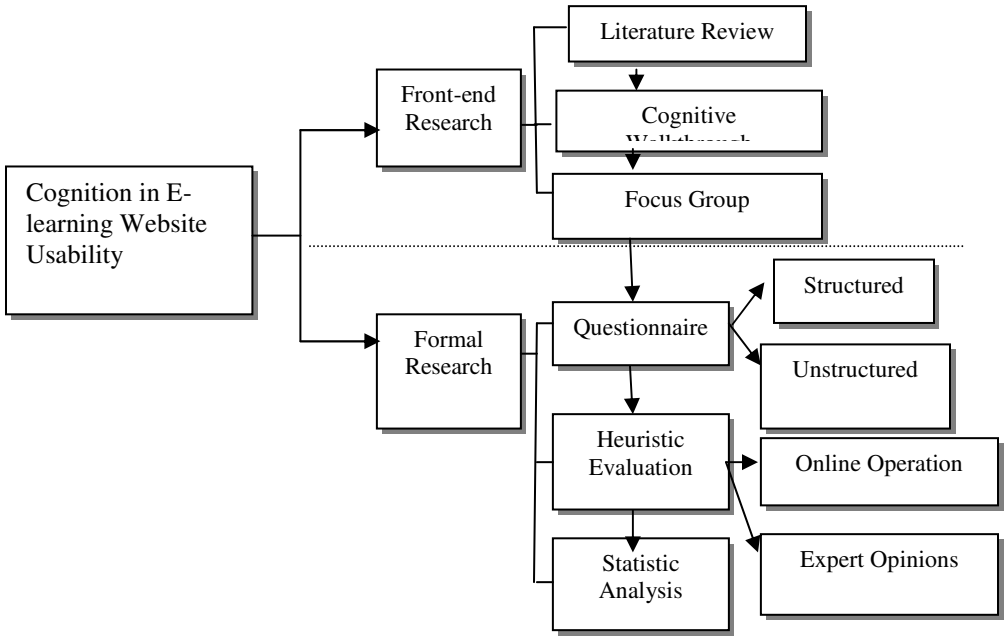

Figure 2. Research Structure

Front-end Research

At this stage, keywords like "e-Learning" and "SCORM" (See Figure 3 for the details) were searched on web-based search engines for entries about SCORM™ based e-Learning platforms. The research results included platforms of British Museum, Tate

Modern in London, Metropolitan Museum of Art in New York, and National Palace Museum in Taiwan. After discussion and selection, the focus group members chose NPM e-Learning for case study.

Related literature was reviewed, and a telephone interview was given to Mistress Huang Xiu –ling of the Department of Exhibition, NPM, in an attempt to gain an in-depth understanding of "target learners" and "course orientation" of NPM e-Learning. In the mean time, this study searched online for literature about museum e-Learning platforms. The results of the telephone interview are as follows: regarding that this was the first year for NPM e-Learning, NPM expected to promote the platform to as many learners as possible. Therefore, courses in Mandarin targeted adult learners, or more specifically, general adult learners with at least secondary educational level. Courses in English targeted foreign learners interested in bronze vessels. As for course direction, the courses about bronze vessels provided by NPM served the following functions both to adults and schools. First, it allowed learners to gain an understanding of bronze vessels prior to visiting NPM. Second, it helped learners in learning the art and history of Chinese bronze vessels. Third, it served as a complementary material for school teachers.

Formal Research

Due to geographical convenience, the questionnaire survey of interface was carried out on fifteen graduate students and doctoral candidates from the Department of Industrial Design, National Cheng Kung University (NCKU). Four experts were also invited to inspect the design and usability of the interface through heuristic evaluation. The details are as follows.

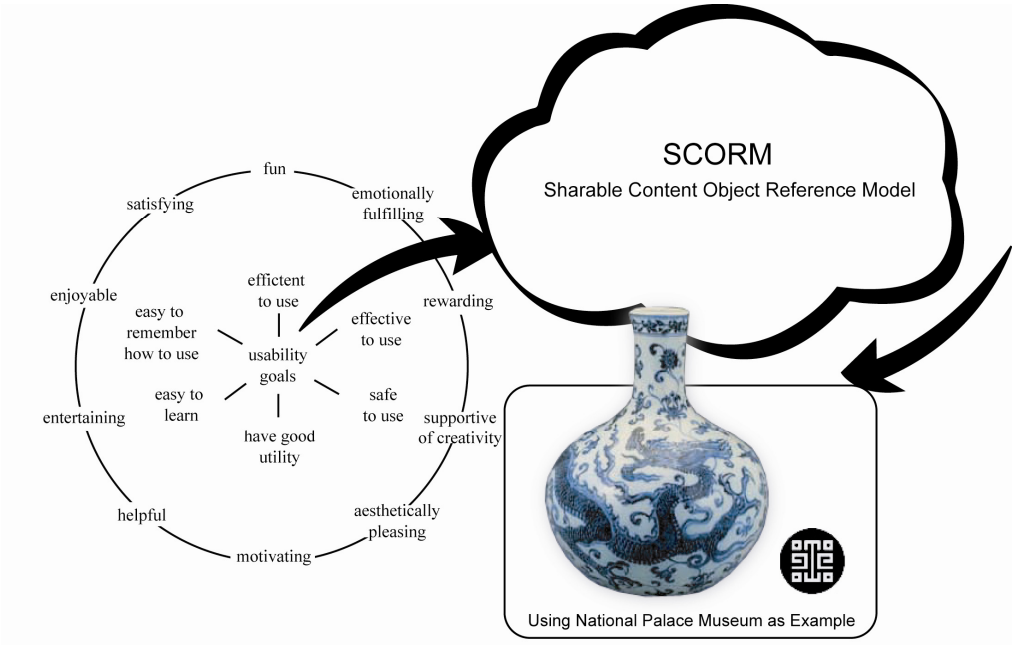

Figure 3. Cognitive Walkthrough

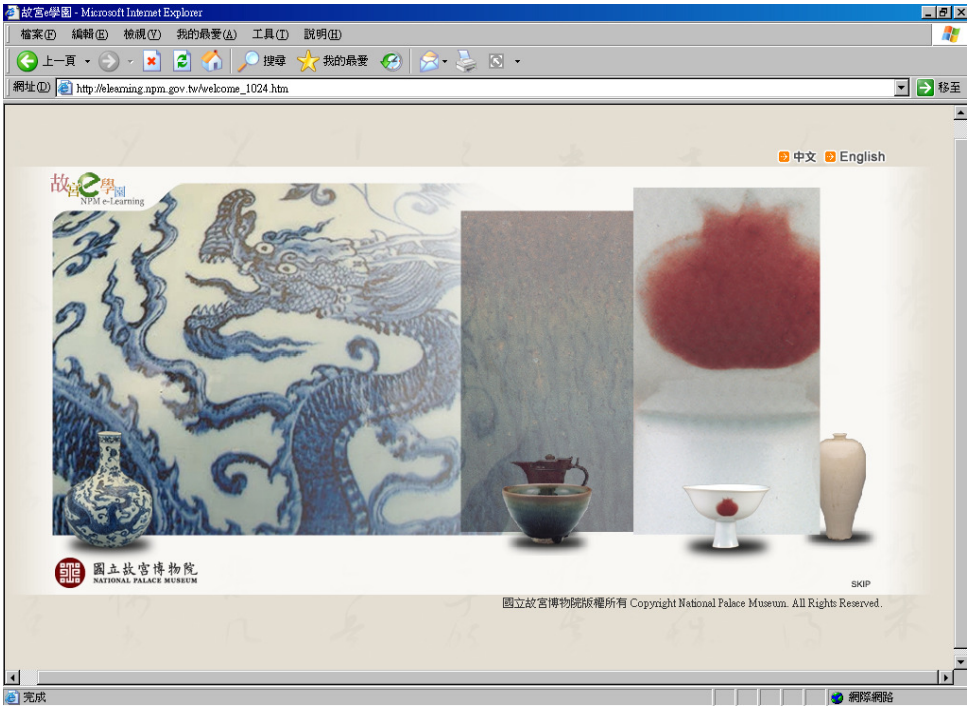

Figure 4. NPM E-Learning Entry Page

Figure 5. SCROM™ Interface of NPM E-Learning

Table 1. Evaluation Guidelines (by the Authors of this Study)

Item No.	Evaluation Guidelines
I Overall Interface Operation	
1	Website Design Intentions
2	Unit Information Transfer
3	Content Descriptions
4	Content Descriptions through Chapters and Sections
5	Navigator
6	Interaction
7	Window Titles
8	Web Address
9	Linkage
10	Technical Issues
II Visual Communication Design	
11	Interface Composition and Design
12	Pictures and Animations
13	Fonts
14	Colors
III Satisfaction with Quality and Service	
15	Information Quality
16	Service Quality
17	Learning Motivation and Attitude
18	User Satisfaction

Table 2. Evaluation Items and Questionnaire (by the Authors of this Study)

(12) Pictures and Animations	Strongly Disagree	Disagree	Fair	Agree	Strongly Agree
Pictures in the interface are clear	☐	☐	☐	☐	☐
Pictures in the interface come with text description	☐	☐	☐	☐	☐
Pictures in the interface match texts	☐	☐	☐	☐	☐
Button icons come in high resolution	☐	☐	☐	☐	☐
Pictures are consistent with the overall website style	☐	☐	☐	☐	☐
Pictures and graphs come in proper proportion	☐	☐	☐	☐	☐
The interface provides watermark icons	☐	☐	☐	☐	☐
Important items are presented with flash animations	☐	☐	☐	☐	☐
The interface forces users to view flash animations	☐	☐	☐	☐	☐
The contrast between texts and background colors is high	☐	☐	☐	☐	☐
The interface uses different template designs	☐	☐	☐	☐	☐
The interface uses the registered trademark of the NPM carefully	☐	☐	☐	☐	☐
The picture quality is sufficient	☐	☐	☐	☐	☐
Pictures are complemented with texts	☐	☐	☐	☐	☐
Pictures use consistent light source	☐	☐	☐	☐	☐
Feedbacks are provided above the mouse	☐	☐	☐	☐	☐

In Table 2, respondents were required to answer the questions in the questionnaire by rating the Likert-scale (Strongly Disagree, Disagree, Fair, Agree, Strongly Agree). Later, the results were used for a linear analysis and correlation coefficient statistics.

Respondents

The subjects of the questionnaire survey were graduate students and doctoral candidates from the Department of Industrial Design, NCKU. Among the fifteen respondents, there were eight males and seven females. Eight out of the respondents had experience in teaching (arts, technology, and design). Therefore, it is highly possible that these respondents will use informational technology as a teaching aid in the future. Figure 6 shows the operation process and environment for the questionnaire survey.

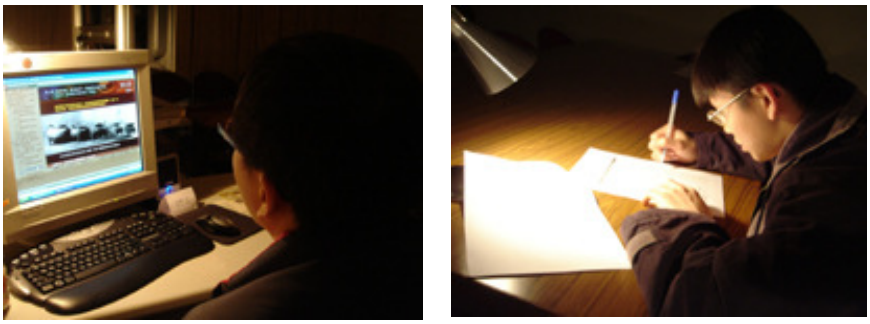

Figure 6. Operation Process and Environment

Heuristic Evaluation and Case Study

Four experts were invited to operate and evaluate web pages of the case at the same time and same place. The web pages included the entry page of NPM E-Learning, the homepage of NPM E-Learning, and the SCORM system of bronze vessel courses. The evaluation process was divided into three stages. The first stage was open cognitive walkthrough which lasted for ten minutes. The second stage was individual expert evaluation which lasted for an hour. In the third stage, the four experts discussed their evaluations at the same time and same place.

Data Analysis

Statistics of Correlation Coefficient

The results of Likert scale of the fifteen respondents were entered into SPSS12.0 word by word for a descriptive statistic analysis. Strongly Disagree marked one score, while Strongly Agree marked five. Figure 7 shows the mean value of each evaluation item of the sequence charts of the fifteen samples.

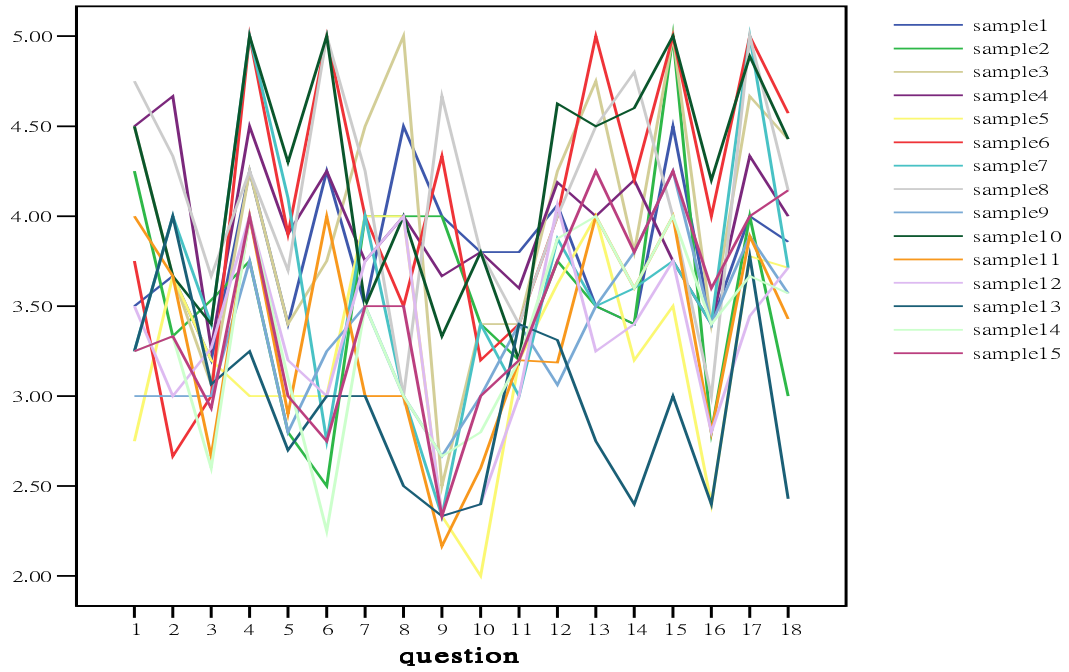

Figure 7. The sequence charts for the mean value of each evaluation item

Table 3 shows the mean and standard deviation of each evaluation item. Later, the means of the eighteen evaluation items of the fifteen respondents were entered into the statistical software respectively for correlation coefficients (See the Table 4 for the details). The correlation

Table 3. Descriptive Statistics

Evaluation Items	Mean	Standard Deviation	Number
(1) Website Design Intentions	3.7333	.6371	15
(2) Unit Information Transfer	3.6007	.5228	15
(3) Content Description	3.1520	.2943	15
(4) Content Descriptions through Chapters and Sections	4.1333	.5891	15
(5) Navigator	3.3467	.5181	15
(6) Interaction	3.5833	.9481	15
(7) Window Titles	3.7167	.4212	15
(8) Web Address	3.6000	.6866	15
(9) Linkage	3.0440	.8655	15

(10) Technical Issues	3.1200	.5846	15
(11) Interface Composition and Design	3.3067	.2120	15
(12) Pictures and Animations	3.8427	.4173	15
(13) Fonts	3.9333	.6085	15
(14) Colors	3.7200	.5846	15
(15) Information Quality	4.1833	.6158	15
(16) Service Quality	3.2267	.5230	15
(17) Learning Motivation and Attitude	4.2227	.5444	15
(18) User Satisfaction	3.7800	.5631	15

Table 4. Correlation Coefficient Statistics

Items	Items / Significant Levels of Correlation Coefficient (Two-tailed)					
(5)	4	--	--	--	--	--
	.000*	--	--	--	--	--
(10)	1	4	5	9	--	--
	.005*	.003*	.007*	.004*	--	--
(12)	5	--	--	--	--	--
	.001*	--	--	--	--	--
(14)	4	5	6	10	13	--
	.006*	.005*	.005*	.006*	.001*	--
(16)	4	5	14	15	--	--
	.000*	.006*	.006*	.007*	--	--
(17)	4	5	10	14	--	--
	.001*	.000*	.005*	.005*	--	--
(18)	4	5	12	13	14	16
	.007*	.004*	.007*	.000*	.000*	.002*

* When significance level is at 0.01 (two tailed), the correlation is significant.

Table 5. Correlation Coefficient Statistics

(5) Navigator	
p=.000	(4) Content descriptions through chapters and sections, significance achieved
(10) Technical Issues	
p=.005	(1) Web design intentions, significance achieved
p=.003	(4) Content descriptions through chapters and sections, significance achieved
p=.007	(5) Navigator , significance achieved
p=.004	(9) Linkage, significance achieved
(12) Pictures and Animations	
p=.001	(5) Navigator , significance achieved
(14)Color	
p=.006	(4) Content descriptions through chapters and sections, significance achieved
p=.005	(5) Navigator , significance achieved
p=.005	(6) Interaction, significance achieved

p=.006	(10) Technical issues, significance achieved
p=.001	(13) Fonts, significance achieved
(16) Service Quality	
p=.000	(4) Content descriptions through chapters and sections, significance achieved
p=.006	(5) Navigator , significance achieved
p=.006	(14) Colors , significance achieved
p=.007	(15) Information quality , significance achieved
(17) Learning Motivation and Attitude	
p=.001	(4) Content descriptions through chapters and sections, significance achieved
p=.000	(5) Navigator , significance achieved
p=.005	(10) Technical issues, significance achieved
p=.005	(14) Colors, significance achieved
(18) User Satisfaction	
p=.007	(4) Content descriptions through chapters and sections, significance achieved
p=.004	(5) Navigator , significance achieved
p=.007	(12) Pictures and animations, significance achieved
p=.000	(13) Fonts, significance achieved
p=.000	(14) Colors, significance achieved
p=.002	(16) Service quality, significance achieved

coefficient statistics of the study is shown in Table 5.

Results of Heuristic Evaluation

At this stage, questions were extracted based on an "unstructured heuristic evaluation". The four experts who were invited to evaluate the interface had more than two years of experience in web page design, so they understood usability engineering. After the evaluation, the experts discussed the results together and discovered several usability problems of NPM e-Learning. The experts proposed the following concrete suggestions.

1. Guideline for "content descriptions through chapters and sections": "Content descriptions through chapters and sections" showed a mean of 4.1333 (Agree) in the statistic analysis. However, feedbacks about the function of content descriptions were not favorable during the post-operation discussion stage. Learners were constantly confused by web tiers. The experts suggested that buttons like "End" or "Next Chapter" to be inserted at the end of each section to direct users to the next chapter. "Chronology"

showed the historical contexts of a description. The experts suggested that highlight or flash should be used in combination with course narration to help learners to clearly distinguish different historical contexts. The aspects which are significantly correlated with this guideline are “colors” and “navigator”.

2. Guideline for “navigator”: NPM e-Learning placed the navigator at the left column of the webpage. Learners could adjust the navigator based on their habits. However, learners were easily confused by “chapters” and “sections”. The main reason was that the font sizes and colors of chapters and sections were too similar for users to select one correctly. The experts suggested that colors should be used to distinguish chapters from sections. In addition, the “Replay” button at the upper right of the webpage did not function, making the replay function available only for the first chapter. The replay function should be made available to every chapter and section. The aspects which are significantly correlated with this guideline are “pictures and animations” and “colors”.

3. Guideline for “pictures and animations”: NPM e-Learning demonstrated pictures and animations both two-dimensionally (2D) and three-dimensionally (3D). Therefore, it took a few seconds for learners to get accustomed to the shift from 2D to 3D. The experts suggested that only 3D or 2D-simulated 3D should be used for integration. The aspect which is significantly correlated with this guideline is “navigator”.

4. Guideline for “colors”: NPM e-Learning used mainly warm colors, making learners feel that every page seemed to be identical. The experts suggested that suitable color combinations should be selected in compliance with course contents. The aspects

which are significantly correlated with this guideline are “navigator”, “font”, and “content description through chapters and sections”.

5. Guideline for “font”: The demonstration of words in NPM e-Learning was not reader-friendly. In addition to the left navigator which was described in words, there were also other contents described in words below video clips. The experts suggested that contrast colors should be used to improve feedbacks to interface. The aspects which are significantly correlated with this guideline are “colors” and “user satisfaction”.

6. Guideline for “interaction”: The mean value of the interaction of NPM e-Learning was 3.5833 (Fair). From the standpoint of information-aided technology, there was still room to improve the interaction. The experts suggested that 360-degree rotation (including X, Y, Z axes) should be applied to allow learners to manipulate contents with the mouse and increase control over the interaction. In addition, NPM e-Learning presented “full texts” word by word through synchronized narration, which made learners become passive in the interaction. The experts suggested that a synchronization mechanism of “pictures” and “texts” should be provided to learners. The aspect which is significantly correlated with this guideline is “colors”.

7. Guideline for “website design intentions”: In addition to increasing learners’ learning interests, a more important intention of designing NPM e-Learning was to tell learns what they would learn from the website. Therefore, the experts suggested that an abstract should be provided at the beginning of every section. The aspects which are significantly correlated with this guideline are “pictures and animations” and “colors”.

8. Guideline for “technical issues”: NPM e-Learning should avoid situations such as data errors or content unavailable. The experts suggested that the website use built-in

software which required no plug-in programs for viewing. Aspects significantly correlated to this guideline are “pictures and animations” and “colors”.

Conclusion and Future Research

This study follows evaluation guidelines and checklists proposed of Nielsen & Tahir (2002) and the nine guidelines and 54 evaluation checklists of Brink, Gergle, & Wood to design eighteen guidelines and 112 checklists for usability evaluation. Research results indicate that most of the aspects show significant levels.

In the category of overall interface operation, “content descriptions through chapters and sections” is the most significant, showing that learning on SCORM™ platform is most influential to learners. In the category of visual communication design, “fonts” is the most significant, showing that word recognition is most influential to learners. The second most significant aspect is “pictures and animation”. In the category of satisfaction with quality and service, “learning motivation and attitude” is the most significant, showing that an active or passive attitude is affected by “content description through chapters and sections”, “navigator”, “technical issues”, and “colors”. The above-mentioned aspects are influential to e-Learning users thus are proposed to interface designers for reference.

This study aims for evaluation of interface usability. Other issues regarding interface should also be discussed in the future. Future research can extend to the evaluation of emotions and learning benefits related to interface.

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