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ECOLOGICAL INFORMATION INTERFACE DESIGN, SYSTEM USABILITY, AND USER EXPERIENCE

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ABSTRACT

This study focused on bird species in Taiwan, investigating the design and usability of an app for Taiwan's endemic bird species through simplified bird images, interactive framework, text icons, and user interface, along with heuristic evaluation and usability testing. The usability test results verified that the app system designed had a usability score of 74.773 with the level between "good" and "excellent"; and was rated "excellent" in dependency, stimulation, and novelty under user experience; was rated "good" in attractiveness and efficiency, and was rated "above average" in perspicuity. Furthermore, significant usability and user experience differences were observed in introducing bird information between the interface using narrative and text icons. When the same ecological information interactive framework is applied, the use of simplified bird images and text icons helps improve the system's usability, as well as the attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty of the system in terms of user experience.

Keywords: *interface design, ecological information, user experience, system usability*

1 INTRODUCTION

Interaction-based information on a smartphone interface involves both static and dynamic representations; the viewer can freely determine the viewing method, speed, and duration. The user can seek information related to how they understand wildlife, thereby ensuring that the information is accessible and engaging. Specifically, visual representations through cell phone interfaces are restrained through carrier dimensions and must balance between visual fatigue and visual aesthetics. Therefore, graphics or icons are primarily in simplified and flat form. Representations of wildlife graphics and information on cell phone interfaces must operate within norms and restrictions. The connection and recognizability of graphics concerning the real world must be maintained to convey information properly. Popular science and illustrated books are

used as the primary materials for learning and teaching about bird species; birds are represented chiefly through highly realistic wildlife photographs and intricate illustrations, accompanied by text descriptions, thus intuitively demonstrating their features, categories, and distribution (Liao, 2012; Liu, 2015). The information thus represented is rich and comprehensible but may be unsuitable for quick search and outdoor usage. This study designed an application (app) to introduce bird species endemic to Taiwan. An interactive information structure was conceived to meet user expectations, and representations of bird graphics and relevant information for the cell phone interface were examined. Furthermore, the correlations of the interface design with system usability and user experience were investigated, thereby summarizing the principles of applying ecological information to interactive interface design.

2 LITERATURE REVIEW

2.1 Visual graphics

Whether an image can enhance the reader's understanding and learning efficiency of biological knowledge is essential in designing wildlife illustrations through an information visualization structure. Based on the level of graphic stylization, Meyer and Laveson (1981) classified graphics (from realistic depictions to pure abstractions) into the following five levels, which are natural photography, pictorial illustration, graphical rendering, graphic symbology, and abstract symbology. Through a comparison of the aforementioned five-level stylization hierarchy with existing presentation of information about bird species, this study revealed that popular science and illustrated books are the primary materials for learning and teaching bird species, with birds represented through natural photography and graphical illustration with enhanced realism. However, the rather intricate structures of these graphics and images prevent readers from immediately grasping the essential details. In addition, transporting and consulting these images outdoors is inconvenient, particularly in outdoor birdwatching, thus decreasing the practicality of the current illustrated books on birds. Moreover, because smartphones have become the most widespread information carrier, styles of visual communication design have been modified accordingly. Interface icons have more vital functions than text descriptions and can guide the user in intuitive operation (Lin & Lai, 2015). In addition, graphics or icons are chiefly represented in flat form, pertaining to the level of graphical rendering, graphic symbology, and abstract symbology.

2.2 Interaction-based information

The category and structure of information affect representations conveyed through information visualization and include information design, graphic design, and chosen carrier. Interactive representations consist of static and dynamic representations; the user can autonomously explore the content through interactive clicking and searching (Pimenta & Poovaiah, 2010; Lankow, Ritchie, & Crooks, 2013). The interaction-based information function of allowing users to determine the duration and method of viewing has changed the user's reading habits and enhanced the efficiency of absorbing information through the function setting, thereby providing more detailed information (Dur, 2014). According to related studies, in

facilitating individual learning and comprehension through multimedia, the simultaneous provision of visual, auditory, verbal, and nonverbal stimulation yields greater individual learning outcomes compared with the provision of only one type of stimulation, thereby allowing the learner to effectively memorize and store information (Mayer, 2001; Mayer, Lee, & Peebles, 2014). Therefore, interactive information visualization must prioritize visual aesthetics and pleasure for the user. In addition, the operational convenience of the interface must match the user's habit to maximize the effectiveness of the operation. Hence, an appropriate information structure is essential in interactive design and must be accompanied by an interface design that assists the user in relating the operation or content of information to real-life experiences or memories, thereby creating a good user experience and promoting long-term memory.

2.3 Interface design

Interface design involves mutually corresponding images, text, and color. The configuration of these components and interactions affects the information reception, attention, learning, and memory of the user during system operation. Therefore, user satisfaction can be improved using a system with an adequate interactive interface design. An interface design that centers on the visual aesthetic of the interface and overlooks the principles of user experience often necessitates complex operating procedures for browsing information, which reduces information-use efficiency and the user's operation motivation. The interactive design prioritizes a user's rapid adaptation to the system interface, effectively obtaining information and enjoying a pleasurable user experience (Hoffman & Novak, 1995). Facilitating the user's information operation through the appropriate planning of the content, interface, and function settings is essential in information design to enhance the cognitive efficiency of users in the digital age. The size and location of icons in an interface influence the accuracy and speed of system operation by the user, which further affects user satisfaction (Park & Han, 2010). Specifically, Nielsen (1994) proposed ten basic usability heuristics in interactive interface design, namely (1) visibility of the system status; (2) match between the system and the real world; (3) user control and freedom; (4) consistency and standards; (5) foolproof mechanisms; (6) recognition rather than recall; (7) flexibility and efficiency of use; (8) aesthetics and minimalist design; (9) assistance for users to recognize, diagnose, and recover from errors; and (10) assistance and documentation.

3 DESIGN PROCESS

3.1 Design of interactive structure and interface

This study designed an interactive structure and interface using a focus group and heuristic evaluation. The focus group comprised six members interested in birds or wildlife activities and with more than two years of experience in interactive design research and practice. They established the basic structure and functions of the app for introducing endemic birds in Taiwan and proposed potential problems and solutions regarding usability. The primary functions of the app are as follows: (1) information about bird species; (2) personal profile; (3) community; and (4) search. The information about bird species covered the environment and habitat altitude, size

and length of the body, color and shape of the beak, and color of the feathers; a search function was incorporated owing to the outdoor usage scenario.

After completing the interactive structure and interface design, a highly accurate prototype was produced for the heuristic evaluation. Five experts who had worked in interface design or interactive product design for more than five years were invited to conduct a heuristic evaluation and examine issues regarding the interactive structure interface design details. The following multistep evaluation was conducted: (1) review of the interactive structure chart; (2) free operation of the prototype; (3) semi-structured interview; and (4) expert opinion and feedback. The content of the semi-structured interview referred to the ten usability principles proposed by Nielsen, with the experts requested to evaluate the system usability and provide feedback. The process was repeated twice to identify and solve problems regarding design details and repeated prototyping, thereby improving the accuracy of the prototype.

3.2 Sample design

After the interactive structure and interface were revised, a sample design was created for a usability test to explore whether, in the same interactive structure, differences in interface representation correlated with usability. The samples were divided into an experimental group and a control group. The interactive structure for each group was identical, but the interface of the experimental group used text icons, while the control group used narrative in introducing bird information (see Figure 1).

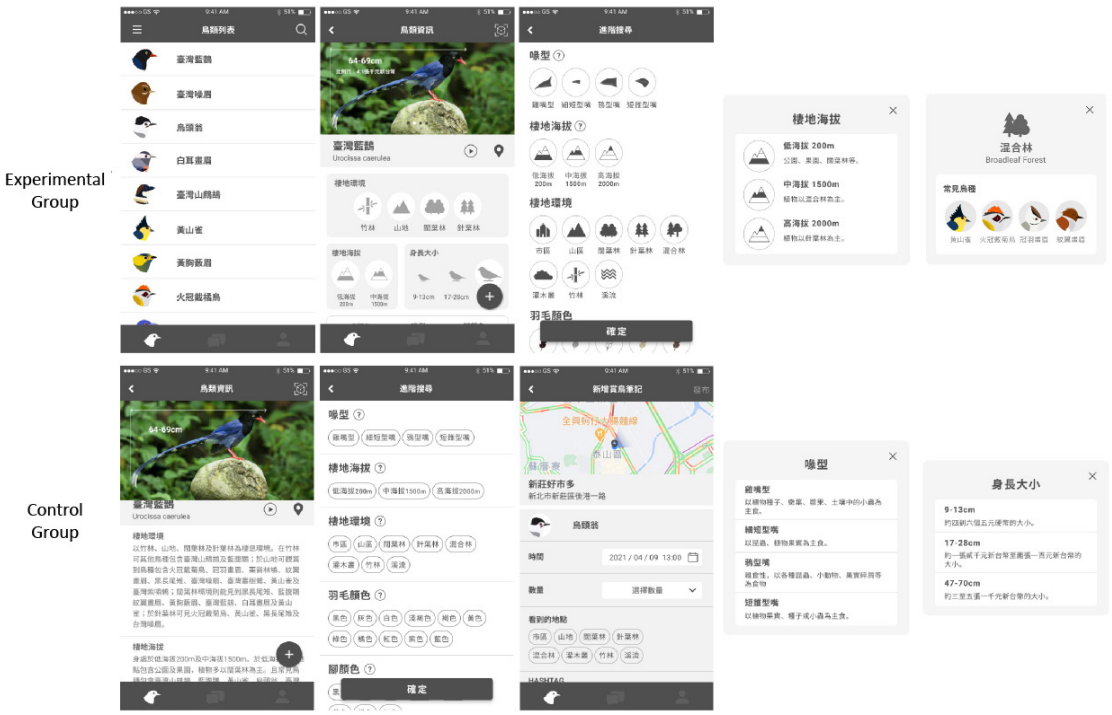

Figure 1. Interface comparison between the experimental group and control group

3.3 Usability Test

In response to the COVID-19 pandemic, the usability test in this study was conducted using remote testing on the Maze website. The participants comprised Taiwanese adults over 20 years old who owned smartphones and used social media. The experimental and control groups were subject to intergroup testing. The test included task operation, free operation, completion of a questionnaire survey, and provision of feedback after the test. The questionnaire's content was based on the System Usability Scale (SUS) and User Experience Questionnaire (UEQ). The SUS is widely applied for measuring a product or system; according to one large-scale study, the scale's reliability coefficient was 0.91 (Bangor, Kortum, & Miller, 2008). The total score is classified into five grades, namely Grades A, B, C, D, and F, representing the system's most positive and negative user perceptions, respectively (see Figure 2).

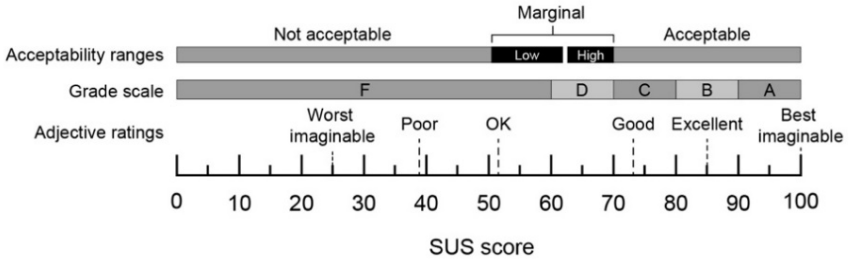

Figure 2. Basis for the SUS score interpretation (Brooke, 1996)

The UEQ measures the user experience of interactive products on a 7-point Likert scale, comprising 26 items with semantic differences; the score for each item ranges from −3 to 3. (Schrepp, Hinderks, & Thomaschewski, 2017). The UEQ results offer a comprehensive impression of user experience, including product usability and user engagement. This questionnaire contains six items or scales: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty scales. Attractiveness refers to the overall evaluation of a product. Perspicuity, efficiency, and dependability measure the product's practicality (i.e., whether the user can effectively achieve their goal in operating the product). Finally, stimulation and novelty represent the enjoyment gained from the use of the product, with a focus on the user's perception of product operation. The results of the UEQ measurement are ranked according to five grades, namely "excellent," "good," "above average," "below average," and "bad."

4 RESULTS

The usability test of this study included 70 effective samples, of which 33 were used in the experimental group and 37 in the control group. In the experimental group, the average total SUS score was 74.773 (standard deviation [SD] = 15.147), and the average user acceptance in terms of usability was “acceptable” (Grade C), ranging between “good” and “excellent.” The result demonstrated the higher quality of the app developed in this study than similar products in general. In the control group, the average total SUS score was 62.297 (SD = 18.07); the average user acceptance was “not acceptable” (Grade D), ranging between “ok” and “good.” According to the independent samples t test results, the p value of the total SUS score of both groups was 0.003 (<0.05), indicating that, in the same interactive structure, using simplified bird graphic icons

could improve system usability. A significant difference was thus observed between the icon-based and narrative-based interfaces in terms of usability (see Table 1).

Table 1. Independent sample t test results for the SUS score of the developed app

Group	N	M	SD	Grade Scale	T	P
Experiment Group	33	74.773	15.147	C	3.109	0.003
Control Group	37	62.297	18.07	D		

The result of the user experience and independent sample t test results of the six UEQ scales indicated that the experimental group's average total score ranged between 1.6 and 1.9; the grade was "excellent" in the scales of dependability (M = 1.765), stimulation (M = 1.742), and novelty (M = 1.682), "good" in the scales of attractiveness (M = 1.848) and efficiency (M = 1.796), and "above average" in the perspicuity scale (M = 1.697). The control group's average total score was lower and ranged between 0.6 and 1.1; the reported grade was "above average" in the novelty scale (M = 0.845), "below average" in the attractiveness (M = 0.887), efficiency (M = 0.838), dependability (M = 1.047), and stimulation (M = 0.926) scales, and "bad" in the perspicuity scale (M = 0.669). The independent sample t test results revealed significant differences between the two groups in all six scales. This indicated that in the same interactive structure, simplified bird graphics and icons could lead positive user experiences for the system, which was consistent with the users' cognition and was easier to learn to operate than the interface used narrative in introducing bird information, allowing the users to complete their task with greater ease (see Table 2).

Table 2. Grades of the six UEQ measurement items and related t test results

Scale	Group	N	M	SD	Grade	T	P
Attractiveness	Experiment Group	33	1.848	0.858	Good	4.396	0.000
	Control Group	37	0.887	0.957	Below Average		
Perspicuity	Experiment Group	33	1.697	0.960	Above Average	4.184	0.000
	Control Group	37	0.669	1.082	Bad		
Efficiency	Experiment Group	33	1.796	0.804	Good	4.654	0.000
	Control Group	37	0.838	0.906	Below Average		
Dependability	Experiment Group	33	1.765	0.760	Excellent	3.476	0.001
	Control Group	37	1.047	0.944	Below Average		
Stimulation	Experiment Group	33	1.742	0.993	Excellent	3.543	0.001
	Control Group	37	0.926	0.935	Below Average		
Novelty	Experiment Group	33	1.682	1.103	Excellent	3.163	0.002
	Control Group	37	0.845	1.108	Above Average		

Interface design affects how information entries are conveyed. A synthesis of the SUS and UEQ results indicated that, between the two interfaces with an identical interactive structure, the system usability and user experience of the interface with simplified bird graphics and text icons were rated higher than those of the interface used narrative in introducing bird information, and the differences were significant. In addition, the simplification of bird graphics effectively improved the perspicuity of the information, thereby enhancing operational efficiency for the users and improving their trust in the system. Therefore, representing ecological information using clear icons and touch keys was critical and increased users' ease of learning, thereby effectively improving their engagement with such information.

5 CONCLUSION

This study developed an interactive information app for the ecology of birds endemic to Taiwan through graphic design, interactive structure, interface design, heuristic evaluation, and usability testing. Moreover, this research analyzed whether system usability and user experience were affected by different representations of graphics and icons in the same interactive structure. In the interactive structure developed in this study, and interface applying simplified bird graphics and text icons, the system usability was rated "good"; user experience, dependability, stimulation, and novelty were rated "excellent"; attractiveness and efficiency were rated "good"; and perspicuity was rated "above average." The app's system usability and user experience were more favorably scored than the interface used narrative in introducing bird information. Moreover, according to the statistical results, using simplified bird graphics and text icons in the interactive information interface improved the user experience in terms of the system's usability, attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. The interactive prototype for the proposed app must be continually reviewed according to the results above and expert suggestions, and the correlations of different types and aspects of interface design (such as navigation interface and representation of bird species information) with system usability and user experience must be further explored. The study results provide a reference for establishing structures for ecological information in design and education, thereby improving citizens' understanding of the ecological environment and more effectively disseminating related knowledge and information. Moreover, users are more likely to be inspired to respect the ecological environment in Taiwan and raise awareness of environmental protection, fostering identification with and care for the land.

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