THE COGNITIVE DIFFERENCE OF USABILITY ON GENDER: A CASE STUDY OF RESPIRATORY PROTECTIVE DEVICE

Pongsak Kitirojpan and Sakol Teeravarunyou

School of Architecture and Design, King Mongkut's University of Technology Thonburi

ABSTRACT

This article reviews cognitive differences and compares two types of Respiratory Protective Devices on usability issue. Sixty subjects were assigned to use the products. The result shows that there is no significant difference on duration time but on human error instead.

1. INTRODUCTION

Several studies have shown the difference between genders in term of cognitive ability such as arithmetic, spatial visualization, perceptual speed, and others (Feingold, 1993). There has also an investigation of users' perceptions toward e-learning courseware usability between males and females from various age groups (Koohang, 2004). The result indicated no significant difference for age and gender. However, there is evidence that men and women exhibit different preferences in layout and presentation of stimuli (Moss et al. 2006). There is no study that shows how an emergency product such as respiratory protective device (RPD) relates to the gender issue. There is a potential likelihood that females will fail to use the rescue product because they tend to have more panic and less familiar with mechanic than males. To investigate this gender issue, Performance Measure is selected as a usability method. It can be used to measure the cognitive performance by asking subjects to use the product without telling them how to use it (Jeffrey, 2008).

In this study, two RPD products called Type I and Type II are tested. Both of them were designed without considering the types of gender. Type I was designed by using the transparency hood, and manual air tube connection. Type II differs from Type I in that it has a ready to use air connection. Subjects just press another valve on the next canister when the previous one becomes empty.

2. METHODOLOGY

Usability testing method in this study is Performance Measures (Jeffrey, 2008). Two type of RPD product from SMEs named Air Pak was tested and was found many usability problems, for example, subjects complaint that the product is difficult to use (Teeravarunyou, 2008).

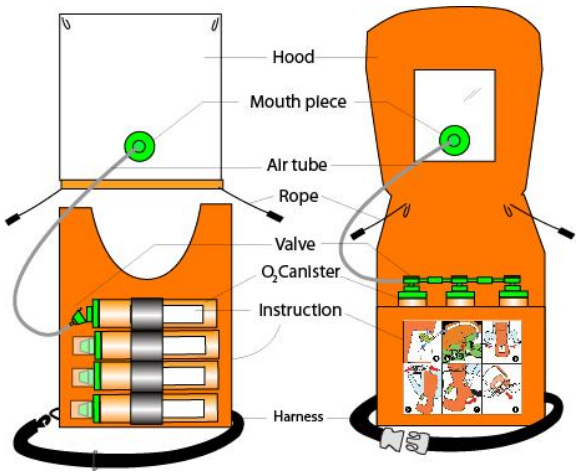

Fig. 1 Components of RPD products; Type I (left) and Type II (right).

The differences between Type I and Type II RPD are show in Figure 1. The details of differences are as follows:

1) Hood – For Type I, the hood is transparent and the shape is similar to a plastic bag separated from the jacket. The Type II RPD looks like a hood with the visor in the center. Hood and pack are connected together as a jacket.

2) Pack – The Type I RPD has the user guide inside the jacket. The Type II RPD has the user guide in front of the jacket. The harness of the Type I RPD requires users to adjust the length according to the circumstance of waist, while the Type II RPD is made from an elastic strap.

3) Air canisters – The canister provides breathable air to the hood via mouth piece. The Type I RPD has a canister requiring users to connect the air tube, while the air tube for the Type II RPD is already connect and ready to use.

4) User guide - The Type I RPD has four tasks: donning the hood, inserting air tube, pressing the pump cap, and escaping to the safe area. An instruction of the Type II RPD has an enlarged size of images and has six tasks: pulling the hood, donning the hood, fastening the harness, pulling the neck rope, pressing and locking the pump cap, and inhaling and exhaling the air.

2.1 Testing room setup

The test room was designed to imitate the walkway of a fire escape route (see Figure 2) According to the Confederation of Fire Protection Associations in Europe, the speed of occupants in a fire situation is assumed at 0.5 m/s. (CFPA-E, 2009). One air canister can supply breathing air for approximately 1 minute; the length of walkway should enable the subject to change a new canister while the testing is going on. Total length of walkway at 28 meters (56 seconds) was designated. Due to space limitation, it was built like a zigzag pattern to increase the walkway distance and to meet the criteria. The width of walkway was built at 1 meter to respond to the minimum width of escape route without accessibility of wheelchair user as defined by the Scottish Building Standard 2001.

Fig. 2 Testing room configuration.

Inside the smoke tunnel, infrared video cameras and fire exit signage were installed in each corner. Additional cameras were placed to capture the activity at donning area and exit way. During the test, the environment of test room was dark and covered with smoke except the light from fire exit signage. Fire alarm was activated to stimulate the subject alertness. At the area near the exit, there was a signage to inform the subject to change a new air canister to check whether or not the subject could release air in the smoke.

2.2 Participants

The total number of subjects is 60. Thirty subjects participated in each type of product, 15 males and 15 females. They are all officers who work in the university and have a potential to use RPD. The mean ages of the male and female groups are 28.07 years and 31.60 years, respectively.

2.3 Testing procedure

All subjects needed to attend the orientation session. The subjects were requested to don the RPD before entering the smoke tunnel without instructing them how to use it. Then each subject was assigned to crawl and to walk through the tunnel, one at a time. After the subjects exited from the test room, the retrospective interview was set to investigate unobservable tasks such as breathing and pressing the cap of air canister which could not be captured evidently by the cameras. Then the subjects rated the satisfaction of comfort and ease of use.

All tasks were recorded and analyzed by using the behavioural analysis software called The Observer® XT (Noldus, 2011). The software was used to analyze the behaviour based on time duration and number of errors. The result was a statistical output of subjects' performance.

3. RESULTS AND ANALYSIS

To find out the products ease of use, donning time and error were used for analysis. Additional data were collected from interviews including user's satisfaction.

3.1 Donning time and error vs gender

Donning time of the RPD in urgent situation is a major requirement. However, it is important to don the RPD correctly in order to escape from fire safely. Escape time depends on the modes of escape (crawl and walk) to which the subjects were assigned.

The results from the study are shown in Table 1. There is no significant difference in donning time between males and female in both types of products, although males spent a bit shorter time than females. In Type I product, male spent 196.89 seconds to complete all tasks, while females required 210.99 seconds. For Type II, the average donning time for male and female is 81.74 and 98.96 seconds, respectively.

Table 1 Comparison of Type I RPD and Type II RPD in terms of duration and errors.

		Duration (sec)	Errors (times)
Type I	Male	196.89	5.2
	Female	210.99	4.73
	Sig.	0.687	0.46
	Df	28	28
Type II	Male	81.74	1.67
	Female	98.96	2.8
	Sig.	0.173	0.033*
	Df	28	28

*Significant difference at 95%(p value < 0.05)

In terms of error analysis, Type I has an average error for both males and females at 5.20 and 4.73 ($t(0.75) = 0.46$, p value = 0.467) which has no significant difference. However, the error in Type II in males and females is 1.67 and 2.80 ($t(15) = 2.240$, p value = 0.033) and significant difference at 95%. These numbers indicate the ease of use of Type II over Type I RPD, but in Type II males have less error than female significantly. Detail of error in each sub task is shown in Figure 3.

Males have no error in searching pack and reading user guide, while the number of errors for both tasks in females is 2 times more. Two females were running into smoke tunnel without searching and wearing RPD. The error of pulling hood occurred when the subjects pulled out the air canisters out of the pack instead of the hood by 3 males and 5 females.

The main error of using Type II RPD is press/ lock the valve and also use next canister task. There were 12 errors by males and 13 by females in both tasks. For the task of using the next canister, the errors mostly found are 'operation incomplete', 'operation in wrong direction' and 'operation omitted'. Many subjects did not press the next canister because the air in it was still not empty. Some subjects did not press the valve hardly enough until locked, since the valve was difficult to lock. For the operation in wrong direction, subjects held the valve without freehand. As a result, the valve mechanism needs to be modified in order to reduce the pressing forces and also error.

The one task that females performed better than males is inhale/exhale, where 6 errors were made by male and 3 by female. The most common error is the subject did not exhale through mouth (5 male, 2 female). Another cause of error which one male and one female did is inhale via mouth.

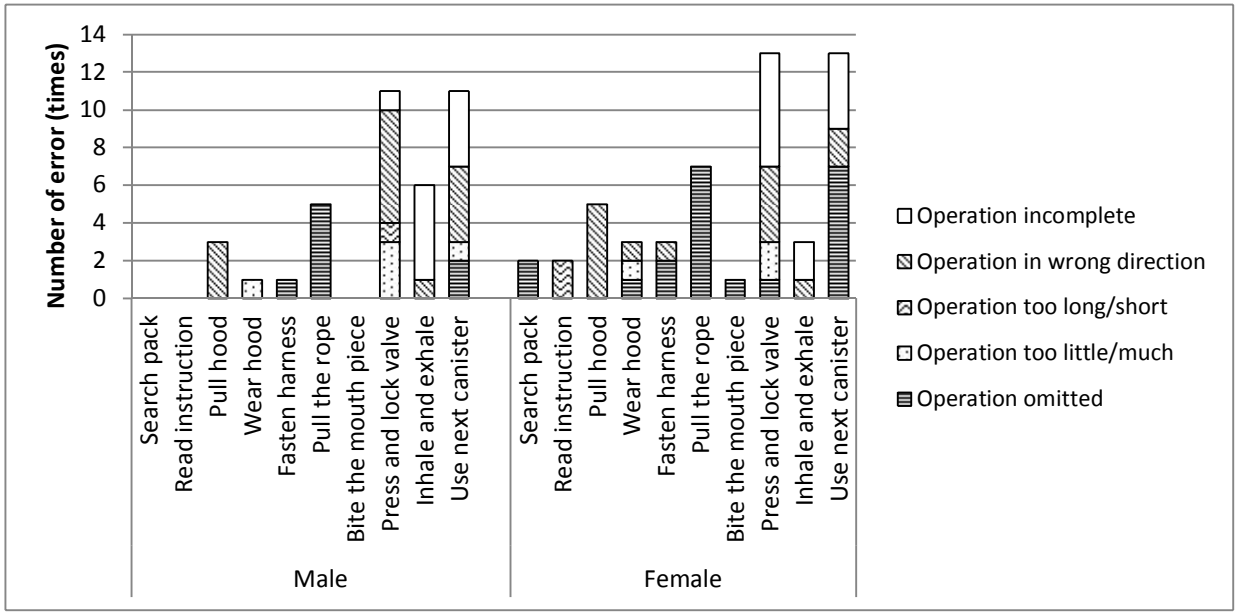

Fig. 3 Comparison of error between male and female while testing the type 2 product

To compare the error of each task, the error was classified into ten actions according to SHERPA error taxonomy (Embrey, 1986) (for full list of criteria see Figure 3). In total, the error of females tends to be higher than males in most tasks except inhale and exhale task.

CONCLUSION

In conclusion, usability testing reveals some differences between male and female. Although there is no significant difference in average donning time, males tend to use less operation

time than females. Additionally, the error in females is higher than males in both types of products and has significant difference in Type II RPD. The interview found that females have less understanding in graphic user guide and operation process than males. Nevertheless, some design is not totally effective especially the valve. The difficulty in pressing valves made the subjects confused and consequently made a lot of error. Improving the design of valve mechanism could improve the usability of the product.

Usability needs to use with an iterative process. The product needs to be tested several times and make changes along the process. Only a reading user guide may not be enough to communicate the subjects within an emergency situation. Finally, usability can define the problems and quantify the number of each problem behind the design of the product, and it could be a supplementary of product safety standards.

Funding Source:
This work was supported by the Higher Education Research Promotion and National Research University Project of Thailand, Office of the Higher Education Commission.

REFERENCES

The Confederation of Fire Protection Associations in Europe (CFPA-E), Fire Safety Engineering Concerning Evacuation from Buildings, Guideline No. 19, 2009. Citing Websites. http://www.cfpa-e.org/files/PDF/Guidelines/Ratified%20Guidelines/CFPA_E_Guideline_No_19_2009.pdf (accessed September 26, 2011)

Feingold, A., Cognitive Gender Differences: A Developmental Perspective, Sex Roles, vol.29. 1/2, 1993.

Jeffrey, R., Dana, C., Handbook of Usability Testing : How to Plan, Design and Conduct Effective Test, 2rd Edition, Wiley Publishing, Inc., 2008.

Koohang, A., A Study of Users' Perceptions Toward E-learning Courseware Usability. International Journal on E-learning, 3(2), 10-17. Norfolk, VA: AACE.

Moss, G., Gunn, R., and Heller, J. "Some Men Like It Black, Some Women Like It Pink : Consumer Implications of Difference in Male and Female Website Design", Journal of Consumer Behavior(5:4), 328-341. July 2006

Noldus Information Technology. Citing Websites. http://www.noldus.com (accessed August 24,2011).

Pongsak Kitirojpan received his B.Arch. degree in Interior Architecture in 2003, and Master degree in Building Technology program from King Mongkut's University of Technology Thonburi in 2008. Currently he has worked in King Mongkut's University of Technology as a researcher. His work has primarily focused on computer simulation: lighting, energy and wind analysis.

Asst. Prof. Dr. Sakol Teeravarunyou received his B.Arch. degree in Industrial Design from King Mongkut's Institute of Technology Ladkrabang in 1995, Master degree in Interface Design from the Ohio State University in 1997, and a Ph.D. in Design Methods from Illinois Institute of Technology in 2001. Since 2001 he has worked in King Mongkut's University of Technology. His work has primarily focused on the usability testing, including human perception, eye tracking and image usability issues. He is a member of the Ergonomics Society of Thailand.