Usability Test of an Interactive Dietary Recording

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Abstract

Dietary intake methods are used to collect one's diet habit which is essential in nutrition assessment. Food diary, food frequency questionnaire (FFQ) and 24-hour recalls are the most common dietary intake methods. However, they are not welcomed by most clients. Digital handheld devices are now readily available, and the cost of digital transmission is low. eDietary Intake Portal (the Portal) is a new developed interactive web-based system for recording dietary intake. In addition, the Portal also evaluates energy balance and nutrient balance on individual basis. Nutrition assessment could then be reported online and this serves an education tool for promoting nutrition information.. Clients could adjust their food intake gradually and learn from the assessment reports to eat in a more healthy way. Usability test was carried out to evaluate user acceptance of the Portal. A convenience sample of twenty participants was recruited. Seven male and thirteen female with mean (S.D.) age 33.43 (8.01) were asked to evaluate the Portal in 3 domains: system usability, information quality and interface quality. Average scores for the three domains ranged 2.60-3.05. The overall usability was 2.5. The Portal demonstrated a high usability, thus encouraged continuous dietary recording and facilitated nutrition education through Internet.

Key Words: Dietary Recording, Nutrition Assessment, Nutrition Education, Nutrition Promotion, Usability Test.
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Introduction

Dietary intake methods are used to collect one's diet habit. Knowing one's energy profile and nutrient profile can help to assess whether the individual has balanced energy or has risks for metabolic syndromes or obesity related diseases. Food diary, food frequency questionnaire (FFQ) and 24-hour recalls are the most common dietary intake methods applied currently. However, the user-friendliness of the common dietary intake methods is poor. This discourages clients to record their diet in a specified period of time. Black et al. [1] stated that absolute agreement between energy intake and energy expenditure is impossible from a single measurement because of the intra-individual daily variation that occurs in food intake. Wang et al.[2] found that most clients thought the food records and 24-hour recalls were somewhat burdensome and time-consuming. This indicates that current methods discourage clients from keeping good dietary intake records, which could be valuable for health promotion and disease prevention.

Most dietary recording methods rely heavily on memory recall and cognitive development. All of the common methods are in paper format, which means it is not convenient for clients to bring them along as they go about their daily activities. Many clients record their dietary intake at the end of each day, and thus the food they ate earlier in the day may be forgotten,[3] which indicated that this could significantly affect the reliability of diet analysis. Contemporary dietary recording instruments also take the assumption that individuals have clear memories of their usual dietary habits and that these memories can readily be recalled and quantified.[4]

Serving sizes is another problem for documentation in the food diary and 24-hour recall methods. A serving size is the amount of each food or beverage consumed and is difficult to standardize because food is served in different ways and in different containers. Usually, clients were given descriptions or photographs of pre-defined portion sizes for reference during dietary intake recording. However, they may still lack confidence in converting the portion they consume to the pre-defined portion size, which will eventually affect the reliability of dietary analysis.

Good-quality food diaries required intensive coaching and follow-up contact.[5] Debriefing or close monitoring during the dietary intake recording process is a must, even if the logbook contains instructions. For example, users may just write down "buffet" instead of what type of foods they ate during the buffet, or they may just write down "spaghetti" without mentioning the sauce and ingredients used. When these common errors occur, it is difficult for nutritionists to make further nutrient analysis. When incomplete food records are received, follow-up phone calls or interviews are required to supplement the information.

FFQs were commonly adopted as alternative to the food records and 24-hour recalls. FFQs offer a list of food items from which respondents can choose what they have eaten, and how frequently, in the previous week. But the lists are usually long and require a certain literacy level. Some food items may be unfamiliar to respondents and such questionnaires are unable to show meal patterns, which are important in revealing people's eating behavior. Therefore, important data may be missed if FFQs are used as the dietary recording method.

Purpose of Study

The objective of this research was to design and develop an interactive dietary recording instrument with dietary education and to evaluate its usability.

Methods

New Dietary Recording Instrument (The Portal)

The research team developed an interactive dietary recording instrument using 2-dimensional food images. It is named eDietary Inake Portal (the Portal). Apart from this recording function, the instrument is programmed to report nutrient profiles of daily diet and report evaluation results. These functions cannot be done efficiently with the current dietary recording methods as most of them are in paper format. A few of them although making use of the information technology, the inventions still could not be widely applied because of poor design in the recording process.

Web-based recording method

This new invention is a web-based application so it can be accessed by using any Internet browser (Fig. 1). The users were required to complete a survey with questions about their eating behavior and their bio-measurements like body height, body weight. In addition, gender and birth date were required at the first attempt. These parameters were mandatory for the system to calculate the basal metabolic rate of

each user. The formulae applied in the system were from Harris and Benedict.[6]

Before inputting their daily food questionnaires, users were asked with 8 simple questions. These questions address users' emotion and sleeping quality which were important for the nutritionists to understand the users' health problems and the self-reported physical activity level. These data were used to calculate TEE by formula built in the system.[7-9]

Food Images Upload

The Portal was designed to support 2-dimensional images. Each time when users ate, no matter they ate at home, in cafeteria or in restaurants, they took the images by their digital camera or mobile phones with camera function. The image files could be uploaded by browsing the food image file location in the local computer (Fig. 2).

Dietary Intake Recording

After food images had been uploaded, individualized food questionnaires could be built by the system immediately. The food recording process was the kind of "drag and drop" mode (Fig. 2). For example, if a user eats a portion of the shown cheese cake and a cup of cappuccino at dinner, he/she could move the mouse to the cheese cake image, click and hold the left button on the mouse, and then move the mouse to the "Dinner" column of the bottom of the webpage. At last by releasing the left button of the mouse in the "Dinner" column, the cheese cake text block is shown in this column with an Arabic number in the bracket (Fig 2). The number indicates the number of portion the user consumed. Each food image "drag and drop" movement would be counted as half portion and two "drag and drop" movements would change the number in the bracket to one and so on (Fig. 2).

Calories and Nutrient Values

After the users uploaded the food images, nutritionists could evaluate the calories and nutrient values of each food item. The portion size would be based on the food volume shown in the image uploaded. Nutritionists could assess the webpage designed to enter all new uploaded food images in a single page, so it could be more convenient and time-saving to complete the nutrient analysis of those newly uploaded food items (Fig 3). The nutritionists could clearly see the ingredients on the photos and the text or language on the food packaging will not affect the evaluation. This is accomplished because the users could input supplementary details on the text box when they upload food photos to the Portal. To assist nutritionists to perform more accurate food evaluation, the user will be instructed to place a tablespoon a standard reference beside each food item when the photographs are taken.

Dietary Reports

After the client completing food recording in the Portal, the system could calculate the energy profiles and nutrient profiles immediately. A "Dietary Intake Report" was generated to displace all the nutrient details and grouped by each food item (Fig. 4). Another "Dietary Analysis Report" was generated to give user commentary related to the energy balance (Fig. 4). By matching the client's energy requirement computed by the users' TEE, the total energy input from the diet daily should be within the tolerance limit. In the Portal, the assumed tolerance was 10%. With such comparison, the Portal could indicate the users' daily energy balance by "Too Much", "Pass" or "Not Enough", meaning energy input was higher than energy requirement, energy input was similar to energy requirement and energy input was not enough to sustain energy requirement, respectively.

This report also indicated the nutrition status of each nutrient based on the Dietary Guidelines for Americans.[10] The advantage of this report identified those nutrients consumption with corresponding amount eaten not appropriate, although the diet was in energy balance. By looking into these two reports, users could understand their nutrition status and identify the food items containing too much unhealthy nutrients. Users could thus know how to manage the food choice and food portion in daily meals. By repeated dietary recording, reporting and commentary, users could be trained to eat in a healthy way.

Usability Test

Subject and Sampling

Twenty clerical staff were recruited from a department of an university through convenience sampling. They were recruited by email invitation and no incentive was provided for the completion of the test. Volunteers had no prior experience in the design or development of the Portal, thus, sampling bias was not a concern.

Procedure

Participants were given a standard 15-minute briefing on the objectives, applications, features and functions of the Portal, followed by a demonstration. The participants were asked to complete a food diary and

to input their food intake using the Portal for one day. Finally, they were asked to complete the usability questionnaire for the Portal.

Instrument

Usability test is a method used by human factors to evaluate a device's user interface and its effect on user performance and safety.[11-13] Participants were asked to complete the Computer System Usability Questionnaire (CSUQ) after they had used the Portal. CSUQ was developed by IBM was applied.[14]

Outcome Variables

There were 19 questions with 7-point scales in CSUQ. Score "1" was the best and score "7" was the worst. Question numbers 1-8 belonged to "System Use", question numbers 9-15 belonged to "Information Quality", question numbers 16-18 belonged to "Interface Quality" and question number 19 was overall score to the usability of the Portal. If participant did not answer or marked "Not Applicable" (N/A), then average scores would be calculated for the remaining number of questions.

Results

Demographic Characteristics

All recruited staff attended the usability test and all of them completed the study. The demographic characteristics of the participants in the usability test are listed in Table 1. Seven of them (35.0%) were male, and 13 (65.0%) were female ($p = 0.681$). Their mean age (SD) was 33.43 years (8.01).

CSUQ Ratings

Table 2 summarized the statistics of each question in CSUQ. For the evaluation of "System Use," the mean scores ranged from 2.35-2.83. The scores showed strong agreement on the design of the system use functions. The best scores in this domain were obtained for Questions 6 and 7, which asked whether the Portal was "comfortable to use" and "easy to use." For the evaluation of "Information Quality," the mean scores ranged from 2.55-3.30. The best score in this domain was obtained for Question 14, which asked about the effectiveness of completing work with the Portal. The range of scores in this domain was less dispersed, with half of the questions scoring 2-4 and the other half 2-5. The response rates for Questions 9, 10 and 11 were low, with many participants marking "N/A". As these questions concerned error messages, recovery from mistakes and on-line help, this indicates that most of the participants did not come across any errors during the dietary recording process. The average scores of each domain were calculated. The corresponding means of the average scores of "System Use," "Information Quality" and "Interface Quality" were 2.56, 2.84 and 3.00 respectively.

Discussion

The Mypyramid Tracker is a good example of web-based dietary recording tools developed.[15] Since Mypyramid Tracker's search method is by text, the users are required to choose the number of serving size from a list of standard portion in the combo boxes near the food intake items. However, it is a common problem that users do not know the name of the ingredients and errors may happen when the users need to do the serving size conversion. For example, the choices of serving size from the combo boxes are different from the users' food utensils. The Portal is designed with food images upload, so as to shift the food estimation (type of ingredients, portion size estimation and cooking methods estimation) from self-report to nutritionists as the latter have the expertise to do so.

Digital handheld devices are now readily available, and the cost of digital transmission is low. Innovative dietary intake recording methods, such as photography and wireless transmission, have been investigated.[2,16] Portable digital devices ensure real-time image capturing to avoid memory lapses, and real-time data transmission record time-stamped meal patterns. Food images may offer a better level of communication than text. They also require less follow-up, which saves time and manpower. Recent research on the use of digital photography in dietary intake recording indicates that it is clinically useful because it allows nutritionists to see images of the food eaten without any misunderstanding.

The instrument developed by Wang et al.[2] indicated that the food photos recording and the food assessment was tested reliable. However, this method requires use of a personal digital assistant (PDA) that is equipped with a mobile function. This method with a specific device may imply its uncommon use among all populations. To improve this problem, the Portal introduced in this study can build on the reliable food image method developed by Wang et al, but using web-based application instead of PDA. This is feasible because camera, personal computers and internet access are already inexpensive and are

commonly used by most people currently. Even the groups with lower education level like children and manual workers have no problem in using internet for searching information or using mobile messenger to communicate with each other.[17-19] It appears that computer competency is not a limiting factor to the lower educational groups when using the Portal as the web-based dietary recording tool.

Although each food item still requires initial data entry and coding, the process is improved by the electronic format of the diet questionnaires on website. The advantage of the Portal is that it stores the uploaded food images along with their corresponding nutrient values in the database. Clients can then retrieve this information for subsequent meals, and nutritionists need only provide nutrient analysis for newly uploaded food items. Users also choose the number of servings eaten, and the Portal calculates the calories and nutrients automatically. Data-entry time is thus drastically shortened because each food or combination of food needs to be analyzed only once.

The application of IT benefits the dietary intake recording process in large-scale research studies, including epidemiological studies. No compromises in time or manpower are required with the Portal. It also offers the advantages of good accessibility, good interactivity and a familiar interface to motivate users to continue logging their diets over a longer period of time. These factors also benefit research that requires continuous dietary monitoring, such as cohort studies.

The links between diet and such chronic diseases as diabetes, cancer and cardiovascular disease are well-recognized internationally. Attempts to improve people's health through dietary change are widespread. The general approach is to educate people about how to choose healthy foods, which ultimately guide people to eat more healthily. The underlying assumption is that, given sufficient knowledge, people will change their diet. However, this assumption may be wrong.[20] The association between nutrition knowledge and dietary behavior is minimal without broader coverage of the nutritional value of particular food items. For example, people usually misclassify foods, particularly pre-packaged foods and foods with numerous ingredients, when grouping them according to the Food Guide Pyramid. For example, cakes and cookies are often misinterpreted as bread and biscuits, instant noodles as noodles and margarine as a good substitute for butter. With the reporting functions in the Portal, users are able to acquire the accurate nutrient values of all foods they eat from the Dietary Intake Report. This helps to distinguish between healthy and unhealthy food items. In addition, individual energy requirements, and the corresponding proportions of major nutrients, are calculated and annotated in the Dietary Analysis Report. If a user finds that one particular nutrient, for instance cholesterol, exceeds his or her daily recommended allowance, then he or she can return to the Dietary Intake Report to determine which foods contributed to the excess amount. This will help him or her to learn to eat less of this food item or even avoid it. Thus, food choices and portion sizes can be changed step by step.

The participants in this usability test were convenient sample with majority of young and middle-aged adults, and there were more females than males. All of them were working in a university and thus had at least a secondary level of education. Therefore, the sample may be biased in terms of sex and educational level. Further research with large sample size and more representative participants is needed to further validate this dietary assessment tool. Also, further research to enhance the usability by using touch screen application instead of mouse-application could be conducted. The touch screen method of the Portal could be more users friendly for children, old age groups and the less computer competent individuals to operate.

Conclusion

Diet plays a crucial role in the management of chronic diseases; therefore, dietary recording instrument should be user-friendly and education emphasis. The Portal was given a preliminary usability testing and indicated that it is a clinically practical method for food recording. In addition, the Portal also appears to provide good education channel for healthy food choice and portion sizes.

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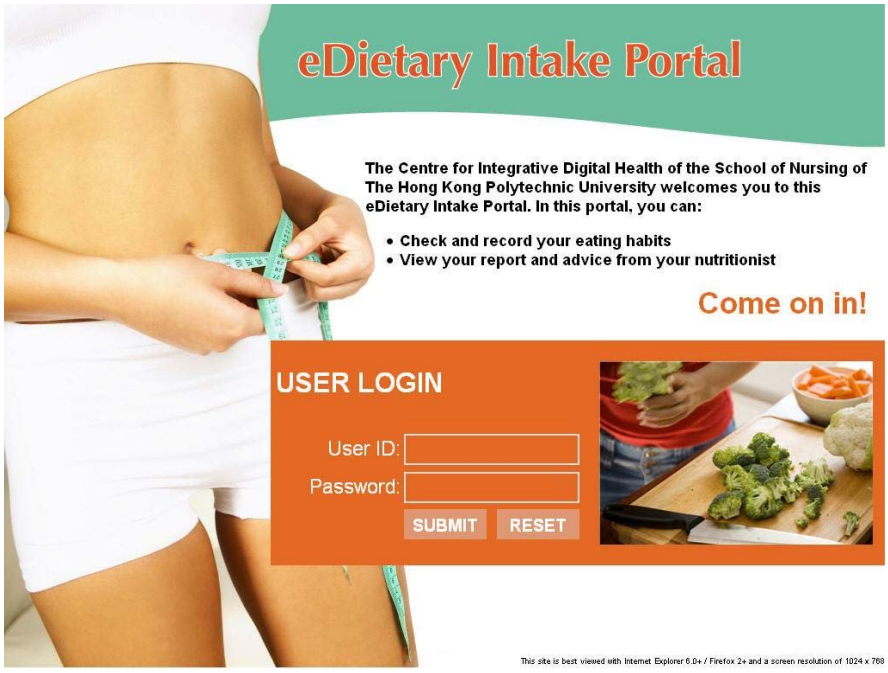


Fig. 1 Main Page of the eDietary Intake Portal

Fig. 2 Dietary Intake Interface with Individualized Food Questionnaire

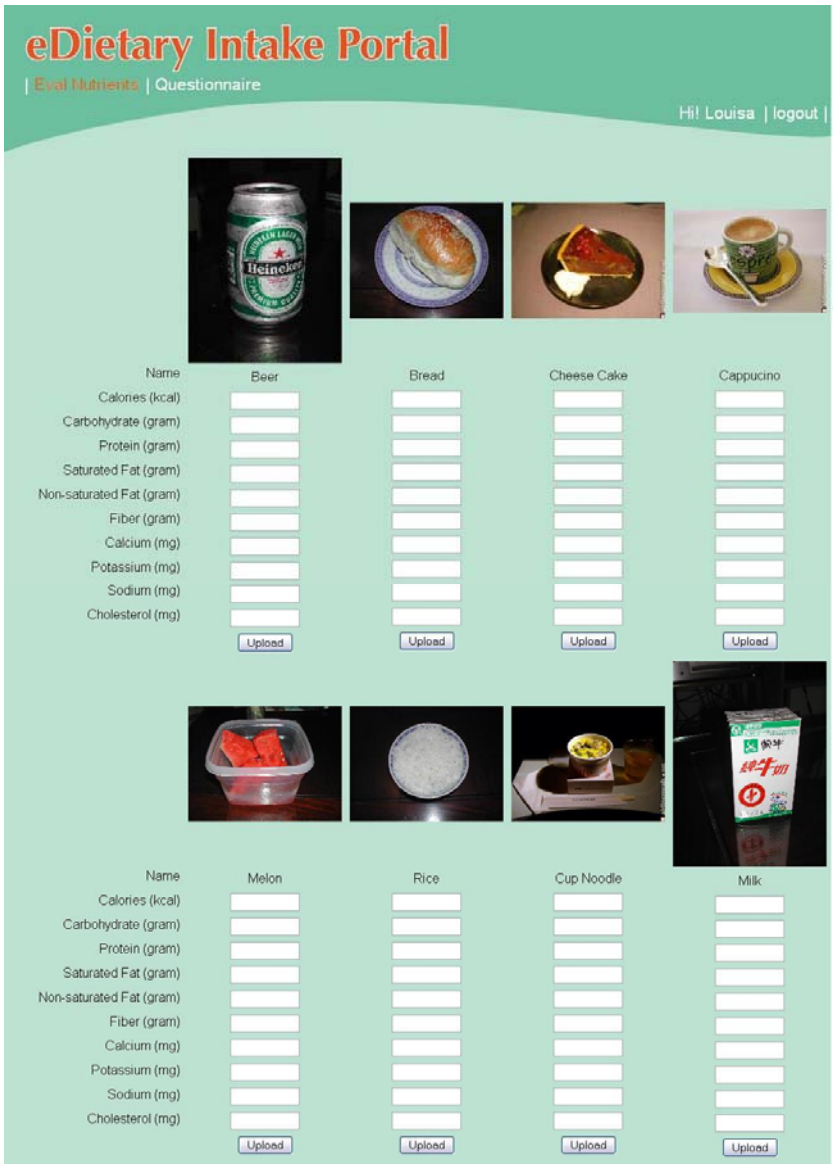
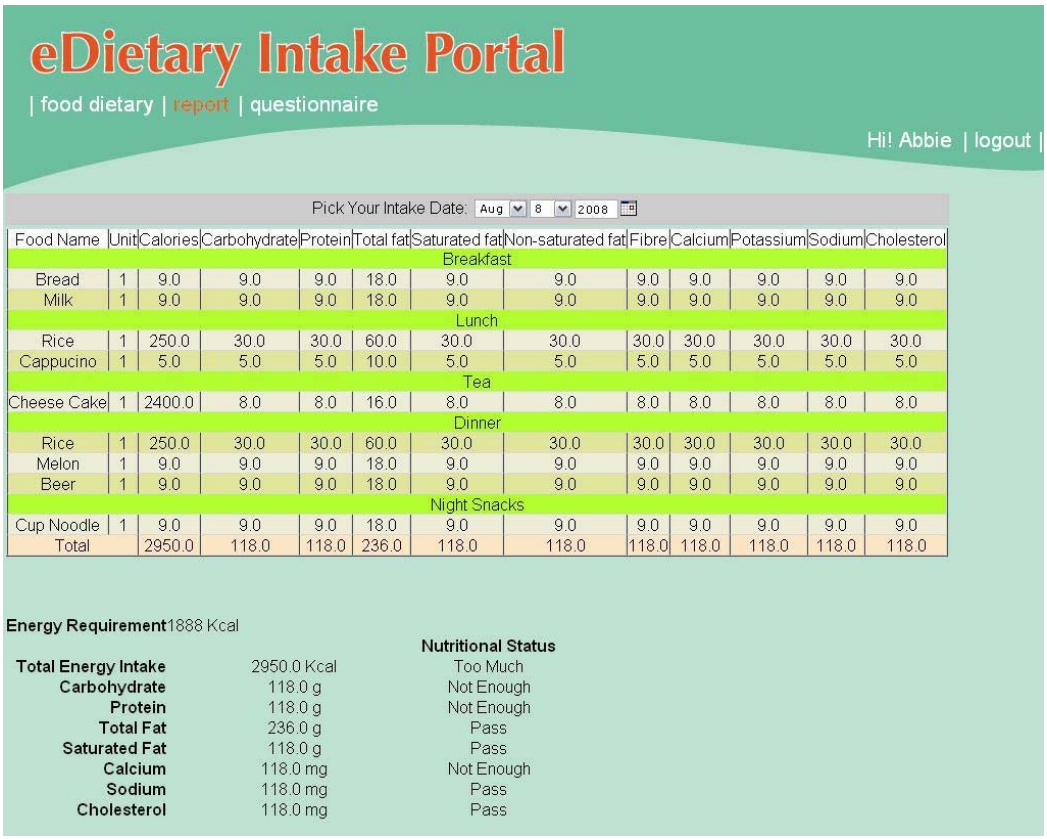


Fig. 3 Nutritionist Interface for Calories and Nutrient Values Input



eDietary Intake Portal

| food dietary | report | questionnaire

Hi! Abbie | logout |

Pick Your Intake Date: Aug 8 2008

Food Name	Unit	Calories	Carbohydrate	Protein	Total fat	Saturated fat	Non-saturated fat	Fibre	Calcium	Potassium	Sodium	Cholesterol
Breakfast												
Bread	1	9.0	9.0	9.0	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Milk	1	9.0	9.0	9.0	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Lunch												
Rice	1	250.0	30.0	30.0	60.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Cappucino	1	5.0	5.0	5.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Tea												
Cheese Cake	1	2400.0	8.0	8.0	16.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Dinner												
Rice	1	250.0	30.0	30.0	60.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Melon	1	9.0	9.0	9.0	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Beer	1	9.0	9.0	9.0	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Night Snacks												
Cup Noodle	1	9.0	9.0	9.0	18.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Total		2950.0	118.0	118.0	236.0	118.0	118.0	118.0	118.0	118.0	118.0	118.0

Energy Requirement 1888 Kcal

		Nutritional Status
Total Energy Intake	2950.0 Kcal	Too Much
Carbohydrate	118.0 g	Not Enough
Protein	118.0 g	Not Enough
Total Fat	236.0 g	Pass
Saturated Fat	118.0 g	Pass
Calcium	118.0 mg	Not Enough
Sodium	118.0 mg	Pass
Cholesterol	118.0 mg	Pass

Fig. 4 Daily Dietary Reports

Table 1. Demographic characteristics of the participants in usability test.

	n	%	Chi-square
Sex			
Male	7	35.0	0.681
Female	13	65.0	
Education[1]			
Secondary	4	21.1	0.369
Tertiary	11	57.9	
Postgraduate	4	21.1	
Occupation			
Clerical	5	25.0	0.130
Information Technology	4	20.0	
Administration	10	50.0	
Teaching	1	5.0	
Marital Status			
Single	12	60.0	0.003
Married	8	40.0	

[1]One subject declined to answer this question.

Table 2. Descriptive statistics for the CSUQ question items

Question Items	**n**	**Mean**	**S.D.**
System Use			
1. Overall, I am satisfied with how easy it is to use this system.	20	2.65	0.81
2. It is simple to use this system.	20	2.50	0.76
3. I can effectively complete my work using this system.	19	2.53	0.91
4. I am able to complete my work quickly using this system.	20	2.50	0.83
5. I am able to efficiently complete my work using this system.	20	2.80	0.95
6. I feel comfortable using this system.	20	2.35	0.99
7. It was easy to learn to use this system.	20	2.35	0.81
8. I believe I became productive quickly using this system.	18	2.83	0.86
Information Quality			
9. The system gives error messages that clearly tell me how to fix problems.	10	3.30	1.16
10. Whenever I make a mistake using the system, I recover easily and quickly.	9	2.89	0.78
11. The information (such as on-line help, on-screen messages and other documentation) provided with this system is clear.	15	2.93	0.70
12. It is easy to find the information I need.	18	2.94	0.73
13. The information provided with the system is easy to understand.	20	2.80	0.95
14. The information is effective in helping me complete my work.	20	2.55	0.76
15. The organization of information on the system screens is clear.	20	2.70	0.98
Interface Quality			
16. The interface of this system is pleasant.	20	2.85	1.23
17. I like using the interface of this system.	20	3.05	1.05
18. This system has all the functions and capabilities I expect it to have.	19	3.16	1.07
Overall			
19. Overall, I am satisfied with this system.	20	2.50	0.76