An Empirical Study of the Health Status Questionnaire System for Use in Patient-Computer Interaction

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ABSTRACT

Patient involvement in the health care process is very important to any attempt to improve health care quality and patient satisfaction. Although many computerized medical record systems have been introduced, physicians are the only players in the process of data collection and interpretation. A computerized version of the Health Status Questionnaire has been developed to provide a simple, inexpensive method of direct patient entry into the medical record. The system philosophy emphasizes user-centered design and an empirical study was conducted with one hundred twelve outpatients to evaluate the interface aspects of the system as well as the hardware preference of the patients. Statistical analysis indicate that the patients involved in the study rated the user interface of the Health Status Questionnaire System highly. The study also revealed that a considerable number of the general population still have negative preconceptions about their ability to handle a computer or similar looking machinery. When they were asked to use a desktop computer with a mouse, 26 out of 50 patients refused, while 61 out of 62 agreed to use a hand-held pen computer.

INTRODUCTION

Over the last few years, many software developers have started to realize that the computer-user interface design plays the most important part in the success of a software product. Well-designed interface systems usually have benefits like reduced training time, reduced error rates and improved productivity. Recently, user-centered design methods have come to be recognized as the most compelling method for creating effective computer-user interfaces.

Computerized medical record systems began to emerge during the early 1980s and they have improved access to patient information, supported clinical research, and improved medical education. Advanced Clinical Systems (ACS) [1] from HealthPoint was developed by the UHS/The Chicago Medical School and the Illinois Institute of Technology to help physicians capture complete patient data including a comprehensive history, physical examination, and laboratory data using hypermedia interfaces. But, Advanced Clinical Systems, like most other computerized medical record systems, is based on physician directive software and does not allow direct patient entry of information into the medical record.

IMPLEMENTATION OF THE HEALTH STATUS QUESTIONNAIRE SYSTEM

Our approach to solving this problem is a computerized questionnaire system that collects information on general health status from the patients directly. The Health Status Questionnaire 2.0 [2] has been adapted to a computer using hypermedia-based Spinnaker PLUS [3]. The Health Status Questionnaire was chosen because it is commonly used as an outcome measure of overall functional status, well-being, and risk of depression for adults. The purposes of this system are to provide a tool for a client-entered medical record environment, to automate the conventional paper-pen based questionnaire procedure, to provide more accurate and complete information that physicians can use in their decision making in terms of health care maintenance problems in the preventive medicine area, and to generate reports about general patient health status for physicians, patients, and the Advanced Clinical Systems. The Health Status Questionnaire System comprises four individual modules including the patient identification module, the data input module, the scoring module and the report generation module. The system is designed to function as a stand-alone system, but it can be used as a part of the Advanced Clinical Systems. There is also a data review module that allows the physician to review the answers entered by the patient.

Patient Identification Module
This module collects basic patient information

including the patient name and identification number using a keyboard or a stylus.

Data Input Module

The data input module collects patient answers to the questionnaire and sends them into the scoring module. The first section of this module is the system introduction page, which contains basic information such as the purpose of the system, a basic description of the buttons, and how to change your answers. The second section of this module is the question cards. The next twelve cards belong to this section and each card contains multiple choice general health status questions (Figure 1).
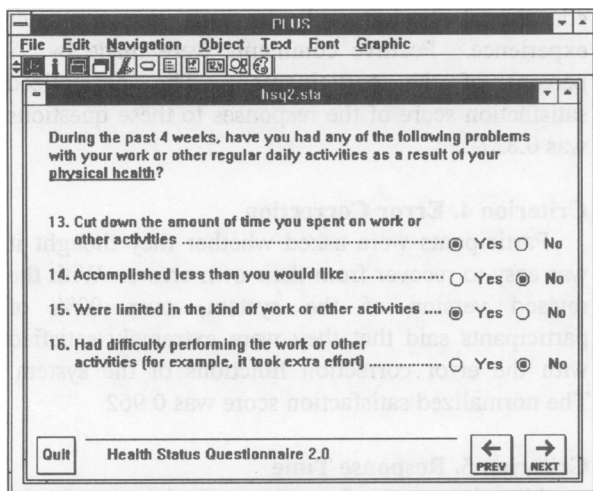

Figure 1. The Data Input Module of the System

Scoring Module

After the patient clicks or points to the "Next" button on the last card of the data input module, the system starts the scoring module, which calculates and displays average scores for eight specific health attributes (Figure 2). A higher than average score represents a positive health result. Then the scoring module sends each piece of information including patient name, identification number, date, answers, and average scores into the data log. This simple procedure eliminates a separate data saving process. Patients never have to worry about saving files, and at the same time, we can make sure that the system never loses any patient data.

Report Generation Module

The report generation module collects information from the data log and generates a report containing summary scores for each of eight health concepts, suggestions on lifestyle changes, and simple advice on exercise, determined by their
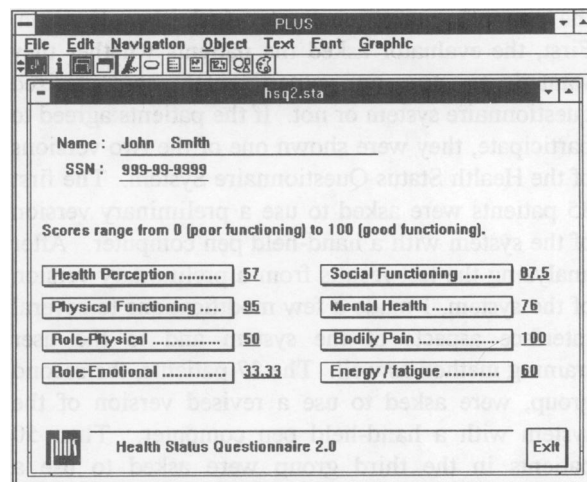
scores, for patient motivation.

Figure 2. The Scoring Module of the System

EMPIRICAL STUDY OF THE HEALTH STATUS QUESTIONNAIRE SYSTEM

Objectives of the Experiment

Once the iterative system design was completed and the implementation process as well, we designed a series of experiments under realistic conditions. One goal of this experiment was to determine if the user interface of the Health Status Questionnaire System was acceptable to patients and, if not, to find out where the problem areas were and to make suggested modifications. We also included experiments in the plan for comparing different hardware and data input mechanisms, in order to find out user preferences and most suitable hardware configurations for a clinic environment.

The Setting

The setting for this experiment was a HealthPoint clinic that served as an Advanced Clinical System beta site. It is a private clinic located in Evanston, IL, with five physicians and ten clinic staff including clinic administrative members. A hand-held pen computer and a desktop PC with a mouse were prepared for the experiment and all sessions were held in the waiting room of the clinic.

Subjects

A total of 112 participants took part in the study; all were outpatients arriving for clinic visits. All patients were eighteen or over, mostly in their sixties, and had not previously used the Health Status Questionnaire System. They were informed that they could voluntarily withdraw at any time.

Evaluation Procedure

All experimental sessions were completed before the patient's actual encounter with the physician. First, the evaluator asked the patients whether they wanted to try an experimental computerized questionnaire system or not. If the patients agreed to participate, they were shown one of the two versions of the Health Status Questionnaire System. The first 35 patients were asked to use a preliminary version of the system with a hand-held pen computer. After analyzing the test results from a preliminary version of the system, I made a few modifications to several interface aspects of the system and to the user training method as well. The 27 patients, the second group, were asked to use a revised version of the system with a hand-held pen computer. Then 50 patients in the third group were asked to use a revised version of the system with a desktop PC with a mouse to find out the effect of a different hardware and data input mechanisms. Before the actual session, subjects were presented with a brief description of the system and an explanation of the purpose of this investigation by the evaluator. Then they used the system to answer questions about their general health status. Finally in the third phase, all subjects were asked to evaluate the system by filling out the post questionnaire. Each session lasted no more than 15 minutes, including all three phases.

ABSOLUTE ANALYSIS OF THE SYSTEM WITH PEN COMPUTER

We used a post questionnaire to identify problem areas and to collect initial user response to the system. Seven measurement criteria were defined to identify problem areas in the user interface aspects of the system. The following presents measures of subjective user satisfaction of the revised version with the hand-held pen computer by looking at the overall normalized score (scale of -1 to 1) of each measurement criterion [4]:

Criterion 1. Ease of Use

The normalized satisfaction score of the responses to this criterion was 0.875, which is very positive. Among the 26 patients who used the revised version of the system with a hand-held pen computer and answered the post questionnaire, 19 patients described themselves as computer novices and 7 patients categorized themselves as intermediate users. Despite the lack of previous computer experience, most participants were able to use the system from scratch without any major problems and no one was entirely negative.

Criterion 2. Screen Display

For interactive computer systems, the screen display is a very important factor because it is what users see and interact with most of the time. The normalized satisfaction score for this criterion was 0.875 and close to 77% of the participants expressed an extremely positive reaction. We believe that the use of conservative colors, consistent screen display, and other details like carefully located buttons help to raise the normalized score given by the user.

Criterion 3. Instructions/terminology

No special medical terminology or computer jargon was used because the system was aimed at a general population that has widely varying educational background as well as computer experience. Positive comments were made by 98 percent of the participants. The normalized satisfaction score of the responses to these questions was 0.827.

Criterion 4. Error Correction

Participants were asked whether they thought it was easy to recover from their own errors. With the revised version of the system, over 92% of participants said that they were extremely satisfied with the error correction functions of the system. The normalized satisfaction score was 0.962.

Criterion 5. Response Time

All tasks were performed on a Toshiba hand-held pen computer with a 486 processor and 20 megabytes of memory. Even though Spinnaker PLUS runs in an interpreted environment, most operations are completed in a matter of seconds. As the normalized satisfaction score to this question, 0.863, indicates, most participants were very happy with the performance of the pen computer.

Criterion 6. Input Device

Despite the lack of experience with a pen computer or a stylus (only 3 of the 26 participants said that they had previous experience with a digitized pad or pen computer according to our post questionnaire survey), most participants stated that the pen was very comfortable and easy to use. Also, many patients commented that they liked the simple exterior and the portability of the hand-held pen computer. The normalized satisfaction score of the responses to this question was 0.827.

Criterion 7. System Usefulness

In order to determine how likely a participant was to use the system again and to find out user

attitudes toward the system, not to the interface aspects of the system, all subjects were asked to answer the behavioral intent question. The response to this question was overwhelmingly positive. The normalized satisfaction score was 0.962. Most participants were very supportive of the idea of the computerized questionnaire system and very excited about their involvement in the medical record system.

Overall Evaluation of the Revised Version

The overall normalized user satisfaction score of the revised version with a hand-held pen computer was 0.885 which is very positive (Table 1). 77% of the participants, 20 of the 26 patients, rated the interface aspects of the revised version with a pen computer "Extremely satisfied" and surprisingly, not a single participant rated the system on the negative side of the modified five-scale. This was a very encouraging test result considering most of our subjects are in their sixties.

Table 1. Normalized User Satisfaction Scores on the Pen Computer with the Revised Version (n=26)

	Normalized Score	Standard deviation
Ease of use	0.875	0.219
Screen display	0.875	0.239
Instructions/Terminology	0.827	0.260
Error correction	0.962	0.136
Response time	0.865	0.227
Input device	0.827	0.243
System usefulness	0.962	0.196
Overall Score	0.885	0.217

RELATIVE COMPARISON OF PC AND PEN COMPUTER AS INPUT DEVICES

This section presents a comparison between the two different hardware configurations, a conventional desktop PC and a hand-held pen computer. Both the post questionnaire and benchmark task results were used to find out user preferences and differences in user performance. But first, we will start the comparison by examining the difference in the user participation ratio.

User Participation Ratio

Since the participants were informed that they could voluntarily withdraw at any time, a few of them decided not to participate or withdrew during the experiment session. All 35 patients finished

answering the system with a hand-held pen computer in the first group and 26 of the 27 patients finished their task with a pen computer in the second group which means a participation ratio of 98.4% among the pen computer user group. However, only 24 of the 50 patients in the third group agreed to use the system with a desktop PC (Table 2). This means that more than half of the participants who were asked to use the system with a desktop PC refused to use it. Statistical analysis indicates a significant difference between the PC and the pen computer user group (chi-square = 38.73, p < 0.001).

Table 2. Comparison of User Participation Ratio: PC vs. Pen Computer

	User Participation Ratio
PC	48% (24/50)
Pen Computer	98.4% (61/62)
Statistically Significant?	Yes, at p < 0.001

These test results strongly indicate that people still get easily scared by the computer or similar looking machinery and there are substantial benefits for hand-held pen computers because they don't look like ordinary computers.

Analysis of Quantitative Data

The overall normalized user satisfaction scores by PC and pen computer user group were 0.874 and 0.885 respectively, which indicates that both user groups were very satisfied with interface aspects of the system, although users favored a hand-held pen computer over a desktop PC as a data input device (Table 3). Additionally, t-test results confirmed that there was no significant difference between two user groups in their attitudes toward the system (t (48) = -0.31, p, n.s.).

Table 3. Comparison of Normalized User Satisfaction Scores with the Revised Version: PC (n=24) vs. Pen Computer (n=26)

	PC User		Pen-Computer User	
	NS*	SD**	NS*	SD**
Ease of learning	0.885	0.212	0.875	0.219
Screen display	0.911	0.192	0.875	0.239
Instruction	0.844	0.276	0.827	0.260
Error correction	0.958	0.141	0.962	0.136
Response time	0.875	0.221	0.865	0.227
Input device	0.771	0.294	0.827	0.243
System usefulness	0.875	0.448	0.962	0.196
Overall score	0.874	0.255	0.885	0.217

* indicates normalized score
** indicates standard deviation

Analysis of Benchmark Tasks

Benchmark tasks have been used to compare the performance of the two user groups; the pen computer and the PC user groups. Test results show that the pen computer user group completed their task about 20 seconds faster than the PC user group, but the difference was not statistically significant (t (48) = 0.59, p, n.s.). Also, the pen computer user group committed fewer errors than the PC user group. But, again, the difference was not statistically significant (chi-square = 0.22, p > 0.3).

FUTURE RESEARCH

Since we received very positive responses from the patients about the computerized questionnaire system, we want to explore the use of a pen computer for patients with or without diseases. We are proposing an expanded patient interface. In this proposal the system would first ask patients to answer the Health Status Questionnaire System, then it would ask general questions for all patients about their social history including their exercise, smoking, and drinking habits. Third, the system would query the patient about possible side effects of all medications currently presented for him/her. Finally the system would ask disorder-specific questions about hypertension or diabetes or other chronic diseases to patients who have that particular disease. What questions patients should see also depends on how long it has been since the last visit.

We plan to develop lists of disorder-specific questions and patient-specific for hypertension and diabetes for review. Then we will implement them on a pen computer, and try them out in a clinic setting. The optimum number of questions should be studied because too many questions will irritate the patients.

As we develop more disorder-specific questions for patients, we also need to investigate how to inform physicians of questionnaire results. Obviously, physicians do not want to read all the answers from the questionnaire and we have to find the best way to collect abnormal information from the database and report them to physicians. This issue is very challenging because abnormal medical information can vary depending on the patient's disease, age, sex, medication, etc.

CONCLUSION

We have designed the Health Status Questionnaire System to allow direct patient entry of information into the medical record. With this client-centered system, patients can contribute to their own medical record and active patient involvement in the health care process will lead to better communication between physicians and patients, which can produce better health care results.

The results of the statistical analysis of the post questionnaire indicate that the patients involved in the study rated the user interface of the Health Status Questionnaire System highly. The study also revealed that a considerable number of the general population still have negative preconceptions about their ability to handle a computer or similar looking machinery. As we mentioned earlier, 62 patients were asked to use the system with a hand-held pen computer, and 61 of them agreed to use the system. However, among 50 patients who were asked to use the system with a desktop PC, only 24 patients agreed to use the system. Most of the outpatients of the HealthPoint beta site were in their sixties and we expected that this would serve as a negative factor in their attitudes toward computers in general. But, apparently the hand-held pen computer has substantial benefits over a conventional desktop PC because its simple exterior makes it less intimidating to an older user group. This result indicates that the hardware interface, in other words, what the machine looks like, is as important as the software interface of the system in some cases.

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