

Collaborative Software Development for a Brazilian Telehealth Program

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Abstract. Telehealth services in the State of Pernambuco, Brazil are led by the Telehealth Center (RedeNUTES) and based on HealthNet 2.0 software. Among the tele-assistance services, health professionals have clinical discussions focused on second opinions. This paper reports the experience in a PhD study through mixed-methods, to evaluate the telehealth services, planning and modeling a new tool to improve a telehealth system. We described the nurse's role in each phase of this study. The method of User-Centered Design was explored in three phases as Identification of work process, User's perception and collaborative modeling, Observational usability study. The main frame was based on collaborative techniques as Collaborative Prototype Design Process, cognitive walkthrough, and thinking-aloud. The users also identified all usability problems identified by the evaluators. The methods were useful in identifying usability problems, and easy to employ using standard equipment and software thus a relatively low cost approach to usability testing.

Keywords. telehealth, software designs, group processes

Introduction

In Brazil, in order to capacitate the Family Health Strategy teams, the Health Ministry implemented the Brazil Telehealth Program (Telessaúde Brasil Redes) to provide health support and continuous education in the Health System [1]. In Pernambuco state, the Telehealth Center (RedeNUTES) offers telehealth services to 94 municipalities, through tele-education (web conference courses) and telesupport through the teleconsultation. This synchronous and asynchronous communication allows for clinical discussions between primary care professionals and RedeNUTES teleconsultants [2].

Looking for an expansion of the telehealth, as a result of a national effort to improve the quality of primary care in the Brazilian national health system, RedeNUTES developed a system called HealthNet (version 2.0) that allows a health cooperative based on Web Services [3].

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At present, HealthNet 2.0 enables the real-time discussion of clinical cases and the submission of clinical questions via electronic forms. Using this system, primary care health professionals (nurses, doctors and dentists) working in areas of Brazil with limited physical access to referral centers are able to confer with distant experts, obtain guidance, and receive second opinions [2-3].

With increasing demand for second opinion consultations, developing a new tool to enhance the role of the teleconsultant, could improve the educational and telecare process of the HealthNet 2.0.

Therefore, the principal investigator, as a nurse and teleconsultant, noted that in the current version 2.0 of HealthNet, does not had a tool that could search for requests posed by primary care users or answered by teleconsultants.

In this study, we described how was the planning, development and evaluation of a new tool for HealthNet, using collaborative strategies from nurses in different roles.

1. Background

The teleconsultants who work on the RedeNUTES telehealth program are doctors, nurses, and dentists with different specialties, who can attend to health professionals' demands for a second opinion and present online courses (web seminars). In the case of a remote second opinion, the RedeNUTES triage team receive the requests and determine which professional is the most adequate to handle the case. This discussion can be done in real time, via a Web conference with a teleconsultant, or asynchronously, via an electronic form [3].

The triage optimizes the response time of the teleconsultants. Each country has its own regulations for the selection of the professional who acts as the in-formation regulator, but the nurses are involved with information technologies and can contribute positively in this position, based on their broad health education [4].

The use of remote communication can promote education, research collaboration, and second opinion sessions and therefore bring better support to the population [5].

Developing software requires care at the time of system modeling. Considering how the software could be used, under-stand the user context it is important to start any system project. The planning stages preceding the identification of requirements and prototyping should get the focus on the usability of the final product [6]. Adopt one or more appropriate methodologies for requirements modeling should be part of research studies in software engineering [7].

The first step of system development is requirements modeling. This step helps in the identification of effective work processes, which can guide software engineers in the production of the object proposed [8] and allow designers to determine how users will apply the software in order to achieve successful final results [9-10]. Because it is a critical step, the process of recognition of requirements must follow a detailed methodology. Neglecting this step can have negative effects on the development of software and will influence the final product quality [11].

Despite the different methods of requirements modeling, what is observed is that there is no gold standard adopted in the studies, leaving researchers to define its resources and potential users. In this case, methods that utilize the users' perception have a great advantage [11].

The Collaborative Prototype Design Process (CPDP) brings together users across multiple groups in collaborative techniques such as discussions and interviews. These

collaborative techniques can be combined with the use of low and medium fidelity prototypes [12].

Furthermore, to exploit the method of User-Centered Design, the users should be able to see a preview of the product as soon as possible. At that moment, adopting the strategy of prototyping can provide to users theoretical and visual information, without requiring specific demands of a team of programmers or a finished product [13].

During the prototyping phase, user involvement should occur as soon as possible in order to show a vision of the final product, enabling corrections before production [12]. In this case, information of users from a medium fidelity prototype (wireframe), creates an interactive environment conducive to new suggestions, criticisms or solutions for the product in question.

Usability studies, optimally conducted before deployment, should consider the context of use, ease of use, and examine the aspects of learnability, flexibility, effectiveness, and user attitude [14-15].

Studies of usability are important for any innovative eHealth system because for a system to have true value and impact, it must first and foremost be usable and accessible by health professionals, consumers, and other stakeholders [16].

A number of different methodologies complement the assessment of usability and user behavior [17]. Many in the literature call for mixed-method approaches to assessing usability, asserting that the use of various methods (i.e. qualitative and quantitative) will strengthen the reliability of the findings [18-19]. Therefore, the formalized study of usability is frequently conducted using a variety of techniques such as cognitive walkthroughs, user and environmental analyses, surveys, and user observation.

A common approach to the conduct of usability studies conducted early in the development process is to engage representative participants in a scenario that approximates targeted real-world use. A mixed-method usability approach in which subjective impressions (qualitative) are combined with quantitative assessments provides a robust approach for evaluating effectiveness, efficiency and user satisfaction [20-22]. A combination of heuristic evaluations, cognitive walkthroughs using think-aloud techniques, observations, and surveys are often employed in two different user groups (experts and standard subjects), consistent with accepted usability frameworks. In the cognitive walkthrough technique, users are asked to “think-aloud” while “walking-thorough” the process under study. This approach focuses on the cognitive processes involved in task completion, instead of the deeper functionality of the system [23].

The goal of this study was describe the nurse participation in a collaborative methodology to plan, develop and evaluate a new technology improvement to HealthNet 2.0.

2. Methods

This paper reports the experience in a PhD study through mixed-methods. The subjects, settings and the nurse's role were explored in each phase of this study. The purpose was to plan a search tool called "Case Search", to be implemented in HealthNet 2.0.

2.1. Identification of work process

To understand the real scenario, was proposed a descriptive study about the telehealth services developed in Pernambuco. The focus was the direct participation of nursing professionals in tele-education and telesupport. The analysis covered two years, started in January 2009 until December 2010. The data was collected from secondary storage at RedeNUTES.

2.2. User's perception and collaborative modeling

Two groups were participated in this study. In the first group, eight professionals joined the Discussion Group – Rede NUTES (five professionals from technology's area, one informatics biomedical and two nurses). The second group "Discussion Group - Health Professionals" formed by eight professionals (three nurses, two physician, two dentists and one psychologist) cooperated with the requirements assessment. All subjects had experience in telehealth and HealthNet 2.0 functionality.

2.3. Observational usability study

This observational usability study identifies features of usability and current errors and also user behaviors when interacting with the "Search Case" prototype. Throughout, we apply evaluation methods reported by Abbott (2012) [24] and Kushmiruk (2005) [25]. The study was conducted in two independent phases, each with different subjects. Phase 1 involved a *cognitive walkthrough* to refine the usability study procedures and Phase 2 was an *observational study* with *expert users*.

The *evaluators*, (the subjects used in Phase 1) were invited based on experience in usability testing; *users* (the subjects used in Phase 2) were nurse practitioners and clinical nurse specialists recruited from a doctoral program in nursing.

A scenario was created to simulate an approximation of the expected actions of an "actor" (user), using the "Search Case" prototype. A Task List (TL) was created to guide the users, and validated through the evaluators.

Phase 1: The expert evaluation was conducted based on *cognitive walkthrough*. Two evaluators followed the task list "walking through" the prototype. The audio, video and screen data was recorded. They validated the task list and others proposed survey form (demographic and satisfaction questionnaire). The expert feedback was included with a usability problem and error list.

Phase 2: Each subject received a PC laptop and headset; in the browser was loaded the HealthNet 2.0 and provided an individual login and password; Screen navigation and audio recordings were captured and tagged to each subject ID. Subjects were instructed on the "Think Aloud" procedure and allowed to practice the technique if desired. Without explaining HealthNet 2.0, users were asked to think-aloud about the experience while following the task lists refined in Phase 1. After completing all tasks, users completed a demographic survey and user satisfaction questionnaire.

3. Results

The RedeNUTES team of teleconsultants is broad and diversified with regard to types of education and specialties. However, two nurses work as regulators, evaluating requests, and are able to provide opinions and coordinate teleconsultations with other nursing professionals, according to the needed specialty.

Table 1. Cumulative distribution of professional categories represented in the web conferences courses in the years 2009 and 2010, Pernambuco, Brazil.

Professional category	2009		2010	
	n	%	n	%
Community health worker	3045	40.8	4070	40.7
Oral health attendant	358	4.8	580	5.8
Dentists	388	5.2	648	6.5
Nurse	1577	21.1	2156	21.6
Physicians	316	4.2	173	1.7
Nursing technician	1114	14.9	1397	14.0
Others	673	9.0	967	9.7
Total	7471	100.0	9991	100.0

We can highlight the nurse's participation in web conferences as user (**table 1**) and as a lecturer (**table 2**).

Table 2. Distribution of the lecturing professionals for the courses in 2009 and 2010, Pernambuco, Brazil.

Professional category	2009		2010	
	n	%	n	%
Nurses	46	30.5	67	33.8
Physicians	69	45.7	60	30.3
Dentists	8	5.3	16	8.1
Psychologists	19	12.5	40	20.2
Others	9	6.0	15	7.6
Total	151	100.0	198	100.0

It is possible to see, in **figure 1**, the importance of the participation of nurses in submitting questions to the telehealth services and as teleconsultants, formulating an opinion regarding a question raised via an electronic form or in a Web conference. In addition to the clear participation of nurses as requesters, the telesupport provided by them accounted for 33% of all the telesupport provided in 2009, with an increase to 48% in 2010.

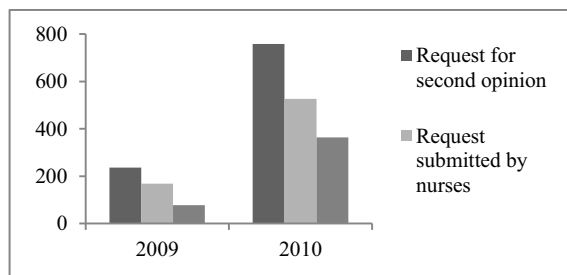


Figure 1. Distribution of the demand for online teleconferences handled by nurses in 2009 and 2010, Pernambuco, Brazil.

About the functional requirement of the prototype, identified on “User’s perception and collaborative modeling phase”, 18 requirements were described. In each meeting with the Discussion Group - RedeNUTES lasted 90 minutes. Other 180 minutes were used for transcription of the relevant information. Only three requirements received low score.

A planning and specification of software functions (requirements) can guide future users on how to use the tools correctly. Through this procedure, favorable outcomes in futures studies of satisfaction and usability will be achieved [22].

Table 3. Comparison of Usability Problems from Heuristic and Performance Evaluation

Theme	Usability problems and errors (Heuristic evaluation)	User’s actions completed with help (Performance evaluation)	Suggestions
Access to community	Notification to join in the community is not clear; It is possible to see the second opinion service, but the user cannot access without join the community.	Users tried open second opinion before join in the community;	Hint the services when the users are not accepted in the community; The alert could inform to user joint in the community;
Icons and nomenclature	There is not evident option to associate a patient; File/document are confusing; Delete icon is not clear; The refresh button is not evident;	Users submit question without patient associated; Users tried first to create a new patient; Files was deleted; Users were logout after refresh the browser;	An alert could confirm the request; Change the icon or use label; Disable buttons;
Query list	Is not obviously that the query was answered;	Users tried to read pending request;	Create an alert;
Command to back	The back button makes the user exits the program;	Users were logout after use back button the browser;	Disable buttons;
Case list	The case list in Search Case don’t have different descriptions;	Users were looking around to identify the correct case to open;	Create icons; Increase the descriptions;
Case evaluation	The stars already completed may confuse users; The comments could be confused with evaluation;	Users write a comment without make evaluation through stars;	Change the colors; Maintain only 3 star completed;
Query triage list	To triage profile is not default My Regulation;	Users were looking in my request;	Change default to my regulation;
Query to answer list	To teleconsultant profile is not default My Teleconsultant;	Users were looking in my request;	Change default to my teleconsultation;
Layout	The layout from teleconsultant is too long, can be the user confused;	Users clicked more than once “Recommendation to read”;	Change layout eliminating blank frame;

To complete the usability test, seven advanced practice registered nurses enrolled in a health informatics course in the Doctor of Nursing Practice program at the University of Michigan School of Nursing. Nurses were chosen to approximate the results with a scenario close to reality.

In the think-aloud analysis, the narrative comments were replayed during which time the overall theme of the comment was recorded in addition to the specific issue encountered. Comments that reflected some aspect of user satisfaction were also recording along with a determination if these were positive or negative in nature.

The most important correlation between the users and evaluators is shown in **table 3**, which presents the usability errors from *expert evaluators* combined with user's action in the performance evaluation.

This study demonstrates procedures for identifying and validating procedures targeted for use in a larger usability study. There are limited examples of pilot testing usability study procedure in the literature. The study was framed in the context of contemporary frameworks for usability studies. The procedures we employed clearly require validation by others who are developing procedures for conducting usability studies.

The users also identified all usability problems identified by the evaluators; that is, no new problems were detected. The heuristic evaluation by the Cognitive Walkthrough, combined with performance user evaluation, was demonstrated to be helpful in identifying usability problems. This method is appealing because it is grounded in theories of how people learn and allows evaluators to identify cases where the system provides insufficient information to guide users toward the next correct action.

The "think-aloud" technique was a good method to identify the difficulty of tasks that users were trying to do. Using a single, synchronized system for both screen and audio capture allowed the investigator to associate cognitive perceptions with actual usability problem.

There are recognized limitations to this study. First, we did not accrue subjects until saturation was observed as is recommended in qualitative studies; rather our sample size was based on the experience of other investigators in identifying saturation. The sample was predominantly registered nurses, and other targeted users of the Second Opinion tool (e.g., dentists, physicians) may have different perceptions, attitudes, intention to use, and user behaviors. Our sample size was small, and significance and confidence level estimates should be interpreted with caution.

4. Conclusion

The results of this study showed that the combinations of mixed-methods, mainly the heuristic and performance evaluations were useful for informing the next level of usability testing. The nurse's involvement was critical to contextualize the use of HealthNet 2.0 and to transforming the perception of users. Collaborative modeling is a quick, inexpensive and necessary. Through simple techniques such as discussion group and prototyping by wireframe we can understand the universe of users. Cognitive walkthrough and think-aloud methods were useful in identifying usability problems, and easy to employ using standard equipment and software thus a relatively low cost approach to usability testing. However, the applicability should be tested with real users and in a large sample subjects.

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