The Contextual Nature of Usability and its Relevance to Medical Informatics

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Abstract. We report from three usability evaluations of health information systems that illustrate the value of seeing usability as a context dependent property of a product. We show how the definition of usability in ISO 9241-11 can be used as a guiding principle in the evaluation, specification and design of such systems. The contextual view on usability is particularly important for health information systems because of their great diversity concerning user groups, tasks, and work environments.

Keywords. Human factors, user-computer interface, standards, health information systems, usability, context-of-use

Introduction

Compared to other fields of informatics, medical informatics has been relatively late in adopting a focus on usability. This can be seen both as a drawback and as an opportunity. A positive consequence is that the field can draw on 25 years of research in human-computer interaction (HCI). One important sign of a mature research field is that it has developed a shared set of well-defined concepts. Within HCI, one of the most central concepts is usability. Since its infancy in the early 80s, the HCI field’s understanding of usability has changed from a focus on efficiency and “user-friendliness” to a mature definition made explicit in the standard ISO 9241-11 [1]. An important shift in the understanding of usability has been from seeing it as a property of the software as such to see it as a relation between the software and its context of use. This has important consequences for how software should be designed, evaluated and implemented. The heterogeneity of the use situation for health information systems makes awareness of the contextual nature of usability particularly important for such systems. We will illustrate the relevance of a contextual perspective on usability for health information systems with findings from three recent research projects.

1. Related Work

Already 15 years ago Jakob Nielsen [2] discussed the relation between usability and the overall system acceptability of a product. He argued that other factors such as price,
compatibility, and social acceptability are important. More recently, it has been argued that aesthetics and “desirability” are just as important as usability [3]. It has been empirically shown that the technology acceptance of a product can be predicted with technology acceptance models such as UTAUT [4]. Such models list usability (“ease of use”) as one of the most important factors affecting the user’s choice, thus showing the importance of a focus on system usability.

The definition of usability in ISO 9241-11 has been the basis for ISO 25062 [5], which specifies a common industry format for reporting the results from usability tests.

2. Usability Defined

ISO 9241-11 defines the usability of a product as “the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments”. The ISO standard defines usability in terms of three measures: effectiveness, efficiency and satisfaction, and three aspects of the use situation: the users, their goals and the use environment. The use situation as a whole is referred to as the product’s context of use.

Effectiveness is the most important measure. It is the extent to which the goals of the users are achieved. In usability tests this is often measured as task completion. Efficiency is about the resources necessary to achieve the goal. In usability tests this is often measured as completion time. Satisfaction is about the user’s subjective assessment of the product. In usability tests, user satisfaction is often measured with standardized questionnaires. Together, these three measures give an indication of how “usable” the product is. Experience from empirical research shows that these measures can not be reduced to one single measure, and that all three should be reported when usability tests are done [6].

The ISO definition of usability differs from many other ISO definitions by being context dependent. It says that the usability of a product cannot be measured as a property of the product as such, but only in relation to a specific context of use. This is different from context independent definitions as the Kilogram. The weight of a laptop PC is independent of its user, its purpose of use and its use environment.

The ISO definition of usability refers to three aspects of the use situation: (1) Specified users require that the users are identified. For usability evaluations of systems in actual use, the specified users are the actual users. For usability tests it is necessary to characterize the future users to such an extent that it is possible to select a representative set of test subjects. (2) Specified goals are about the users’ purpose when using the product. In usability tests, the users’ goals are defined through the tasks that the test subjects are asked to carry out. (3) The environment is the physical and social conditions of the use situation. This includes physical aspects, such as furniture and noise levels, and ergonomic aspects such as placement of equipment. In usability tests it is necessary to imitate the environment to the necessary level of detail.

3. Usability is Contextual

Let us illustrate the ISO standard’s definition of usability with an example from medical informatics. Many electronic health record (EHR) systems currently offer access through wireless personal digital assistants (PDAs). Let us focus on such a
system’s function for retrieving lab results for a patient. For the current purpose, let this function be what the ISO standard refers to as the product. The effectiveness of this product is to what extent the users (i.e. the doctors and the nurses) are able to get access to the lab results for a given patient. Given that the users are able to complete their task, the efficiency is about how much effort they have to put in to achieve it. The efficiency can be quantified as time used on the task, need to consult written material, and help from colleagues. One way of measuring the user satisfaction could be to ask the users questions about how they like the system on a scale from 1 to 5.

Let us assume that the specified users for our hypothetical EHR system are doctors and nurses. This would then exclude patients, hospital administrators, visitors or any other person present in a hospital who might want to look at lab results. If a patient picks up the PDA, fails to get access to his lab results, and complains about the usability of the product, he has misunderstood what usability is all about. This product was not intended for patients, and it is therefore meaningless to talk about its usability for users outside of its intended user group. Our hypothetical product could have been designed to allow for access by patients, but that would have made it a different product with a different intended user group, and consequently with different criteria for evaluation of usability.

A similar argument goes for the specified goals. If a user criticizes the system for not allowing for text messaging, that is not a statement about the usability of the EHR lab result function, but a wish for some new functionality. Such statements are of course legitimate, and feedback of this sort should even be encouraged in the dialogue with the users, but they say nothing about the usability of the product.

Let us, in a similar fashion, assume that the intended use environment for our hypothetical product is specified to be within the walls of the hospitals and in good light conditions. The fact that the PDA will be useless in the badly lit back of an ambulance far away from the hospital wireless network is consequently irrelevant in a discussion about the usability of this product, as long as ambulances are not included as one of its intended use environments.

4. Context-of-use Illustrated with Three Cases

We will illustrate the relevance of a contextual perspective on usability from three recent usability studies performed in our usability laboratory. The usability laboratory at the Norwegian National EHR Research Center (NSEP) in Trondheim has an 80 m2 room with movable walls that allows for full-scale simulations of situations from hospitals. That makes usability tests possible with a number of users simultaneously.

4.1. Case A: Getting the User Group Right

In cooperation with the system vendor, we did a usability test of an eHealth service for primary care that allows patients to communicate with their doctor through a web interface. The web service allows the patients to make appointments, send requests to their doctor, and ask for renewal of prescriptions.

One of the most critical usability problems found was related to SMS codes sent by the system to verify the identity of the user. These codes had to be read from the patient’s mobile phone and typed in on the PC. The codes were random sequences of digits and letters, e.g. “Bq7cP8”. For a number of users this became a major obstacle.
We observed that this was particularly true for users with pain and on strong medications. This observation led us to question the validity of the usability test, as one might expect that a considerable number of eHealth users will be pain patients. To test if pain and medication actually has an effect on the patient’s ability to use the system, we did a controlled experiment where a group of cancer patients (N=14) and a matched control group (N=14) were exposed to the eHealth system. The study showed a statistically significant difference in completion rate between the two groups [7].

The lesson learned from this case is that one has to be very precise in the definition of the user groups for health information systems. Large between-subject variations in test results are indications that one might have to split the user group into subgroups.

4.2. Case B: Getting the Physical Environment Right

A number of new hospitals now install bedside terminals for the patients. Such terminals are currently to a large extent used for entertainment and web browsing. In cooperation with one of the vendors of these terminals, we explored the potential for letting doctors use handheld devices (PDAs) as input device for the bedside terminals. Seven different prototype user interfaces were implemented. They were tested on a scenario where a doctor uses a bedside terminal to show X-ray images to a patient [8].

Due to patient safety and privacy issues we were not allowed to test the prototypes in situ. The usability tests were done in our lab with a replication of a patient room with a hospital bed, a touch screen and a PDA. The tests were run with pairs of doctors and patients. After having tried out all versions, the doctors and patients were asked to rank the different solutions by sorting cards representing the alternatives. They were asked to give reasons for their ranking. Figure 1 shows to the left the recorded video from the test, and to the right a combined video with the bedside terminal and the PDA.

![Figure 1. The doctor uses his PDA to select which X-ray image to show to the patient.](image)

An analysis of the factors that influenced their ranking showed that the usability of the different design solutions were to a large extent not a result of the usability of the Graphical User Interfaces (GUIs) as such, but of how each design solution affected the dialogue between the physician and the patient. These factors included free eye contact, the ability to have a shared view, and distance to the screen. A “desktop” usability test, focusing only on the system’s GUI, would for this case have given misleading results.
The lesson learned from this case, is that for usability tests of health information systems it is necessary to imitate the environment to a high degree of realism.

4.3. Case C: Getting the Scenario Right

We are currently involved in the usability testing of a new version of a hospital EHR system with new modules for computerized physician order entry (CPOE) and lab result access. The current version only works on stationary computers, while the new version will also work on laptop PCs with WLAN access. The version to be tested is in a beta release, and due to patient safety and privacy issues we are not allowed to test it in situ. Five persons were involved in each test: a doctor, a nurse and three actors simulating patients.

To ensure the realism of the usability test, a portion of a ward has been replicated in our lab, including meeting room, corridor, patient rooms and patient beds. To get the scenario right, it was necessary to do field studies of actual work practice and include health workers in the specification of tasks and goals. It was also necessary to give the patients in the tests realistic medical histories, so that the doctors and nurses had goals that mimicked those in real life. The first phase of the project was a baseline test where pairs of doctors and nurses performed a pre-round, round and medication scenario with the current combination of stationary EHR system and paper-based ordering and lab results. Figure 2 shows the wall setup of the laboratory and a scene from the test.

To check the validity of the baseline test, the video recordings from the test were compared with field notes from an actual ward. The comparison revealed a number of differences related to the scale of the social unit being tested. We had not included any interruptions in the scenario, while the field notes showed that medical work to a large extent is event driven, with many interruptions and with many tasks going on in parallel. We used this knowledge in the planning of the next phase of the test, by introducing unexpected interruptions in the scenarios. Interruptions included physicians being paged due to emergency and nurses being called to other patient rooms.

The lesson learned from this case is that medical work is very complex, and to get valid test results the use scenarios must replicate the tasks and goals of the health workers in great detail. Domain experts should be included in the design of the scenarios, and tests should be compared with observations from real life.
5. Discussion and Conclusions

Our experience from doing usability tests of health information systems shows the importance of taking into consideration the contextual nature of usability as it is defined in ISO 9241-11. The medical domain is highly specialized, with a number of different professions and patient groups, a large number of different activities, and many different work environments – all within the walls of the same hospital. Some systems have only one user group, while many health information systems have a number of user groups, often with different tasks and work environments. It is consequently meaningless to talk about the usability of a particular information system without being very specific about its intended user groups, tasks, and work environment.

This has consequences for the usability evaluation of such systems, but also for the specification and design phase. Due to the complexity of the context of use for such systems it is important that user groups, tasks and work environments are defined in great detail before a new system is being designed. If one or more of these factors are not well defined, the development project runs the danger of making a product that might have a high usability for the project team’s imagined context of use, but not for the actual context of use.

The Human-Computer Interaction field has produced a number of design techniques, such as contextual inquiry [9], personas [10], and scenario-based design [11] that can help in the identification of the correct context of use. Properly used, such techniques can enable developers of health information systems to not only “make the thing right”, but also to “make the right thing”. For this purpose we suggest that the ISO definition of usability can be a powerful guiding principle.

References