

Increased Acceptance in the Interface Development of Nursing Documentation Software

Nowadays it is important to develop effective and efficient software that is, at the same time, easy to use. Since all systems and services are ultimately aimed at human users, it is essential to deal with the interaction between humans and machines. The acceptance of a system, i.e. the question whether a system is interpreted by a user as good or bad, is a complex construct of perception and evaluation processes. The measurement of such processes, which ends in their weighting, is a major step from the scientific field of social and behavioral sciences towards mathematics and computer science. Subject of the work presented here is the web-based information platform INFODOQ. The information, coordination, communication and documentation platform, which has been tested by several empirical and analytical usability tests, helps to improve the communication of nursing staff in the HCI context and to promote the integration of information science in the medical treatment area of nursing.

Keywords: Health Informatics, User Experience, Usability, Information Science

Introduction

Demographic change and the associated improvement in medical care and nutrition as well as changes in housing conditions have a lasting impact on the life expectancy of generations. In addition, reduced birth rates and the resulting ageing of society are leading to a decline in the population and a massive increase in people in need of care. This results in a large shortage of junior nursing staff. Forecasts by the German Federal Statistical Office (Sarodnick and Brau, 2018) show that in the next 15 years more than 66,000 skilled workers will be lacking in outpatient nursing alone. The shortage of nursing staff will result in a loss of value added and overall losses of 35 billion euros by 2030 due to vacant positions. On average, the healthcare sector is growing more than one percent faster than the entire German economy per year and at the same time, it is one of the least digitized sectors. According to (Haefker and Tielking, 2017), only 20 percent of clinics work with electronic nursing documentation. Based on such figures, the question arises as to why information science is so little accepted in this sector in particular. On the one hand, the basis of this scientific work rests on the problem of the increasing number of people in need of long-term care. On the other hand, the following questions are fundamental for this work: Why is there hardly any need for transparent care documentation articulated in the care sector in particular? Which requirements and problems arise during the interaction of nurses with digital care documentation? How can the user-friendliness of interfaces in nursing documentation be increased in the context of these points?

In chapter "Literature Review", the paper gives an insight into opinions on acceptance criteria that generally exist for interactions with software in medical care areas. Chapter "INFODOQ" describes INFODOQ, a web-based infor-

mation platform for use in outpatient residential care groups. Chapter “Evaluation” describes the empirical and analytical usability tests based on the specially implemented software INFODOQ. The Chapter “Discussion” shows the acceptance criteria in nursing resulting from the tests. Chapter “Conclusions” provides a conclusion of the work and a brief outlook.

Literature Review

In the medical field, central administrative activities and services can be supported almost seamlessly by IT systems. According to (Haefker and Tielking, 2017), the entry of information science into the narrower field of medical treatment and care is more difficult due to ethical, social and technical reasons.

Many works in the field of software development are based on the heuristics for the design of interfaces formulated by (Nielsen, 1993) and (Molich, 2017). These include visibility of system status, correspondence between system and reality, user control and freedom, stability, flexibility and efficiency, an aesthetic and minimalist design as well as assistance in recognizing, evaluating and correcting mistakes. As part of the UCARE project from 2017 (Gräfe and Rahner, 2017), a usability competence centre was developed to support small and medium-sized software manufacturers in the care industry. Nielsen's ten heuristics are also taken up here and extended by the subjective perception of the viewer of a software.

In the work by Hielscher, Kirchen-Peters and Sowinski (Hielscher, et al., 2015), the topic of the acceptance of nursing staff is addressed as follows: A decisive factor for the positive acceptance of the IT-supported documentation is the individual self-confidence in the direct handling of computers as well as the acceptance of the care process mapped in the documentation system. In addition, the social context of the group of colleagues and their acceptance of the technology represent a considerable factor, since nursing staff within work teams or shifts have a significant influence on the willingness to use the technology. It should be noted that technical settings should not be regarded as static variables. They can change during the introduction of IT systems and with increasing service life. The administration of the maintenance process is shifted "into the system" by digitizing the documents, away from the management and specialists. This tends to reduce the scope for consideration and negotiation processes regarding the correctness or execution variants of the individual maintenance steps. Deviations are still possible, but automatically become justifiable and directly transparent for management. In this context, the obligation to provide reasons is to be regarded as very important.

(Wechsler, 2015) describes possible contextual challenges within the development of a mobile health-related application on the basis of a mobile health project from the year 2015. She emphasizes that software designers have

to adapt flexibly to the respective needs of nurses. In order to avoid discrepancies between the ideas of nurses and those of designers regarding the application, it should be ensured at the beginning of development that nurses understand that the design process requires their participation in order to achieve the best possible results. A possible way to do this would be to educate them about the value of design research activities in advance. The transfer of knowledge between nurses and designers should be made efficient. Both sides should commit themselves in advance to participate in the respective design process.

INFODOQ

In the medical field, central administrative activities and administrative services can be supported almost seamlessly by computer systems. The entry of information science into the narrower field of medical treatment and care is much more difficult for various ethical, social, and technical reasons.

INFODOQ is a web-based information platform for use in residential care groups with outpatient care. The system was developed due to the desire for a transparent information, coordination, and communication platform for different dementia residential communities to optimize the daily care and nursing routine. One significant factor for the digitalisation of the documentation, which has only been available in analogue form to date, is the enormous increase in performance. In addition to the reduction of redundant or incorrectly addressed information and communication channels and the simultaneous reduction of bureaucratic and administrative effort, the system ensures effective and efficient care and nursing. Furthermore, the information platform offers a transparent way for the information, coordination and scheduling of relatives, carers and auxiliary staff through mobile use.

INFODOQ can be roughly divided into two areas: the front end, which is responsible for the display and direct interaction with the user, and the back end, which is responsible for the operating logic, persistence and provision of data and its security. The following section provides a brief overview of the architecture of the system.

The INFODOQ back-end on the one hand consists of a lightweight Representational State Transfer (REST) web service and on the other hand of the persistence of the data by means of a SQL database. The main task of the back-end application is the provision of resources under consideration of the REST principles. Among other things, these principles include statelessness. This means that each request to the web service contains all the required information and is self-contained. Furthermore, the uniformity of the application interface (API) plays a major role in the implementation of REST web services.

The structure of the front-end application is mainly determined by the two technologies used, AngularJS and Ionic. The basic framework of the front-end application consists of a Single Page Application (SPA), which was developed

using the Web framework AngularJS. The Ionic Framework serves as a bridge between the AngularJS SPA and the native mobile application.

This project is based on the need to reduce the time and resources required. This was ensured by minimized interfaces in the control of processes, responsibilities, attendances, activities, remarks etc. for the persons (groups) involved. INFODOQ increases the quality of life and care as well as the participation and exchange of caregiving relatives in the care process and the further development of quality recommendations for outpatient care arrangements. In this project, the knowledge gained about the possibilities and limits of a documentation and information platform in ambulatory care situations, which is shared by the nursing service, relatives and volunteers, was implemented in a targeted manner.

The conception and further development of the application are complemented by extensive test phases.

INFODOQ aims to provide user-friendly, comprehensible and barrier-free access for members of shared flats of all ages. In addition, the online application will be fundamentally dynamized in order to be available to as many residential care communities as possible.

Usability first - the primary goal is usability. In terms of scientific work, various quality aspects are taken into account in all phases of planning, conception, implementation and optimization of INFODOQ, so that users can use the application as self-explanatory and goal-oriented as possible. In the test phases selected user groups are asked to carry out typical tasks such as communication or documentation of support tasks, which they would like to carry out later in a similar form within the framework of INFODOQ. Difficulties or ambiguities that arise during use can thus be analyzed and resolved.

The focus of the usability test is on the following questions: Is the user interface comprehensible and clearly structured? Can important information actually be found? Are terms clearly formulated? Are there points where the user cannot progress without help?

The different user groups and the associated different needs and expectations of the users pose a special challenge for the design and development of the software in the following project. A structure of the user groups follows.

Caregivers

The persons who have to actively use the system are classified as caregivers. They do that in the sense of digitization, transparency to all other user groups and to increase performance of their work. Caregivers interact with the system on a daily basis, they record activities and behavioural characteristics of the residents, as well as any changes.

Relatives

Relatives are the persons who act as legal guardians of a resident. In most cases, these are relatives within the family circle who are close to the resident. It can be assumed that this group of persons interacts with the system out of emotional motivation, in the sense of covering a knowledge gap regarding the current activities and behavioural characteristics of their relative.

Evaluation

In the following the different analytical and empirical usability evaluations as well as the focus group of the investigations are described. The different needs and expectations of the nurse staff pose a particular challenge to the design and development of the software in the project. A structure of the personas which are presented as fictitious users of the application with their characteristics and abilities follows. Nurses are persons who actively deal with the information platform in order to optimize digitization, transparency to other user groups and, above all, the performance increase of their work. Nurses interact with the information platform on a daily basis; they log the activities and behavioral characteristics of the residents and any changes they make. The following persona represents a member of the nurse staff:

Sahra:

Age: 30, sex: female, marital status: single, occupation: nurse

Interests: singing, jogging, spending time with friends

Used devices: cell phone, tablet, computer

Experience: is familiar with the use of technical devices, uses various management apps such as notes and calendars, registered on various online platforms and has experience with account management

Procedures: systematically examines applications to learn more about their functions, uses full-featured applications and is not afraid of new functions

Targets: creation and editing of documents, addition of people to activities, filtering and printing of documents

Heike:

Age: 50, sex: female, marital status: married, occupation: nurse

Interests: reading, cooking, watching series, playing evenings with the family

Used devices: cell phone

Experience: uses your smartphone mainly for telephoning and writing, has no other experience and interest in technology and the internet

Procedures: is careful when using applications, can explain the functions of an application and then only use those she knows

Targets: creation and editing of documents, addition of people to activities, filtering and printing of documents

Test Execution

In order to scale the usability as well as the later acceptance analysis, various summative (i.e. the evaluation of a system towards the end of the development process) and formative (i.e. the evaluations accompanying the development) usability evaluations were carried out within the framework of the INFODOQ project.

In the analytical methodology, experts try to transform the set of perceptions with fixed formalisms into a numerical description set. A big advantage of this formative methodology is the possible task analytical evaluation without previously implemented functions. In the first step of the development of INFODOQ, several of these analytical methodologies were performed, including the walkthrough method. A written description of the functions and mock-up screens for designing a system are presented to a group of experts. The development can then be optimized by the established heuristics with the help of the experts.

After INFODOQ was completed, empirical methods such as interviews and observing actual users were carried out. It follows a description of the empirical questionnaire method with handwritten notes in which ten active nurses were involved in the evaluation of the INFODOQ project.

Before each test was started, the tests were pre-tested with two independent persons (so-called pre-tests) to ensure that the questions and tasks asked were understandable and that the required equipment was well-functioning. The pretest was conducted under the same conditions as the actual test in order to test the approach.

The usability tests were carried out at two locations in different care communities directly on site. The advantage of on-site testing is that the participants are in their natural environment and can use their devices such as com-

puter, mouse, and keyboard. This means that the focus can be placed solely on the application. Moreover, the test subjects are not influenced by the periphery. Several methods have been used for the tests. At first, the nurses were given tasks to work on. Meanwhile, the test leader logged the observations. This procedure has the advantage that the nurses get to know the functionalities of the application. They can also ask the test manager for help if they are stuck with a task. Following the completion of the task, remaining ambiguities were clarified in a discussion. Parallel to the processing of the questions, the test leader also took notes on the observations. It was recorded whether the task was successfully completed, whether problems occurred and assistance from the test leader was required or whether there were interventions by the test leader.

Observations

The three youngest test subjects, aged 25 and 26, managed to complete the tasks well. They were able to carry out all tasks independently, confident, and needed no help. In addition, they completed the tasks faster as the other participants. The required duration was between 15 and 20 minutes. As soon as they could not complete a task directly, for example because they did not know under which subpage they could find the functionality, the participants independently familiarized themselves with the other subpages of the application and looked for a suitable solution mechanism. The described scenario occurred in task 12. In this task, the participants were asked to create a new info message. In order to be able to do this, the item "Note" had to be selected in the navigation.

In contrast, five of the seven older test subjects had difficulties in completing the tasks. They dared to try less and did not want to make any mistakes. These five participants needed 25 to 65 minutes to complete the tasks.

The fourth participant was noticeably nervous during the execution of the tasks. It took her over an hour to complete the tasks. In addition, she was not trained in operating a computer; for example, she often pressed the right mouse button instead of the left one. The participant also needed more time, as she was disturbed by a person during the performance of the seventh task, asking her why she needed so much time. After that, she was even more nervous and had even more concerns about doing something wrong. This made her ask questions in advance for the following tasks to speed up the test. The participant was motivated by the test leader to try to complete the tasks independently. Furthermore, she was reminded that the results would be treated anonymously and that she could not cause any irreparable damage to the system.

Discussion

Acceptance in nursing care: On the basis of the evaluations described in the previous chapter, this chapter focuses on the digitisation of transparent care documentation, which is necessary but hardly articulated.

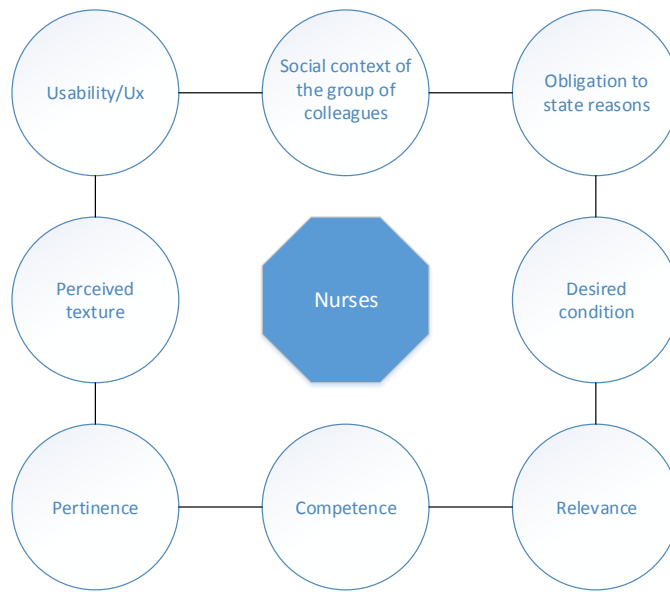
The findings of the summative empirical methodology for evaluating the interaction of nurses with the INFODOQ system underpin various of the problems addressed. Even if the heuristics described by (Nielsen, 1993) had previously been analytically identified by usability experts and integrated into the system, the requirements and problems of the nurses before and during the interaction are not only ensured by the design and function optimization.

The subjective reference of each individual user turns out to be an important point. This includes perceptual characteristics such as hearing and sight as well as behavioural characteristics such as experience, motivation, individual preferences, abilities, and knowledge. It should be noted that age generally represents a strong point of reference to the subjective limits described above. An interface from the point of view of a younger or older user does not seem to be pertinent for both.

It can be assumed that users of a certain age on average no longer possess the same background knowledge in dealing with computer-aided systems as younger users. Their motivation to deal with new systems also decreases with increasing age. If individual self-confidence in the direct use of the computer is not strengthened, even small tasks such as registration seem to pose major obstacles. In the beginning, any design irritation is directly related to the acceptance of the entire system.

Frequently, if a manager or a colleague is not immediately available for advice when problems arise, the hurdle seems insurmountable. After consultation with nurses, it turned out that the desired transparency of all interactions is rather perceived as the external management of the original care work. This diminishes the undisputed advantages of the system and puts the actual added value in the background. Figure 1 shows the acceptance criteria of a nurse during and after interaction with care documentation software.

1 **Figure 1.** *Acceptance Criteria of Nurses*



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3
4 *Usability and user experience* represent the acceptance in interactions with
5 the user interfaces with regard to usability and user satisfaction.

6 The *obligation* to give reasons, which goes hand in hand with the transpar-
7 ency of the digitization of work steps, is a major inhibition threshold that can
8 be perceived as an external line.

9 The *social context of the group of colleagues* - including the subjective
10 references and motivations of colleagues - influences the entire group dynamics
11 with regard to the system's requirements and problems.

12 The subjective *relevance*, *competence* and *pertinence* of a user are directly
13 related to the perceived and desired nature of a system. This means that a phys-
14 ical event of a system, e.g. the view of an interface, is perceived subjectively by
15 a user. This perception is defined as the "process of perception" (the perceived
16 nature of a system). The same physical event is simultaneously evaluated in
17 terms of the user's expectations. This assessment is defined as the "assessment
18 process" (the desired nature of a system). The intersection of the desired and
19 perceived nature leads to a subjective statement about the quality of a physical
20 event.

21 It turns out that experienced computer users have a significantly higher
22 competence. For them, user interfaces are much quicker to become functionally
23 apparent and pertinent. Their perception process is much more pronounced
24 through interaction with other systems. The structure of the system and the re-
25 spective interfaces are more paramount. In addition, these users focus much
26 more on usability and user experience, but also here the heuristics do not pro-
27 vide holistic user satisfaction. In everyday life, nurses must be able to access
28 desired information much more quickly and easily. The heuristic of minimal-

ism is a decisive approach that must be pursued in combination with user experience and usability measures.

How can the user-friendliness of interfaces in nursing documentation be increased in the context of these points?

User experience and usability measures can be understood as the simplification of objective knowledge by refining emotions that build fictional relevance. This means that objective knowledge must be designed in a way that is acceptable to the subject as a person (usability). During the process of information transfer, the user should be given an emotional part that builds up subjective relevance (experience).

In the introductory phase of nursing documentation software, the stress for nurses due to additional work and time expenditure is significantly higher than the actual added value of the system. In particular, many older nurses do not have the pertinence and relevance to use nursing documentation software in addition to their experienced use of computers. The actual work facilitation simply cannot be experienced. Decisions suddenly have to be substantiated; in addition, interactions can be perceived as external management of the original care work. According to (Stock, 2007/8), the fundamental change in perspective in the development of care documentation software is an approach to increasing acceptance - away from summative usability tests and towards a common development strategy in which nurses must be involved from the outset.

Based on the evaluations from the INFODQ project, interfaces must meet the following requirements in the direction of user-friendly interaction between nurses: Be simple. In this context, simple means that a person from the addressed target group has enough basic pertinence to be able to record and carry out the process without user irritations (cf. Gast, 2018).

Another requirement is to be emotional. This means that a person from the addressed target group sees a fundamental usefulness with regard to the relevance of the subjective point of view. It should be noted that the knowledge contained in information is to be classified as relevant if it objectively serves to prepare a decision or to close a knowledge gap.

However, relevance is not the only decisive factor for a satisfying user experience. The information must also be pertinent for a user. Information is only pertinent for a user if it subjectively serves to prepare a decision or close a knowledge gap.

If the system is simple and emotional, then a certain motivation arises which exceeds the threshold potential of the nerve cells of a user and thus allows the objective information to be processed.

It should be noted that care documentation software must be designed to be brain-friendly by means of user experience and usability. This means objective knowledge must be prepared in the context of the internal reference of the target groups addressed and processes must be reduced to the essentials. Objective knowledge must be enriched with emotional values in the context of the internal reference of the target groups addressed.

Conclusions

In the care sector, hardly any needs for transparent care documentation are being articulated. Reasons could be that the digitization of care documentation software for nurses initially involves significantly more disadvantages and hurdles than the actual added value of the system due to additional work and time expenditure. Through previous work and the findings of the empirical evaluation of the interaction of nurses within the framework of the INFODOQ project, the subjective reference of each individual user turns out to be the decisive factor.

Subjective reference includes the relevance, competence, and pertinence of a user which are directly related to the perceived and desired quality of a system. This means that a physical event of a system, e.g. the view of an interface, is perceived subjectively by a user. The same physical event is simultaneously evaluated in terms of the user's expectations. The intersection of the desired and perceived nature leads to a statement about the quality of a physical event. However, if the user lacks the pertinence and relevance to use care documentation software due to his cognitive model, the actual facilitation of work simply cannot be experienced. Decisions suddenly have to be substantiated. In addition, interactions can be perceived as external management of the original care work. The social context of the group of colleagues - including the subjective references and motivations of colleagues - influences the entire group dynamics with regard to the system's requirements and problems.

In everyday life, nurses have to get the information they need much more quickly and easily. The user-friendliness of interfaces in care documentation cannot be ensured by design and function optimization alone. Objective knowledge must be designed to be "easy" to absorb (usability). During the process of information transfer, the user should be given an "emotional" part that builds up subjective relevance (experience). "Easy" in this context means that a person from the target group has enough basic pertinence to be able to record and carry out the process without user irritation. Emotional means that a person from the target group sees a basic usefulness in terms of relevance to the subjective point of view. Objective knowledge must be prepared in the context of the internal reference of the target groups addressed and processes must be reduced to the essentials. It also must be enriched with emotional values in the context of the internal reference of the target groups addressed.

Outlook

Based on the acceptance criteria of nurses described in chapter "Evaluation- Observations", an analysis tool for measuring the acceptance criteria using different tasks of the users of the system will be implemented within the framework of the INFODOQ research project. The analysis tool can be used to compare and analyze user behavior, performance, peculiarities, competence,

regularity, learning success, user irritations as well as the handling of different interfaces of one or more users. For this purpose, analysis procedures and performance metrics such as time on task, task success, efficiency, learnability as well as an effort based and psychological reaction analysis are used. With this analysis tool a usability analyst is able to draw conclusions about characteristics, regularities, and user acceptance. For each task, information about successes, failures, the required effort, etc. is compared both explicitly for one user and for all users, both task-specific and interface-specific.

On the basis of this possibility many possibilities of further analyses for the formation of acceptance criteria will then again result, which could uncover acceptance and design factors not yet known. Special analysis methods for tablets and smartphones can also be integrated. With this work we enter a new field for the analysis of nurses' interactions with documentation systems and, in our opinion, extend the state of the art by many possibilities in the development of previously unexplored acceptance criteria of nurses.

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