A Framework to Measure User Experience of Interactive Online Products

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ABSTRACT
Over the past years, User eXperience (UX) research in the academic community has created various approaches to UX evaluation frameworks. However, industry adopted these approaches rather vaguely into product development. Due to this existing gap between research academics and companies, this paper concerns the question of how UX evaluation can be integrated into the software engineering process of interactive online products. Therefore, influencing factors that need to be measured, including human and system aspects, emotions, a spatiotemporal dimension and motivation, were analyzed. In order to evaluate these factors transparently and to link UX factors to actual product functionalities, existing evaluation methods to collect qualitative and quantitative user data were selected and joint to an evaluation **method set**. First experiences of using the UX framework and this method set by means of a new web-community concept will be outlined and discussed.

Author Keywords
User experience evaluation, measurement of product qualities, user experience framework, online products.

INTRODUCTION
Nowadays, in scientific and application-oriented research user experience (UX) and the question of its evaluation is shifting to a more essential role in product development. Especially, since the use of interactive online applications has become an integral part of everyday life, users expect simple usable and tangible user interfaces. In order to develop products that meet these requirements and differ from the competitor's solution, an exclusive measurement of useful and usable products is no longer sufficient. Consequently, it becomes more important to evaluate the entire user experience of an interactive product during product development. However, there are still barriers to systematically evaluate and communicate UX that make it difficult to develop and design for a good user experience [1, 8, 16]. Main problems include the "lack of understanding of users, insufficient usage model definitions, too many constraints on the technology, and inconsistency and/or inability to integrate the technology with other parts of the ecosystem" [3].

Hence, the question of how user experience can be defined and what factors influence it needs further standardization for interactive products. Especially for companies that develop interactive products, clearly defined, approved and consistent UX evaluation methods will get more and more indispensable in order to obtain comparable results and to easily include UX evaluation into product development [17]. Though, according to Mattila et al., practical UX evaluation methods require to be **valid** and **reliable, fast, light-weight and cost efficient**, **applicable for concept ideas**, **prototypes, and products** (more requirements in [17, p.21]).

Therefore, the following paper discusses (1) **a framework of UX with its influencing factors** and (2) a **scalable combined evaluation method set** in order to measure these influencing factors by **collecting qualitative and quantitative user data** and to draw conclusions on approaches to optimize UX. By means of a new web-community concept, theoretical elaborations were approved in a laboratory study.
This study attempts to create an UX evaluation framework with a holistic view on UX that can easily be integrated into the software engineering process in order to close a little bit more the gap between research academics and companies.

THE UX FRAMEWORK
The following framework includes a definition of UX and influencing factors that aim at creating a uniform understanding and a basis for UX measurement in a company. Considering that impacts of influencing factors differ from product to product, the framework describes factors that need to be operationalized according to the product. The operationalization based on an example of a web-community will be explained consecutively.

Definition of UX

There are many definitions of UX, but not an agreed one [17]. Existing definitions within HCI name three main components of user experience [1, 8, 16, 23]: (1) *emotion* (consequence of a user's internal state [3, referencing 13, 19 and 20]), (2) *motivation* (causal for activated product experience [5], [21]) and (3) *reflection* (spatiotemporal dimension [1]). By interacting with one another these components make up the user experience as a whole.

Consequently, in this context, user experience is defined as:

> "*the degree of positive or negative emotions that can be experienced by a specific user in a specific context during and after product use and that motivates for further usage"*.

Influencing Factors of User Experience

To make user experience measurable, its direct and indirect influencing factors need to be known. In Human Computer Interaction human aspects as well as systems aspects seek consideration. For that reason influencing factors are divided into these two main aspects which together influence UX before, during and after product use. UX evaluation of these three moments describes the change of UX from expectations through momentary experiences until the reflective experience. An overview of UX components and including factors is shown in Figure 1. It is assumed that basic human needs are key drivers of product use and quality perception [4, 5, 6]. Fulfillment and frustration of such needs cause user's experience with an interactive product and are mainly influenced by product qualities. According to Mahlke these qualities can be classified in *utility*, *usability*, *visual attractiveness* and *hedonic quality* [16]. Though, there is no direct correlation of one need to one specific product quality in general which is why direct links between human needs and product qualities need to be identified by analytical and empirical studies. Measurement of UX can be explicitly targeted to evaluate certain aspects of these influencing factors depending on the product goals.

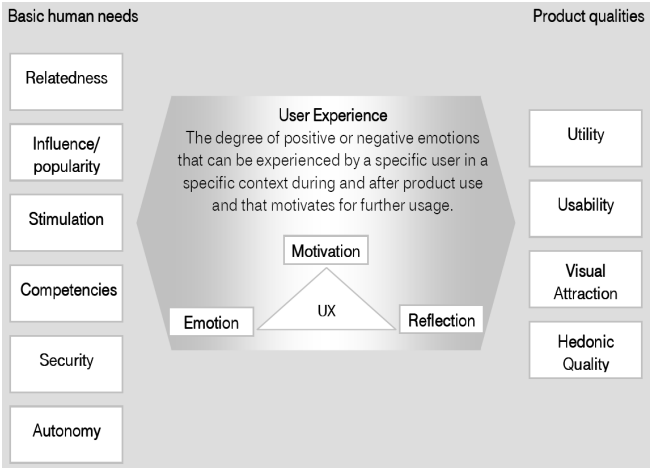

Figure 1. Framework of UX including influencing factors.

Product qualities	Operationalization
Utility: "is the question of whether the functionality of the system in principle can do what is needed" [18, p.25]	Identity management, relationship management and information management [24]
Usability: describes "the extent to which a product (e.g. tool) can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" [9].	Suitability for the task, self-descriptiveness, conformity with user expectations, suitability for learning, controllability, error tolerance, suitability for individualization [18, 10]
Visual Attractiveness: can fulfill human needs and motivate human beings since aesthetic objects contain *intrinsic value* that is higher than functional value [22].	Vanguard design, form principles, color principles [14, p.328 cont.]
Hedonic Quality: can directly fulfill or awake human needs and is also seen as "*be-goals*" (e.g. being competent) [6], [7]	Challenge, identity, stimulation, empathy, trust and credibility [2], [6]

Table 1. Operationalization of product qualities.

OPERATIONALIZATION OF UX FACTORS

In order to have a profound understanding of these influencing factors and to design for user experience during product development, these factors need to be operationalized according to the product type.

For that reason the named product qualities and relevant basic human needs were operationalized according to web-communities. Operationalizations of product qualities are displayed in table 1 and base on [2], [6], [9], [10], [14] and [24]. Operationalizations of basic human needs were discussed and compiled in an expert group and are shown in table 2.

METHOD

The UX test is subdivided into 14 guideline-supported individual laboratory experiments of 110 minutes duration. The test aimed at collecting **qualitative and quantitative user data**. Test object was a new web-community concept of Deutsche Telekom AG available as an online mock-up.

Participants

Target group of the product were users that use the Internet daily and at least one social network with a personal user profile regularly. All of them know at least one of the portals on which the product aims to be implemented.

Human needs	Operationalization
Relatedness	communicate fast and easy, find community of interests, integrate myself
Influence/ popularity	raise popularity, present myself, adopt different roles, gain influence
Stimulation	have fun, be creative, find balance, have a feeling of success
Competencies	reduce complexity, avoid stress, gain competencies, optimize time management, reduce work, help myself, orient myself
Security	feel secure, feel not being watched, build trust, hand over responsibility, have data control
Autonomy	manage information on my own, take over responsibility, help myself, have data control, preserve identity, present myself

Table 2. Operationalization of basic human needs for a web-community.

Fourteen individuals (eight female and six male) from Ilmenau University of Technology participated in the test. All of them matched the target group requirements. They had a mean age of 21 years (Min = 19, Max = 32). Six participants were medium internet users (5-15 hours of internet usage per week) and eight were heavy internet users (more than 15 hours of internet usage per week).

Procedure

Participants were invited via e-mail and each of them got an individual appointment. The test contained (1) a pre-questionnaire including demographic data, user behaviour, expectations and the importance of operationalized basic human needs regarding web-communities, (2) typical usability scenarios describing critical incidents and a short free exploration as well as (3) a retrospective questionnaire containing questions regarding need fulfillment. While interacting with the product, participants were asked to "think aloud" in order to gain a better understanding of user's **mental processes** (see [12]) and **emotions**.

Measurement of UX Factors

During the test qualitative data as well as quantitative data was collected. **Qualitative data** regarding need fulfillment, momentary experiences and emotions was collected via observation and open questions in interviews. **Quantitative data** regarding need fulfillment and product qualities were collected via Likert scales and Semantic Differentials. **Product qualities** were measured by seven-stage ranking semantic differentials and observed during task completion. Items to capture product quality were taken from validated item catalogues in [7], [14], [15] and [16].

Retrospective questionnaires aimed at evaluating the **reflective user experience**. **Momentary experiences, emotions** and fulfillment of **basic human needs** and were observed during task completion and during free exploration.

Basic human needs were additionally measured using five-staged Likert scales with questions resulting from the operationalization. Questions in the pre-questionnaire aimed at evaluating expectations; questions in the follow-up questionnaire aimed at evaluating the actual need fulfillment. This way, a *required profile* and an *actual profile* were determined in order to identify strength and weakness of a product intuitively. Open questions at the end of the test aimed at evaluating the main **emotions** after interacting with the product and **motivation** to use this product in the future. Data from this test can be analysed qualitatively.

CONCLUSION AND FUTURE WORK

Goal of the study was to identify and measure influencing factors of user experience of interactive online products in order to obtain indicators for product optimization and therefore, to include practical UX evaluation methods into the software engineering process.

First experiences have shown that the presented UX framework is applicable during the software engineering processes and that important indications for product optimization can be won. **Influencing factors describe a holistic view with human and system aspects on UX in order to obtain important results for product managers, designers and developers**. Even though a broad sample size is important for a more profound analysis of quantitative data and only a small sample size (n=14) was used to collect user data in this study, the presented framework was not only more easily **practically applicable** than with a broader sample size, but **similarity in results** of both qualitative and quantitative data sets became apparent. This finding clarifies, that **a small sample size can already be useful** to obtain important indicators for product optimization while using the presented UX framework and method set. For instance, the finding that the need for "Stimulation" was only partly fulfilled was discovered during observation, in open questions as well as based on the results of the used Likert Scales. Based on both qualitative and quantitative data clear recommendations to optimize product features and the product on the whole were extracted. An example of a recommendation to fulfill needs for relatedness, stimulation and autonomy is shown in table 3. The example in table 3 describes a weakness in the product quality *Hedonic Quality* (HQ) and recommends changes regarding the specific product feature "forums". Limitations of the applied method set address some of the requirements for practical UX evaluation methods, which were not completely met yet (see more in [17]).

Prod. Qual.	Category	Weakness	Recommendation	Priority
HQ	Forums	Not enough topics to allow for extensive communication in forums	Offer and maintain much more and various forum topics and add descriptions	!!

Table 3. Example of a recommendation to improve UX.

The presented UX evaluation method set is **applicable on concept ideas, prototypes and products**. It can therewith be integrated into different stages of product development and only needs to be adapted to the specific stage. Though, requirements regarding validity and reliability need to be proven in further tests. Because of applying the maximum of this scalable combined evaluation method **the test is only partly *fast, lightweight and cost-efficient and a high level of expertise is required*.**

In conclusion, the presented framework is an applicable approach for measuring UX of interactive online products, but further optimization in the scalability of the method set is needed in order to match the requirement of fast, lightweight and cost-efficient practical UX evaluation methods. Matching these requirements makes UX evaluation manageable in a big company. Further work includes the optimization of the presented method set in collaboration with a company and other scientists as well as proving validity of quantitative data with a broader sample size or the exclusive collection of qualitative data. Especially the impact of UX evaluation on the product lifecycle and the customer relationship lifecycle needs to be researched in further studies.

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