Int. J. Human-Computer Studies 72 (2014) 552–566

Contents lists available at ScienceDirect

Int. J. Human-Computer Studies

journal homepage: www.elsevier.com/locate/ijhcs

Using sketches and storyboards to assess impact of age difference in user experience ☆

Giorgio Brajnik *, Cristina Giachin

Dipartimento di Matematica e Informatica, Università di Udine, Via delle Scienze 206, 33100 Udine, Italy

ARTICLE INFO

Article history:
Received 20 March 2013
Received in revised form
8 October 2013
Accepted 5 December 2013
Communicated by S. Wiedenbeck.
Available online 16 December 2013

Keywords:
User experience
Usability
Ambient assisted living
Older adults
Experimental evaluation
Prototypes and storyboards

ABSTRACT

We compared two versions of a touch-screen digital thermostat using a framework encompassing several user experience (UX) characteristics, and here describe how the implementation of certain design factors (specialists, praises, tooltips and increased interactivity) was done on mixed-fidelity prototypes of the user interface. We illustrate how the experimental comparison, involving 20 university students and 20 older adults, revealed important differences in UX, including perceived ease of use, behavioral intentions, enjoyment, quality, satisfaction, trust and usability, measured mainly through established questionnaires.

Analysis revealed that using that kind of artifacts is a very cost effective way to elicit interesting and useful results; many UX variables are significantly affected by design factors and by age differences, as expected; effects of design factors go well beyond usability and therefore could not be caught by running an investigation focused only on usability.

Age difference matters: older adults do not respond to addition of specialists, praises and tooltips as younger users do. We argue that potential benefits of these design choices are outweigh by the increase in complexity of the user interface.

From a methodological viewpoint we suggest using a particular array of UX characteristics and metrics when testing mixed-fidelity prototypes. Not all the metrics that we adopted were equally useful, and in particular perceived usability, subjective mental effort, and emotions did not help us highlighting differences.

1. Introduction

Aspects of human computer interaction in general and usability in particular have been identified as being important in the context of technology usage. However, as Hassenzahl and Tractinsky pointed out, from a historic perspective, usability focused too much on instrumental aspects and task orientation (Hassenzahl, 2004; Tractinsky, 1997). Experiential traits are oftentimes neglected, especially in contexts such as the living environment, where they could have a big influence on design of devices and user interfaces.

Smart home technology, and in general ambient assisted living (AAL), is seen as a promising defense against the threats of the demographic change. The potential of AAL to increase autonomy, health and safety, to promote socialization and inclusiveness, to cope with disabilities that older adults face is enormous. And it is in this context that user experience (UX) aspects become particularly important because they act as precursors of acceptability and actual usage of devices and user interfaces (Venkatesh et al., 2003).

Yet, UX aspects that go beyond usability cover a gamut of properties and metrics that is extremely varied and to some extent ephemeral: many properties are contextual, depending on the individual, his or her mood, the particular situation in which interaction takes place, the particular perspective under which interaction is considered, the goals and motivations that drive interaction, and of course characteristics of the device/user interface (Law et al., 2009). This makes it very difficult to mesh them into software development processes. To make UX evaluations more feasible and cost-effective, it is important to embed these practices into early stages of user interface development. It is necessary therefore to understand what kinds of design artifacts can be used, what kinds of design factors to implement, what UX aspects can and should be measured, and how.

In this paper we describe how the implementation of certain design factors (specialists, praises, tooltips and increased interactivity) was done on mixed-fidelity prototypes of a touch-screen thermostat, and how an experimental comparison, involving 20

☆This paper has been recommended for acceptance by Effie Lai-Chong Law.

* Corresponding author. Tel.: +39 0432 558445; fax: +39 0432 558499.
E-mail addresses: brajnik@uniud.it (G. Brajnik), cristina.giachin@gmail.com (C. Giachin).
URL: http://www.dimi.uniud.it/giorgio (G. Brajnik).

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http://dx.doi.org/10.1016/j.ijhcs.2013.12.005

university students and 20 older adults, revealed important differences in several UX aspects, including perceived ease of use, behavioral intentions, enjoyment, quality, satisfaction, trust and usability.

The contribution of this paper consists of

(i) The identification of a combination of design factors, design artifacts, range of UX aspects and metrics that allows one to elicit important differences. Results we obtained are significant, reliable and valid, providing strong evidence that the particular combination works well.
(ii) The different impact that the design factors we considered have on younger *vs.* older users: what works for younger people has not the same effect on older ones. While younger users rate the user interface that implements those design choices as being simpler to use and more enjoyable, older adults are slowed down, and rate it as more complex.
(iii) We show that this kind of UX evaluation technique can be adopted during early phases of product development, and results can be used to make important design decisions that go beyond usability and visual layout. Because UX metrics we used are mainly based on questionnaires (the exception being usability metrics), we argue that the technique can be easily adopted by mainstream designers, at least as much as "guerrilla usability" techniques can.

For these reasons we believe that the way in which we characterized UX is useful for engineering high quality user interfaces. Practical implications of these decisions could include more effective use of a heating system, with more satisfaction, less effort, more energy savings, and increased attractiveness.

2. Related work

In this section we summarize the research work that was done in the areas that are mostly relevant to our project, namely user experience, older adults and ambient assisted living.

2.1. User experience

User experience (UX) is a complex notion. According to Law et al. (2009) it can be defined as "the entire set of affects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meanings) and the feelings and emotions that are elicited (emotional experience)". And furthermore "UX is the consequence of a user's internal state (*e.g.*, predispositions, expectations, needs, motivations, and mood), the characteristics of the designed system (*e.g.*, complexity, purpose, usability, and functionality) and the context within which the interaction occurs (*e.g.*, organizational/social setting, meaningfulness of the activity, voluntariness of use)".

Therefore, one could view UX as an umbrella concept that goes beyond usability and accessibility, embracing a range of properties that deal with many psychological, physiological and social human phenomena. In particular, in addition to usability/accessibility, UX covers at least the following aspects:

Aesthetics: Aesthetics has since long been an important attribute of devices and user interfaces, affecting how people feel and behave with respect to other beings or things. It was claimed (Tractinsky, 1997; Tractinsky et al., 2000; Lavie and Tractinsky, 2004) that there is a dependency between aesthetics and perceived usability (dubbed "halo effect of aesthetics"); one could argue that because aesthetics can be appraised during a quick first impression (Lindgaard et al., 2006), it taints other properties as well, including perceived usability. Subsequent studies, however, challenged or qualified better such a link: Law and Hornbæk (2007) highlight that in several studies dealing with usability and aesthetics there are issues with definitions and with measurements; Tuch et al. (2012) found strong experimental evidence that aesthetics does not affect perceived usability, but instead bad usability lowers aesthetics and hedonic attributes ratings.

Emotions: In his book, Norman (2003) discusses the notion of "emotional design" which is based on an underlying model of affect in HCI. According to the model, three levels of our nervous system (visceral, behavioral, reflective) are tightly coupled and intertwined within rich feedback loops that allow us to appraise situations from an affective point of view (*i.e.*, assigning arousal and valence value). This influences the affective state of a person, which in turn affects how the person thinks and behaves, which further influences how the situation is appraised, priming therefore a complex feedback loop.

Perceived usability: Before using a device or user interface, a user estimates the level of usability of the device on the basis of his/her experience, capabilities, abilities and more superficial qualities like aesthetics. Notice that this is different from objectively assessed usability, normally based on user performance indexes such as task completion time, success level and rate, number of errors (Rubin and Chisnell, 2008). The notion of perceived usability was studied, among others, by Hassenzahl (2004) who dubbed that "pragmatic attributes", *i.e.* connected to users' need to achieve goals.

Hedonic attributes: Hassenzahl introduced also attributes which refer to pleasure-related properties, and more specifically to growth (*i.e.*, how stimulating, novel and challenging a device is), to identification (*i.e.*, addressing the need to express one's self through objects), and to evocation (*i.e.*, the ability of the device to evoke memories).

Cognitive load: Closely related to pragmatic attributes and usability is the cognitive effort felt by users when trying to achieve goals. It is related with the complexity of task and user interface (Michailidou et al., 2008), as well as with how attention ebbs and flows between external stimuli and internal trains of thoughts (Varakin et al., 2004). It is also affected by how interruptions are handled, *i.e.* how the user who is involved in a primary task is notified of a pending secondary task, how s/he can be supported in switching context between the two, and in resuming the primary task (McCrickard et al., 2003).

Interactivity: Sundar and Kim (2005) discuss this notion and illustrate the wide range of definitions that could be used to characterize it: interactivity could be seen from a process point of view (emphasizing the conversation that occurs between the user and the system), or from the perspective of the range of different components that the user interface offers (basically the number of different widgets that are available and the granularity of user actions), or