# The Aware User Experience Model, Its Method of Construction and Derived Heuristics

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**Abstract.** Psychological experience possesses many different determinants of affective, cognitive, and behavioral order in complex interaction and mostly hidden to our consciousness. User experience models face this complexity by presenting a reduced set of variables and interactions. Most of these models have been created on a deductive but also largely intuitive basis. This poses three problems: First, the UX models' authors don't propose a systematic response to the question of "how to know what variables use into the UX model?" Second, most UX models overlook the components that arise to the user's consciousness. Third, even with this multitude of UX models, UX designers continue to rely heavily on intuition. Based on previous work, we propose the Aware UX Model, built systematically, and gathering empirical users' data. It focuses on the components, mostly thoughts, and feelings, that arise in the user's consciousness. The model provides their characterization and a rational account of its emergence in the UX. In addition, we propose a construction method for UX models based on our own process. We expose a case study to substantiate the Aware UX model and to contribute to its validation. Finally, we propose heuristics coupled to the Aware UX model components.

**Keywords:** UX · User consciousness · User modeling

## 1 Introduction

Psychological experience possesses many different determinants of affective, cognitive, and behavioral order. Their interaction is highly complex and mostly hidden to our consciousness: we manage to see just the tip of the iceberg. Most user experience models try to tackle that complexity by presenting a reduced set of variables and interactions; they simplify the user experience, UX, to decrease its complexity, turning it into a more manageable phenomenon. Most of these models have been created on a deductive but also largely intuitive basis. This poses three problems: First, the UX models' authors don't propose a systematic response to the question of "how to know what variables use into the model or, on the contrary, leave them out of it?". Second, even if UX happens in the user's consciousness, most UX models do not focus on identifying and characterizing what happens there. Ortiz-Nicolas (2014) shows that for 11 UX models, artifact, user, interaction and context are the main dimensions, and the so-called aggregates or properties, are subjective, conscious, emotional, interconnected, and dynamics. However,


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none of the 11 UX models specify what probably happens in the user consciousness; this always appears difficult to specify and fragmented (Revonsuo 2009). In addition, every component has a different definition and role among the models (Ortiz-Nicolas 2014). This has led to uncertainty about the UX components that are important in UX design. Therefore, this poses a threat to the validity of those UX models too. Consequently, we want to propose a UX model that can specify what arises to the user's consciousness during the interaction: their inner thoughts, images, feelings of knowing, and so on, which have no clear location and extension in phenomenal space (Velmans 2009, p. 297) but are present in the consciousness, and are essential for UX design. Third, we believe that the large complexity of UX models, with so many components and properties, avoids their application to UX design, making them hardly actionable, and difficult to apply. Moreover, even with this multitude of UX models, UX designers continue to rely heavily on intuition (Tonetto and Tamminen 2015). This makes that many relevant aspects of the UX are missed, designers don't know how those aspects are related and don't know either their relative importance. We believe that the persistence of UX designers in relying mostly on their intuition is because UX models are not coupled to methods based on them. So, what type of UX design methods can be coupled to a specific UX model? In this paper, we try to contribute with answers to these three questions.

The paper is structured as follows: in the methods sections, we expose the methods used to answer each of the questions. In the results section, we expose the results of applying each method: for the first question, firstly, we reviewed the methods available to identify UX components, and secondly, we expose a method to systematically build UX models trying to avoid the biases from the researcher's intuition. For the second question, we propose the Aware UX Model resulting from the application of the aforementioned systematic method. Moreover, we present a case study to show how the Aware Model can explain the UX of a market successful product. For the third question, we propose a UX design method composed of heuristics extracted from different sources. The final section exposes the conclusions, limitations, and future work.

## 2 Methods

### 2.1 Question 1: How to Know What Variables Use into a UX Model or, on the Contrary, Leave Them Out of It?

We reviewed the methods available to identify UX variables. We expose a method to systematically build UX models trying to avoid bias from the researcher's intuition.

### 2.2 Question 2: Which Are the UX Components Important in UX Design?

We applied the aforementioned systematic method to propose a UX model. Moreover, we used the case study method to show how the UX model can explain the UX of a market successful product with a UX desired by users.

### 2.3 Question 3: What Type of UX Design Methods Can Be Coupled to a Specific UX Model?

We propose a UX method composed of heuristics extracted from different sources.

## 3 Results

### 3.1 Review of the Methods to Identify Affective and Cognitive Conscious Components

We have identified some approaches or methods to identify the human affective and cognitive components present in UX. We're just aware of the tip of the iceberg visible in consciousness. Consequently, we're not only interested in explicit, conscious, variables, but also in the unobserved, latent ones; all of them are causes or consequences of the user´s observable behavior (Hoyle and Duvall 2004). Then, we review phenomenology, introspection, theory of mind, cognitive interviews (think-aloud protocols), self-report methods, and the Exploratory Factor Analysis (EFA) technique.

**Phenomenology**. Phenomenology is both a methodology and a philosophy to understand complex individuals' problems based on researching their intern and subjective experiences. It emerged as a philosophical movement concerning how to look at the world, providing insights to "understand certain phenomena" (Creswell 2007). Using it, we can get a deep comprehension of a phenomenon as experienced by several subjects (Creswell 2013). It provides an opportunity for systematic reflection on the lived experiences of people in certain circumstances. Its purpose is to "reduce individual experiences with a phenomenon to a description of the universal essence" (Creswell 2007). It has been used in organizational and consumer research but very few in product design. A phenomenon would be "an 'object' of human experience (van Manen cited by Creswell (2013), p. 163). These phenomena could be anything felt by the user while interacting with a product (Creswell 2013): try to find a song in the smartphone, experimenting anger because being unable to handle properly a drill, etc. Basically, the researcher collects data from people who have underwent the same experience and makes up a description from these multiple sources of the essence of the experience for all those persons. "This description consists of "what" they experienced and "how" they experienced it" (Creswell 2013). This method allows participants to express their experiences, which in turn, allow investigators to uncover the essence of the human experience (Creswell 2013).

What distinguishes phenomenology from other qualitative research is its emphasis on the subjective point of view (van Manen 1990). In addition, it provides the tools for discovering something meaningful and insightful, "through meditations, conversations, daydreams, inspirations, and other interpretive acts, we assign meaning to the phenomena of lived life" (van Manen 1990). However, one of the dilemmas of using a phenomenological method is whether it results in descriptive scientific research or in an interpretive personal inquiry. Can researchers avoid imposing their personal experiences and biases on the description or analysis of the experiences shared by the others? (Husserl 1982). Ajjawi and Higgs (2007) argue that it is impossible to achieve total objectivity because objectivity is situated in a reality constructed by subjective experiences.

**Introspection.** Introspection is a means by which we pay attention consciously to the mental conditions we are currently in (Rosenthal 2001). Introspection is different from our informal, transient, and fuzzy manner we are conscious of a lot of our mental states. Introspection encompasses the mental states being introspected and any mental representation of those mental states. Introspection collapsed as a psychological experimental method because of its lack of reliability: the results from distinct laboratories using it frequently disagree (Rosenthal 2001). Moreover, it has been shown that people invent their own introspective mental states to justify their behaviors as something acceptable or normal. However, many psychological experimental methods continue to rely on people's access to their actual mental states. All in all, introspection represents badly our mental states and misses to uncover a lot of concurrent mental states, both in usual and exceptional situations. It is probable that introspection only reveals a little part of the mental properties of the subject. As stated by Lashley's (1958, cited by Rosentahl) dictum "introspection never makes mental processes accessible, only their results". Nonetheless, it is fairly used among design practitioners because it is informal, flexible, and low-cost (Goodman-Deane et al. 2010). In conclusion, although introspection is easy to use, it is an unreliable method.

**Theory of Mind (ToM).** ToM is a branch of cognitive science regarding the comprehension of our minds and others' (Gopnik 2001). ToM is about our skill to attribute mental states (desires, beliefs, intentions, etc.) to others and understanding others' minds using our ordinary and intuitive comprehension of the mind (Gopnik 2001). ToM has been extensively researched in developmental psychology to understand when and how the different abilities of ToM arise and develop. The knowledge provided by ToM is theoretical, both for the mind of others and ours. ToM is related to folk psychology because it supports our comprehension of people's behavior in terms of desires, beliefs, expectations, intentions, etc. When we attribute a belief, we make a hypothesis of a mental state of the believer. The question is: do we have a method to understand our minds and others'? Some mechanisms of ToM have been researched, for instance, the ToM decoding (Lee et al. 2005). This is defined as the ability to use context information available such as tone of voice, body posture, and facial expressions, to identify and name precisely the others' mental state (Lee et al. 2005). However, we are talking about an innate ability deeply ingrained in our minds that would be hard to formalize as a method, in order to study the mental states of others. For instance, we're able to interpret which emotions someone is feeling by reading her facial gestures; notwithstanding, we're not able to do this on a systematic basis. For this matter, a method such as FACS, Facial Coding Action System, should be used (Ekman and Friesen 1978). There are two dilemmas of using an approach based on ToM to identify the UX components. First, it is easy to attribute false beliefs to other people if the researcher is not well trained since some mechanisms behind ToM acquisition are difficult to articulate to be easily tested at the neural level. ToM is a rather abstract construct that could take many forms at both the behavioral and neural levels (Mahy et al. 2014). Second, ToM's application mostly focuses on cognitive tasks rather than affective ones (Mahy et al. 2014).

**Cognitive Interviews-Think Aloud Protocols.** Cognitive interviews are a set of techniques for eliciting how a subject understands and responds to a diversity of situations,

i.e., an interaction with a product. The most useful would be the think-aloud interviewing: the subject should say aloud what he is thinking while he is on a task (see "cognitive interview" by Knafl (2008)). In think-aloud protocols the verbal reports of the subject's own thinking processes are used as data. Think aloud protocol could be used insofar it was devised as a method to verbalize problem-solving activities, at every moment of that activity (Ericsson and Simon 1993). Since its creation by Newell and Simon in 1972 (Newell and Simon 1972), protocol analysis has been a central method in cognitive science. Two drawbacks of protocol analysis are, first, the method has been used mostly to study tasks where the cognitive elements are dominant, i.e., for sequences of thoughts: many tasks of problem-solving character, decision-making, judgment, expert tasks performance and learning (Ericsson and Simon 1993). And, second, it is not adapted to study affective phenomena.

**Self-report Methods.** Self-report is any method in which respondents relate their feelings, emotions, beliefs, etc., when they are asked to answer a question. Even if it is a very used method, its nature and lack of verifiability are a matter of debate (Robinson 2009). When considering the complexity of a self-report, at least concerning emotion self-reports, there are two types of components of distinct nature: dialecticism and granularity (Lindquist and Feldman-Barrett 2008). Basically, these two terms refer to people's ability to characterize their own experiences (Lindquist and Feldman-Barrett 2008). Dialecticism is the relationship between pleasant and unpleasant emotions as inversely related or as a dialectic experience (not seeing pleasurable and displeasurable experiences as opposed) feeling both pleasant and unpleasant emotions at the same time (Bagozzi et al. 1999). The other component, granularity, is the skill to verbally report the emotional experience precisely (Lindquist and Feldman-Barrett 2008). Emotional granular people use emotion qualifiers (i.e., angry, afraid, sad, joyful, etc.) to "represent discrete and qualitatively different experiences". The criticism of using self-reports is: one, self-reports rely on language which may not be equivalent to experience, sometimes experience is highly nuanced; two, we possess different skill levels to conceptualize or verbalize our experiences using language words. In this regard, a self-report would always be a flawed image of experience (Robinson 2009). Moreover, self-reports are problematic for cognitive scientists, on the one hand, because the conditions under which self-reports are to be trusted are unknown; and, on the other hand, the inferences from objective observations from states of consciousness are determined by the comprehension we have of the causal relations between the subjects' conscious states and what we observe on them (Natsoulas 2005).

**Other Affective Information Assessment Methods.** In this group, methods such as emotion-related vocal acoustics, specific affect coding system (SPAFF), affect rating dial, time sampling diary, facial image analysis such as FACS (Ekman and Friesen 1978), etc., should be used. Etc. These methods are highly specific focusing only on one affective phenomenon, look to obtain a global measurement of affect, or are highly complex and time-consuming. Consequently, they are not adapted to our needs.

**Exploratory Factor Analysis (EFA).** Even though latent variables cannot be measured by direct means, we can obtain information about them by measuring observed variables

that represent them (Everitt and Howell 2005), in other words, we can measure them indirectly. Latent variables have the possibility of explaining a large number of behaviors using only a low number of constructs (Hoyle and Duvall 2004). Latent variables should be inferred, statistically, from data showing associations among observed variables, which presumably, are caused, to some extent, by one or more factors (Hoyle and Duvall 2004). Factor Analysis (FA) is a multivariable statistical analysis technique appropriate to analyze large numbers of variables and reduce them to a more manageable number or factors (Field 2009). Researchers in education, psychology, and cognate social fields have employed or evaluated their research with Factor Analytic procedures, including exploratory factor analysis (EFA) (Beavers et al. 2013). EFA describes associations among a very large number of observed variables or indicators, using a comparatively low number of factors (Hoyle and Duvall 2004). EFA works inductively because it allows, based on the observed variables data, to determine, *a posteriori*, the underlying factor model. None of the methods or approaches presented earlier to identify the UX elements seemed adapted to investigate our research problem. Consequently, we trust in EFA because of its long tradition to investigate many different and complex latent psychological phenomena, such as intelligence or personality (John and Srivastava 1999). EFA's main limitation is that the results should not be considered to provide a complete theory to a specific subject (John and Srivastava 1999). Nonetheless, a good application of FA provides a conceptual foundation that helps to examine theoretical issues and could be used as a base to develop further work (John and Srivastava 1999).

### 3.2 A Construction Method for UX Models

We propose a complete structured method to identify and characterize UX components using empirical data from users. This method uses a combination of techniques traditionally used in experimental psychology. The present research looks for identifying and classifying constitutive UX elements from an empirical study that integrates diverse latent variables behind the UX. Instead of a deductive process, based on existing theories on affective and cognitive phenomena to identify the UX elements, we propose a structured process of data gathering. The analysis is performed to finally identify, through EFA, the components that are crucial for an experience to occur, i.e., that arise in the user's consciousness, and, in this way, making them visible. The construction method has four stages responding to four objectives: first, identify the theoretical components of the UX by using thematic analysis; second, measure how those components are experienced by gathering user's data; third, reduce the number of components through EFA; fourth, construct the UX model. The three first parts provide the input or "bricks" to construct the UX model in the fourth part. Below, we expose the method.

**First Part: Thematic Analysis.** Use thematic analysis to identify systematically which the components of the UX are from a theoretical point of view. This technique is explained in Braun and Clarke (2006). It is very used to find patterns on a heterogeneous mass of qualitative text. It allows a structured process of coding and pattern recognition within the data avoiding researchers' biases. It provides themes and subthemes of variables present in the data, i.e., dimensions and groups and variables. These themes constitute the core

for the construction of the further UX empirical study. One example of application in the context of UX modeling is in Ariza and Maya (2014a).

**Second: Gathering Empirical User Data.** Gather empirical evidence about how the different variables influence the final user experience. Construct a questionnaire transforming the theoretical variables into measurable ones; use Likert scales. Transform each variable into an empirical one, using the sub-themes to describe the variable in a more integral way. Improve the reliability and content validity of the instrument taking as reference questionnaires previously validated for other UX components. Design a protocol for the whole experiment. Select a product with features allowing to evaluate instrumental and non-instrumental aspects, according to your objectives. Have in mind that the product category will introduce a specificity in the people's responses to the whole experiment. Consider evaluating the UX in different stages corresponding to the prior expectations, the participants' immediate feelings, impressions and perceptions, the aftereffects, and the accumulative aspects. Before, during, after and long-after are common stages for this. Split the whole questionnaire into the questions corresponding to each stage. Propose a first draft of the questionnaire. Refine it by reviewing the definitions and questions to ensure a good relationship and clarity. Do a pilot test with some users. Design a sample according to EFA reliability requirements (usually in the hundreds of people). According to Field (2009) and Beavers et al. (2013), an EFA's good sample size is conditional upon the strength of the factors and variables, rather than a large sample size. These values must be validated while running the EFA. Apply the questionnaire to measure how those components are experienced by a representative group of users in real interaction with a product; to do so, choose, a free of disturbance, appropriate context. This will increase the ecological validity of the whole experiment. Allow the full manipulation and use of the product when needed. Use an online service to host the questionnaire and collect the data. One example of the application of these techniques for UX modeling is in Ariza and Maya (2014b).

**Third: Apply EFA.** Reduce the number of components to a manageable amount of factors by using EFA. EFA is a data reduction technique. It analyzes many correlations among observed variables reducing them to a more manageable number but retaining the essential (Field 2009). The main decisions for setting up the EFA are: (1) define which variables to include, (2) select a reliable sample, (3) determine the factor extraction method, and (4) define the model-fit considerations, rotation method, and reliability analyses. Choose a proper statistical package for EFA. Do the factorability test on the data. If the test is ok, validate the strength of the variables' relationships for the EFA study. Check the questionnaire's reliability by using Cronbach's alpha coefficient. Do a data optimization to check if the data is factorable. Choose the oblique rotation if, a-priori, the components are dependent, (i.e., they all belong to the UX). Finally, validate the factorial model through a Monte-Carlo simulation (Mooney 1997): this is a resampling technique that creates repeated samples from an original data sample while retaining the correlations. This allows to overcome the generalization problems of the EFA. Naming the factors in EFA is of paramount importance: look at the variable with the highest load on the factor and use it as a reference to label and describe the factor. Examine the other variables and see how they contribute to the full description of the component. This

description should encompass the set of variables of the factor. The factors resulting from part three are the input, or "bricks" to construct the UX model sought. See one example of the application of EFA for UX modeling in Ariza and Maya (2014b).

**Fourth: Construct the Model.** Structure the factors to explain through a model how the UX arises for similar products and interactions. The construction of the UX model comprises several steps: (1) Rewrite the explanation of each factor to have a highly coherent explanation of what the factor is and how their variables are related. (2) Take the label alone of each factor to figure out how they are related and how is their temporal dynamics, i.e., the order of manifestation in the user's consciousness. (3) Propose a graphical scheme of this relation. (4) Check the meaningfulness of the whole model. (5) Check the explanatory capacity of the model by explaining the UX of three types of products: one of a similar category, with a very good UX; one of a similar category but with a failed UX; and one borderline case: a product with a UX where the model fails to explain some UX components. Apply the case study method for this. (6) Adjust the model following the pieces of evidence gathered through the three cases. (7) You will have a pre-model, which is the basis to make a backward process: starting from it, you have to devise an experiment to gather empirical data by operationalizing their variables as a questionnaire in a similar way as explained in part three of the method. (8) Apply Confirmatory Factor Analysis, CFA, to check if the factor model matches the relations posed by the pre-model. (9) If the match is correct, the pre-model reflects validly the user's UX. Otherwise, adjust the pre-model as necessary and repeat the CFA process.

### 3.3 The Aware UX Model

We propose the Aware UX model. It results from the application of the aforementioned systematic method until the case study step, which we use to begin its validation process. The model was constructed using the MP3 headphones of Fig. 1 as stimuli. In the case study, we explain the UX of a market successful product but of a different category (electric chainsaw) to the product used to construct our model.

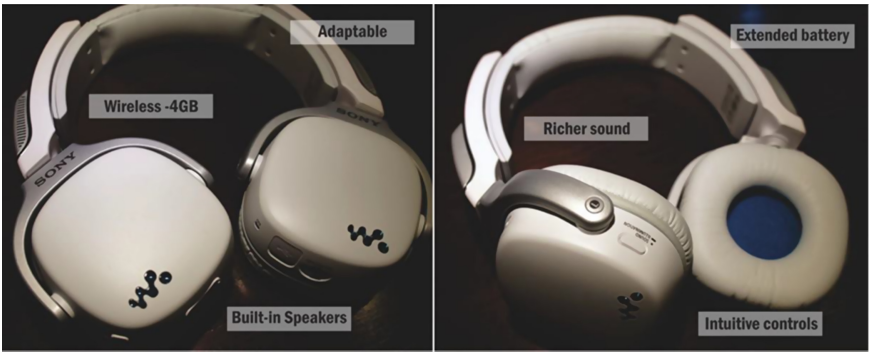


**Fig. 1.** Example of a product used in Ariza Maya (2014b): Sony WALKMAN® MP3 Player NWZ-WH303 headphones. Photo: Ariza.

**The Aware UX Model Construction Process.** In two previous publications we, first, identified UX variables and their dimensions for product design using thematic analysis applied to 13 UX models, 10 UX definitions, and 10 review papers (Ariza and Maya 2014a). Second, based on those dimensions-variables, we designed a study to get empirical user data (n = 200) while interacting with the MP3 headphones. Through an Exploratory Factor Analysis, we reduced the number of variables by identifying the factors behind them (126 variables to 32 factors) (Ariza and Maya 2014b). A further Montecarlo simulation (n = 1000) allowed us to confirm the quality of the factorial model. Based on that factor structure, we proposed the UX model below. The presentation of the Aware UX model is composed of two parts. First, in the components section, we explain each component of the model: we take each factor previously found and explained it as a coherent whole as a group of correlated variables. Each of these components are the different psychological constructs that would arise to the consciousness of the user during interaction. The Aware UX model explains three stages of the interaction. We only present here the components for the BEFORE Stage. For the DURING and AFTER stage see the Appendix. Secondly, in the model section, we fully describe the Aware UX model emphasizing the dynamics and causality relationships of the components.

**A Detailed Explanation of the Components of the Aware UX Model for the BEFORE Stage**

*1. Attractiveness and Interest/Novelty of the product.* In everyday language, attractiveness is the characteristic of an object of being "very pleasing in appearance", and "…causing interest" (Cambridge Dictionary Online 2019). Interest is aroused when the user needs to give selective attention to the product (APA 2015) because the product is significant. Significance can be threefold. The product must look attractive for the user: one way to arise the user's interest is to show him an attractive product. Interestingness is the quality of a product that arouses interest rather than aesthetic pleasure (APA 2015). Attractiveness can be obtained through multiple ways: combining the product's form supports (shape, colors, materials, textures,), through, manipulation of perceptual determinants (gestalt laws for instance) or cognitive determinants such as typicality, prototypicality, familiarity, etc. Once the product has arisen interest, the user's mood comes to the fore.

*2. User's mood.* Unlike emotions, the mood is an affective state "about nothing specific or about everything" (Fridja 2009a). The user's mood has cognitive effects. These are mood-congruent: encoding facilitation, recall, judgment biases, and attentional selectivity (Fridja 2009a). In other words, mood acts as a filter from a perceptual point of view. Certain pieces of information will be of relative interest depending on the user's mood. There are effects of mood on processing. Pleasant moods lead to "more superficial processing in precision tasks, and to more mental flexibility" while unpleasant moods favor deeper processing (Fridja 2009a, p. 258). The user's mood plays a paramount role because it can lead the user to abandon the exploration of the product, or, on the contrary, encourage the user to get more information from the product, i.e., to be more involved in the interaction. Depending on the user's mood, it leads to the product's specific concerns, component 3, or to 4, anticipation of buying and use.

*3. Product's Specific concerns.* "Concerns are the dispositional sources of emotions" (Fridja 2009b). Concerns are paramount for the interaction because they trigger emotions in the cognitive appraisal process (Demir et al. 2009). Emotions are the main component

of the user experience. A concern is a specific state of the world that is important for the user. Many different types of concerns have been identified concerning the interaction with products: needs, goals, interests, etc. However, four types of concerns are central in the before phase of the user experience, from (3.1) to (3.5). (3.1) Interest in the Product's Functionality: ¿am I interested in this product's functionality? Functionality has been pointed out as the main need concerning a product (Jordan 2002). It is a gate for the interaction because if the user is not interested in the product's functionality, the interaction could be halted. (3.2) How valuable is the product? How curious I'll be? Economic concerns are omnipresent in our lives, especially with technological products that can be expensive. If the product is affordable for the user this judgment can lead him to be more curious about it and to try to gather more information that could lead him to the buying process. (3.3) Social approval: who uses the product. This concern is relatively important for every product, but if the product is to be used in public it becomes a very important one. This concern means that we want to know who uses the product to gain more information about affiliation processes such as belonging to the group of users of the product or being different from that group, even if oneself is the user of the product (Berghman and Hekkert 2017). (3.4) Product's professional look. This concern reflects the desire for the user of possessing a product with high performance, i.e., a robust product able to give a high-quality output for their main functions and at the same time able to withstand to small accidents and rough conditions during manipulation. This concern can be at the same time highly specific and highly general. Highly specific for technological products because they are delicate and prone to be easily damaged during rough manipulation. Highly general because it is a general human concern related to the duration of products and to our attachment to them. (3.5) Interest in the product's technology. This concern is highly specific to technological products specially if the product combines simultaneously different technologies in an innovative way. This interest should feed the anticipation of buying and use because it invites the user to judge different aspects of the product. This judgment made frequently based on partial information could lead the user to a buying process.

*4. Anticipation of buying and use.* Anticipation is a user's emotion involving an imaginative speculation process. This speculation concerns the future use and possession of the product. It is produced using information about the product or similar products saved in the user's brain. Anticipation can be pleasurable but at the same time a way to deal with the stress of facing the use of a new and not so easy to use product (Skynner and Cleese 1996).

The components for the DURING and AFTER Stage are explained in the Appendix.

**The Three Stages of the Aware UX Model.** For the BEFORE-UX and DURING-UX stages, we have a small number of factors (components) which allowed us to directly propose the model (Ariza and Maya 2014b). For the AFTER-UX stage, to have a more manageable group of components, we clustered again the factors obtained in two ways: using data from the EFA's correlation matrices and using the KJ method. Finally, the proposed model explains its components in terms of psychological constructs pertaining to the affect, cognition or behavior of the user. It explains some relationship among these components and some aspects of their dynamics while explaining what arises to the consciousness of the user. Even if the model pretends to be a generalization of the

categories presented in the precedent section, the influence of the product's category (MP3 headphones) is clear. The numbers for each component are the same used in Ariza and Maya (2014b).

*BEFORE Stage.* For this stage, Fig. 2, (1) attractiveness and interest arise in the user's consciousness. The user is prompted to pay attention to the product because it offers some novel features to him. Even if the user is finally interested in the product his mood (2) modules his general affective tone: if good, all the downstream UX will tend to be felt positively or the contrary if the mood is negative. Then, the user's attention will address some typical concerns with the product (3), its functionality (3.1.) being, maybe, the most important. Other common concerns will pop up to the user's consciousness, not forcibly in this order: the value of the product (3.2), the social approval of the product (3.3.), if the product has a professional look because it conveys the idea of a sophisticated product (3.4.), and, finally, an interest in the product's technology (3.5). Probably, these concerns interact among them in an inextricable way. This stage finishes with an anticipation feeling to buy and use the product (4): the user imagine himself using and getting the benefits promised by the product.

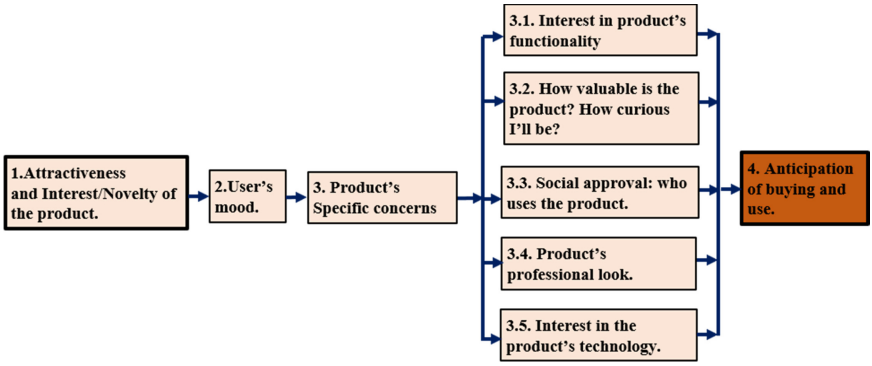


**Fig. 2.** The Before Stage UX model.

*DURING Stage.* In this stage, Fig. 3, the user should know how to use the product (1), he thinks or remembers how he has had previous experiences with similar products, (2), and remembers what the product does and how should be used (3). Components (2) and (3) make a loop where the user must figure out how to use the product to get all its functionalities. As he probably doesn't know how to use some functions, he tries the product's different controls and sees their effects; he iterates until he feels he's able to use the product at a minimum level. Due to its novel features, the product has different functions, (4), which the user could not know how to use, but in the end, he's satisfied with the principal function. Obtaining the main function is a fundamental support for the during stage; otherwise, if the user is not able to get it, he might abandon the interaction. If the user is in trouble trying to get the main function, he comes back to components (2) and (3) and the loop could be active again. When the product is working properly, the

user would enter in a state of flow, (5), where no additional effort is required to get the benefits of the product and where the user enjoys the interaction, i.e., being connected to the product. When the user is in flow, components (2), (3) and (4) are no more of a concern during the UX. After the flow experience, in (6), the user is aware of how he can feel the aesthetic visual and tactile harmony of the product; he feels the product really comfortable on his hands. In conclusion, this stage is highly stimulating for the user: he felt the use of the product as very exciting and stimulating (7).

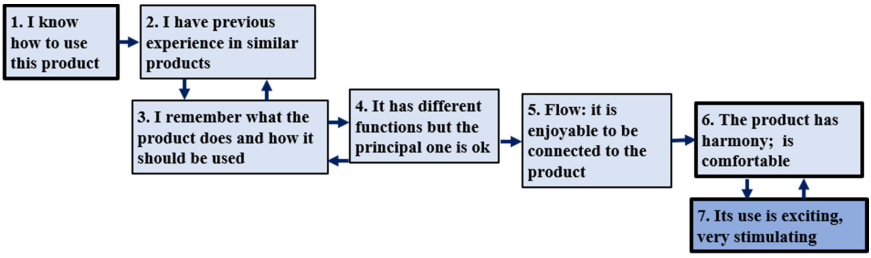


**Fig. 3.** The during stage of the UX model.

*The AFTER Stage.* This is the UX felt immediately after finishing the direct interaction. This stage can be very rich in components, as shown in Fig. 4, even if the user is no longer in contact with the product. This is the part of the Aware UX model that can give the most information about the other two UX stages. This stage begins with a global impression and general memory about the direct interaction that has just finished. This impression is a consequence of two groups of components. On the left side, there is a group of emotions made up of expectations that have been filled or not (3), if the user felt disconnected from the world using the product, (7), and if a recall or even nostalgia arose at the user's consciousness. On the right side, counterbalancing emotions, there is a large set of usability components. This demonstrates that a good usability is fundamental for the AFTER stage, even if there is no direct contact with the product. The set begins by the user asking himself if the product is easy to learn and understand, (2), which is a crucial component in this part because a negative answer will stop this usability cycle and would contribute to a very negative global impression. A clear entry point for the interaction is important, (10); this is made possible by clear marking functions. In turn, if the use of the product was possible, the user would ask himself how else he could use the product, (6), and how to use it in a context different to the original one, (9). To finish the usability group, there is a question about where the user can learn more about the product, (17). The comparison between the global use dimension and the global emotional group would lead the user to a reflection: he enjoyed using the product and he holds a position about it (13). This is important because it is a first evaluation of the UX that has just passed. If the enjoyment was present, the user would come into remembering details of the interaction, in the form of concerns: if the product's brand was ok, (11); if the performance of the product's technology was good (12); if the product's use matched its aesthetic appearance (14) and if the user looked good with the product in that context, (5), which makes the user think of other products with similar style (15), in a loop. After

these personal concerns, leading to product evaluations, there would be a change in the user's perception of the product (16) in the form of an afterthought. If this change in perception is positive, the final component will be activated: the engagement with the product (1). This is important: engagement would be the final goal of a successful UX for designers.

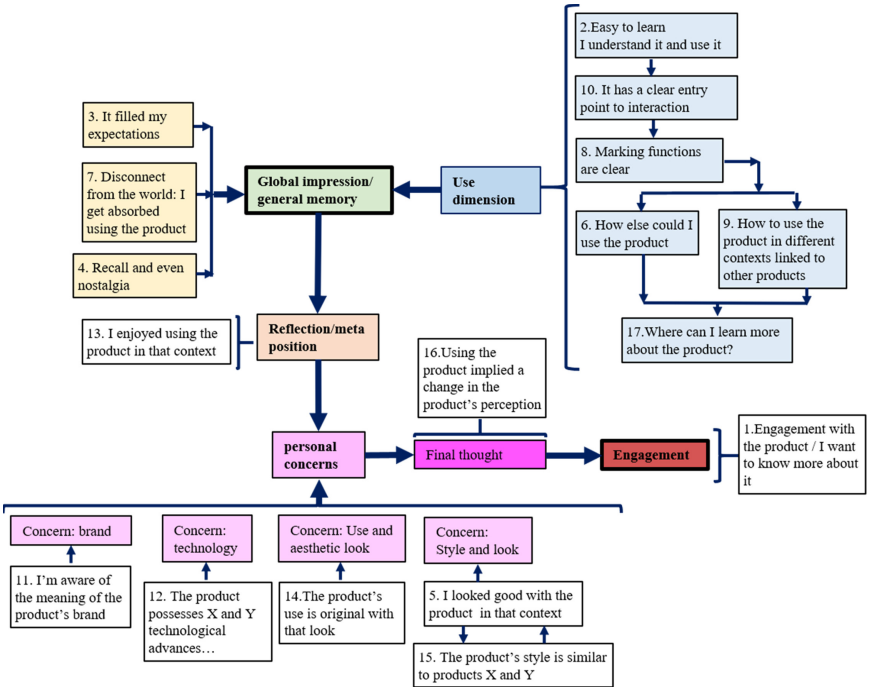


**Fig. 4.** The After Stage of the UX model.

**Discussion.** The Aware UX model is different from most models in the literature because is centered in the user and what arises to his consciousness. Even if the UX is felt as a whole, the model is highly analytical decomposing the UX in its many components. In this way, the model is explanatory. We do not hold that all these components arise in the user's consciousness during an interaction with a product similar to a headphone mp3; just some of them. However, they probably will be behind the UX as latent variables, influencing the contents of the user's consciousness. We use the model to make designers aware of the components by telling them that they exist, by explaining to them what they are and how they would influence the UX. We request designers to not forget the Aware model's components, because, even if latent, they are always there when designing for the UX.

## A Case Study: The JawSaw Worx Electric Chainsaw

This case study concerns a market successful product: the JawSaw® electric chainsaw

from Workx®, Fig. 5. Chainsaws are intimidating for new users. The JawSaw has a safer chain saw to avoid accidents due to the exposed spinning chain. It was designed to be safer for the novice user. It can operate directly on the ground, so the user does not have to lift the logs off the ground and then bend down to cut them. It also has an extension handle for pruning high branches. It has 291 ratings with an average of 4.5 on Amazon.com (Amazon 2020), and an average of 4.6 for 478 ratings in Worx homepage (Worx 2020). The reviews of specialized sites were very good as well. For instance, the ChainsawJournal.com site said in its review that the "JawSaw was the best chainsaw alternative" (The Chainsaw Journal 2020). It won a Silver A' in the A' Design Awards in 2012 (A' Design Awards 2012). With this case study we want to substantiate the Aware UX model: to see if it possibly explains many different thoughts and feeling arising to the consciousness of a JawSaw's user, and to see if they could offer a coherent account of an UX. We did so by proposing supposedly user's self-taking, thoughts and feelings, belonging to each one of the stages and components of the UX Aware Model. The results of this case study should contribute to answer two questions: Do all these thoughts and feelings represent a whole UX experience? Are they important? We believe that designers have the answer to these two questions.

BEFORE stage (stimulus: the promotional videos of the product). 1. That product looks terrific in the video. Its shape is quite different, I've never seen one like that. 2. I'm in a very good mood for gardening this Spring. 3.1. That chainsaw cuts perfectly and it has many different safety features. 3.2. It's only U$110; it's worth the investment! 3.3. My neighbor will like it as well. 3.4. It looks so sturdy to endure very harsh conditions; it looks professional. 3.5. I don't know how it works. It seems they developed three patented systems for it. 4. I'm looking forward to buying it and use it.

DURING stage (stimulus: the real product in interaction). 1. Even if it looks different, I already know how to use this chainsaw. 2. I've used many chainsaws in my garden, some similar. 3. It cuts so well. I know how to cut the higher branches, it's a little bit tricky…I see it has security functions to avoid accidents. 5. What a pleasure to use this chainsaw! I really enjoyed doing all the gardening in one day. 6. The product looks so well. Its textures feel good; it's completely comfortable. 7. I found its use so stimulating; cutting logs on the ground for my first time was exciting, and without breaking my back!

AFTER stage (Stimulus is absent: the JawSaw is no longer present). 3. It's my first chainsaw to completely fill my expectations. 7. During the use I even felt disconnected from the world; it was absorbing to the point of doing all the Spring gardening in one day. 4. The use was terrific; I wonder when I would have the opportunity to use it again. 2. It was so easy to learn to use; I understood immediately all its functions. 10. The start button was the first thing to use. 8. The controls showed clearly what they were for. 6. If it's able to cut logs on the ground I wonder how else I could use it. 9. I might use it to cut branches over the roof if I use a proper ladder. 17. I wonder if there are more training videos on the internet. My global impression is that I bought a terrific product, I loved it! 13. I enjoyed its use all the time for my gardening. 11. That brand is very good and well evaluated on the Internet. 12. The security items are patented, and it has a new lubrication system. 14. Its shape was different which made its use different as well. 5. I think I looked good with the product on my hands. 15. Its style is similar to a high-end chainsaw's brand. 16. Oh my gosh: it made me change my mind about home chainsaws!

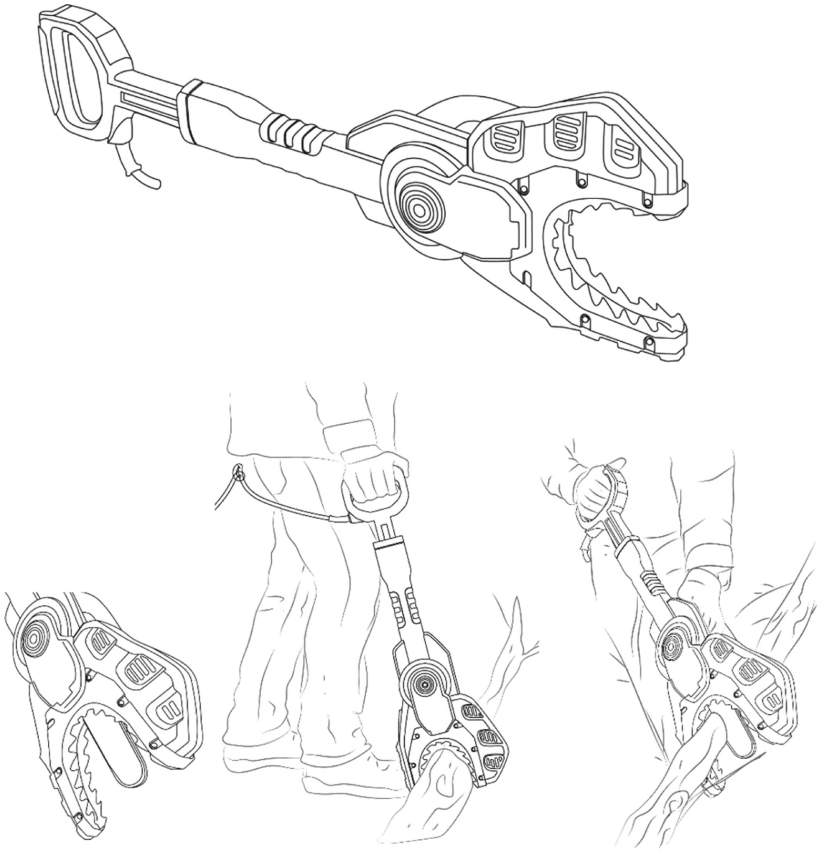

**Fig. 5.** Up, The Worx JawSaw electric chainsaw. Below, left, a close-up of the jaw system that keeps the blade and chain retracted until they're fully enclosed in the guard, avoiding accidents. Center, the JawSaw can cut logs on the ground. Right, it has an extensible pole. Illustrations: Angelica Rocha.

1. This chainsaw now has all my attention, It's really interesting. I want to use it over and over.

### 3.4 The Aware UX Heuristics Method

One criticism to UX models is that they are too broad and difficult to apply. Consequently, we propose a UX method composed of heuristics extracted from different sources. This is what a designer should do to design for UX. The features that are crucial for an UX to occur and the components that favor meaningful user engagement are difficult to grasp due to their different psychological nature. Therefore, instead of relying on highly structured methods for an already complex subject, those features would be easier to grasp through the deliberate application of simple design heuristics chosen from scientific, engineering and design literature. As an example, Table 1, we propose such heuristics

for the DURING stage components. We propose two types of heuristics: the strategic heuristics, to be applied from the beginning and all through the UX design process, and component heuristics, to assist the design of the different UX design components of the Aware UX Model. The number in the beginning is the component of the DURING Stage. *Strategic Heuristic*: what the user wants during use is a lot of proper stimulation.

**Table 1.** Component Heuristics for the DURING Stage.

| Component number | Heuristic |
|---|---|
| 1, 2, 7 | Use a mental model that clearly fits your product |
| 1 | Provide clear marking functions |
| 1 | Provide a clear entry point to the interaction |
| 3 | Use a proper color set for the user interface |
| 3 | Provide keys, pads and other control surfaces with a pleasant touch |
| 3 | Provide keys, pads and other control surfaces with a pleasant mechanical response and sound (clicks and other interaction sounds) |
| 4 | Make the product's functionality perfect |
| 4 | Provide delighter items in the product according to Kano model ("I didn't know I wanted it, but I like it") |
| 5 | Provide a flow experience while using the product (a smooth, pleasant and trouble-free interaction) |
| 6 | Provide a product's aesthetics high in unity |
| 7 | If the product's prototypical shape has been strongly changed provide clear clues to easily identify the product category |

## 4 Conclusions, Limitations and Further Work

We believe that our work improves the theoretical and practical understanding of UX by increasing the designer's awareness of the UX, drawing her attention to many different UX's components that remain tacit and difficult to grasp and express, even for the designer's intuition. We identified and characterize the components of the UX with an information-technology product for listening to music, but, through the case study, we showed that the Aware UX model can explain the UX felt with products of other categories. When UX designers continue to rely heavily on intuition, many relevant aspects of the UX are missed, designers don't know how those aspects are related and don't know either their relative importance. We provide an easy to understand model that can be applied for different stages of interaction to always keep in mind that there are latent components of the UX that are worthwhile to think of. We provided a set of heuristics to do so. The granularity of all UX models is quite different among their different components (Forlizi and Ford 2000; Revonsuo 2009). We believe that this

makes their application difficult. Consequently, we tried to propose a UX model with more regular granularity. We also hope that the factorial structure identified and used for the construction of the UX model would allow the refinement of future UX models and tools to improve UX design in design teaching and practice. One limitation of the Aware UX model is that it is built on EFA, so the results should not be considered to provide a complete theory to UX. We have to remember that what you put into an EFA is what you get out. As further work, we will advance on the validation of the Aware UX model by proposing more case studies and continuing to adjust the model all through the stages of the method proposed here. We will extract more heuristics for all the UX stages and evaluate the results of their application.

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## Appendix

### The During-Stage Components of the Aware UX Model

**1. I know how to use this product.** This is a confirmatory belief of the user while using the product. The user arrives to get the services promised by the product's functionality without a problem. To do so, the user has evoked an appropriate mental model of the product. The mental models "are the conceptual models in people's minds that represent their understanding of how things work." (Norman, 2013, p. 26). This belief recognizes tacitly a correct usability with the product. Even if it seems a cognitive laden affirmation it could imply a positive or neutral affective state in the user.

**2. I have previous experience with similar products.** Experience is one stimulus that resulted in learning (APA, 2015). Being confronted with products with new and different functions and usability entails a significant cognitive-affective effort. According to the product appearance the user could take two paths. One, an exploratory path, where he undertakes a trial and error process to see if his manipulation works on the product. Two, he tries to recover appropriate mental models to use the product. Retrieval and memory resources must be assigned to this task. When a piece of retrieved information is good to solve the task at hand, mostly mental models of similar products, the mental content of "having experience" might come to our awareness. This goes hand in hand with part 3.

**3. I remember what the product does and how it should be used.** This confirmatory belief could be formed based on 2 and previous manipulation and direct knowledge of the product. It is a natural piece of thought in the flow of the experience because the user should strive to get the different functionalities the product has promised through advertising and other media. Especially during the first uses of the product, the user cannot be able to get all those different functions, so the next piece of thought, 4, comes up to experience.

**4. It has different functions but the principal one is ok.** This is the result of new products offering new architectures and integrating multiple technologies: even if the

user explores it and try to get other functions, when he perceives that the product is offering him its main service, fluently, he stops exploring it. This is a necessary element to go into a good emotional state with the product, 5, leading finally to a state of flow.

**5. Flow: it is not boring to be connected to the product.** Flow is a state frequently present in the user experience. Flow is what makes an experience enjoyable (Csikszentmihalyi, 1997). Flow is present when a more or less difficult task is being faced effortlessly in a rather automatic way. The absence of negative emotions, such as boredom, and the presence of stimulating activity, 6, are paramount to flow. When there is flow the activities done with a product become autotelic, i.e., there is no reason to do the activity except because the user wants to feel the experience they make possible (Csikszentmihalyi, 1997).

**6. The product has harmony; it is comfortable.** Harmony refers in everyday language to a balance among all perceptual elements, i.e., to a product presenting a consistent whole. In empirical aesthetics harmony refers to a product presenting perceptual goodness, i.e. it has a good gestalt or Prägnanz (Palmer, Griscom, 2013). This factor is interesting because it is a sensory aesthetic factor, different from all the other factors in this stage (mostly of cognitive nature). This factor adds a layer of positive affect on the user experience. Comfort is the aesthetic sensation for the kinesthetic sense (proprioception). It refers to pleasurable sensations linked to the movements and body positions afforded by the product (Hekkert, & Leder, 2008).

**7. Its use is exciting, very stimulating.** The presence of a highly stimulating environment is, because of perceptual, 7, cognitive or affective reasons, essential for flow experience. By definition, flow is pleasurable (Csikszentmihalyi, 1997). Flow is a complex construct with at least nine elements contributing to it (Csikszentmihalyi, 1997). Being a complex construct, flow summarizes a good experience with a product by encompassing different feelings at the same time.

**The After-Stage Components of the Aware UX Model**

**1. Engagement with the product. I want to know more about it.** Engagement is a complex quality of user experience "characterized by attributes of challenge, positive affect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, interactivity, and perceived user control" (O'Brien, & Toms, 2008, p.938). This is the foremost element in the after phase: with no engagement, the interaction does not go further. Low levels of engagement lead to impoverished interaction. A user's high level of engagement with the product is an ideal objective. Engagement is a consequence of a global positive challenging experience that has turned out well for the product's user. Moreover, and because of the presence of variety and novelty in the experience, the user wants to gather more information about it, maybe to enrich his interaction through the availability of more elements and to gain control over the interaction itself.

**2. Easy to learn. I understand it and use it.** Learning is crucial in user experience: is a change in the user's behavior or capacities "brought about by experiences" (Reisberg, D., p. 460–461). Different forms of learning are caused in our interactions with products: associative learning and skill learning are common, especially to gain procedural knowledge (know how to perform some action with it). Skill learning should lead to automaticity for the skills involved during the interactions with the product, i.e., the skill is "run off as a single integrated action", (p.460) even though it was composed initially

of many different actions. There is a learning curve reflecting how easy or difficult is to learn to use a product for the first time (Reisberg, 2001).

**3. It filled my expectations.** Expectations are generated from current and past experiences; these are a mental construct serving to narrow down the range of possible outcomes of an event (Geers, & Wellman, 2009). Expectations are beliefs about future occurrences. If an expectation is filled, our prediction of an outcome had a small error allowing us to give better responses to future contingencies, i.e. with more adaptive value (Geers, & Wellman, 2009).

**4. Recall and even nostalgia (reminiscence).** It is well known that recalling an experience can arouse emotions linked to that particular experience. Nostalgia, together with longing and poignancy, are a group of complex emotions characterized by "both hedonically positive and hedonically negative feelings" (Shaver, 2009, p. 243). It has no simple cognitive appraisal because the product is mentally portrayed as highly desirable but temporarily unattainable (Shaver, 2009).

**5. I looked good with the product in that context.** This is an aesthetic self-assessment (Palmer et al., 2019) of oneself on one's behalf. This evaluation is done by the individual but is referred to a context. "Looking…" has been identified as one indicator of aesthetic response. This shows how it depends on different elements contributing to the aesthetic response such as background colors, materials, illumination, etc.

**6. How else could I use the product?** This is imagination: it is a special "form of human thought characterized by the ability of the individual to reproduce images or concepts originally derived from the basic senses but now reflected in one's consciousness as memories, fantasies, or future plans" (Singer, 1999). The user can reshape these memories into rehearsals or planning future manipulations of the product. The product, being no longer in the user's sensory field, imagination is an economical method to explore and enrich the experience, all this happening in the user's stream of consciousness.

**7. Disconnect from the world: I get absorbed using the product.** This is one of the characteristics of the flow experience: distractions are kept out from consciousness, making the user focused on the here and now with the product (Csikszentmihalyi, 1997).

**8. Marking functions are clear.** They make visible the product's technical functions showing "how the product is to be handled or operated" (Bürdek, 2005, p. 312). Unclear marking functions make the user unable to get the service the product delivers through its technical functions.

**9. How to use the product in different contexts linked to other products.** This factor concerns how the user's mental model of the product (Norman, 2013, p. 26) shows the possibility of linking the product to other products in other contexts, i.e., connecting two different mental models. This factor is increasingly important due to trends in extending products into services by connecting them to the Internet.

**10. It has a clear entry point to interaction.** Having an appropriate mental model is not enough for the user to have a successful interaction: he must know where to begin the operation of the product. This is achieved by using good marking functions (Bürdek, 2005) providing hierarchy to the interaction, for instance, by applying a contrasting color to the product's start button.

**11. Awareness of the product's brand meaning.** There are four meanings delivered by the brand's identity (Kotler, 1999, p. 572): attributes (labels associated to the brand), benefits (customers buy benefits not attributes; they are functional and emotional), values (symbolized by the company, they attract customers who believe in them) and personality (similar to personality traits). Branding consists of developing this deep set of meanings. Cognitively, a brand is a concept that is recalled due to a prompt in the perceptual field of the user, for instance, the logotype of the brand or a certain brand's aesthetic style.

**12. The product possesses X and Y technological advances.** This is a comparison between the two product's concepts. A concept is composed of features that, in this case, are compared one to one to identify one as superior in a specific item. Product superiority is "the differentiation in characteristics found between similar products that leads to one product being perceived to be of higher value and/or quality to the customer" (Haverila, & Fehr, 2016, p.570). This superiority is vital for customer and user satisfaction (Haverila, & Fehr, 2016).

**13. I enjoyed using the product in that context.** Enjoyment is defined as "an emotional response to the experience of pleasure" (Sundarajan, L. 2009, p. 155). Enjoyment can be experienced at three levels: first, as acceptance wriggles that are movements that expand or increase the perception of the product (its sound, appearance, etc.). They serve to explore the different aspects of the stimulus in an effort to continue interaction; they can form an extensive repertoire (as in tasting wine (Fridja 2010)). Second, "enjoyment is a reportable pleasure derived from the awareness of pleasure" (Sundarajan, L., 2009). Third, enjoyment is like savoring: the user turns the event of use of the product over and over in his mind; this contributes to extend enjoyment beyond pleasure.

**14. The product's use is original with that look.** Consumers get bored with the typical appearance of their products, so an original and new product will get their attention (Veryzer, Hutchinson, 1998). However, originality in the use might produce an intense affective reaction because an incongruity of the use of the product with previous mental models of the product's usability can cause a higher arousal level. Consequently, solving this incongruity will be strongly experienced (c.f. Snelders, Hekkert, 1999).

**15. The product's style is similar to products X and Y.** Style conveys meanings and arises aesthetic, and emotional feelings in the user. Style is a way to make a product different or similar to competing products. Cognitively, presumably, comparing products' styles asks the user to compare meanings, aesthetic and emotional feelings. Style is important because it allows the user to belong to a group (the possessors of a product of certain brand) but, at the same time, allows the user to be different of other people who possess similar products but on other styles or brands (Berghman, & Hekkert, 2017).

**16. Using the product implied a change in the product's perception.** Using a new product implies new sensations for the user. Perception, by definition (Zimbardo et al., 2009), creates new interpretations of sensations, therefore, by using the product, a change in its perception is provoked.

**17. Where can I learn more about the product?** The question itself reveals the motivation to learn more about the product. The user wants to expand the possibilities of interaction with the product. This expansion is a consequence of a change in his pre-existing thoughts and behavior. Different ways of learning exist when interacting with

a new product: by imitation, by trial and error and, through insight. (Strickland, 2001, p384-385).

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