Unveiling Usability and UX Relationships for Different Gender, Users Habits and Contexts of Use

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Abstract

Despite the abundance of research into usability and user experience (UX), there are few works approaching how the context influences the relationships between these two concepts. The actual experience of a user highly depends on personal characteristics, like the social and cultural background. In this work, we address user-related and contextual factors for a better comprehension of usability UX correlations. We conducted a study with 160 participants in entertainment, e-bank, education and e-commerce websites. As a result, for both sex and usage time user classes, a good usability was positively correlated to positive emotions. Despite the correlations between usability and female users negative and positive emotional reactions are greater than for male users, no significant difference was observed. Also, there was no

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significant difference involving correlations between usability and emotional reactions, when comparing less and more frequent users. As another result, there are differences of the degree of the correlations between perceived usability and emotional responses in different contexts of use, when dividing the users on sex and usage time classes, but the correlations between usability and positive emotions remained positive. In spite of the particularities of user classes, similarities on the usability for different user classes and the agreement of patterns of correlations with previous literature, our results reinforces the usability as a determinant aspect for UX.

Keywords: Usability, UX, gender, computer usage time, context of use.

1 Introduction

The ISO norm defines UX as a person's perceptions and responses that result from the use or anticipated use of a product, system or service [1]. While this definition is rather broad, it is challenging to reach a common definition of UX, because UX is mapped to a broad range of dynamic concepts, such as emotional, affective, experimental, hedonic, and aesthetic variables [2]. Also, the landscape of UX research is fragmented and complicated by diverse theoretical models with different foci such as pragmatism, emotion, affect, experience, value, pleasure, beauty, hedonic quality, and others [3–7].

In addition to a lack of consensus on the UX definition, the literature on usability and UX points out that both concepts are still evolving and that there are different perspectives about their boundaries and relationships. A clear view on the demarcation and relationships between usability and UX is lacking [2]. There are different views about the usability and UX concepts and misconceptions regarding their relationship. Many researches consider that UX includes usability [7], [8] and assume that UX is an elaborated form of satisfaction and usability is a precondition for positive UX [7]. On the other hand, frustration is used as a criterion for identifying usability problems [9].

Thring and Mahlke [10] demonstrate that the manipulation of selected system properties may lead to differences in usability that affect emotional user reactions, while there are also other approaches suggesting that usability is not necessarily the main condition.

There is research advocating that negative emotions can affect the instrumental (pragmatic) quality [11] and also research showing that a system with usability flaws led to intense negative emotions [12], suggesting bi-directional relationships between product qualities and emotions elicited during users

interactions. Finally, empirical research provides evidence that relationships between usability and UX and among their sub-elements may vary according to different contexts, such as context of use [13].

Such overlapping and conflicting aspects raise questions about the boundaries of and relationships between the two concepts. It seems important to further examine both concepts. There is still a lack of knowledge in terms of UX constructs and their structural relationships [14]. There is a call for research regarding conceptualizations of usability and UX and a also their relationship [15]. Thus, in this work, our main objective is to unveil correlations between usability and UX features in different use contexts and analyze users differences in their perceived usability, emotional responses and relationships, focusing on their social background.

2 Related Work

The success of interactive technologies is positively influenced by the extent to which they promote a high-quality experience in their users [14]. Hence, modeling users experience as a foundation for providing design guidelines is especially important. In order to unveil how a positive UX can be promoted, research works on delimiting UX and unfolding the interrelationships among UX elements are still in progress. This user experience compasses usability, and also other cognitive, emotional and socio-cognitive aspects of users interactions with systems, such as users enjoyment, desire to continue using, positive affect to use a digital artifact and contextual factors.

One of the challenges related to UX is how to model users experience not disregarding the influences of the context. In accord with the common understanding of UX as subjective, dynamic and context-dependent [6], Minge et al. [16] proposed an UX model, where users interactions in an interactive system are determined by user characteristics, system properties and contextual components. Users expectations and attitudes towards the system as well as present mood and personality traits may impact the experience. Contextual components involve the physical and social environment together with any tasks that the user aims to fulfill.

Despite the abundance of research into usability and user experience (UX), there are few works approaching how the context influences the relationships between both concepts. The actual experience of a user highly depends on personal characteristics, like the social and cultural background [17]. User-related contextual factors are relevant variables in comprehending UX [7]. There are even fewer works addressing the importance of the user

backgrounds during interactions. The user perspective is underrepresented throughout the literature. According to [18], UX studies seem to resort to an experimentalist approach, as opposed to a differentialist perspective, assuming relative homogeneity among subjects of whatever skills are necessary to carry on a task, often neglecting system peculiarities. There is a demand for works having in mind that interactive systems judgments depends on the users background [19].

Walsh and Nurkka [20] raised the importance of cross-cultural design in HCI and argued that more research is needed to respond to the demands of globalization and emerging markets. Some works identified cultural differences in UX design in different use cases. Lachner et al. [17] investigated the relation between users country of origin and their interaction patterns with an e-commerce website plug-in. They analyzed the usage patterns of 5.843 French, 2.760 German, and 5.548 Italian website visitors and found that they show significantly different patterns.

Athinen et al. [21] identified similarities and differences in the comprehension of wellness and its impacts for the design of a mobile application when comparing users from Finland and India. They unveiled that finns and Indians have a different understanding of goal setting, which is an essential aspect for the associated mobile application. Results provided clues that a familiar website brand, comprehensive content and interactive features had the bigger effect on users judgment; users provided more positive answers to a website with a familiar brand, comprehensive content and interactive features, while there were minor effects of health awareness and culture on users overall predilections.

Al-shamaileh and Sutcliff [22] examined UX taking into account users background, task and context. The results indicated that users judgment shown to be susceptible to framing effects of the task and their background, emphasizing that quality assessment of a design seems to be very context dependent. Lee and Koubek [13] signalized that experimental domains and tasks characteristics, which were related with user purposes, interaction styles, and the degree of the embedded emotions could have an impact on the relations between perceived usability and aesthetics. Seo et al. [23] inspected the relationships between user perceptions and emotions in distinct contexts of use. The results provided evidence that the relationships between perceived usability and emotional valence differed in differed for different contexts of use.

Gross and Bongartz [24] scrutinized the effects of users perceptions of usability attributes and emotional responses on users judgments of products.

They found that depending on the product type, the best predictor for judgments differs depending on the product. Other studies [25–28] also have examined the effects of users perception of usability and aesthetics on emotional responses in different contexts.

In Technology Acceptance Models research, contextual effects of tasks and user populations have been modeled in many studies as facilitating conditions and subjective norms including variables such as user age, gender and experience [19]. From the perspective of the UX evaluation, it is important to contemplate any user characteristics (e.g. age, gender, experience, self-efficacy and habit) that may affect results. Few works have previously used gender as a study factor in UX. Barth [29] reached the conclusion that female users have more issues when interacting with websites. Alkhaldi and Al-Sa'di [30] investigated the effect of gender differences on aesthetic preferences for blog interfaces. Female users favor more images, while male users prefer more text in the blogs. The results of Jamil et al. [31] study showed that gender has influence over enjoyment, ease of use and satisfaction, but has no impact on usefulness in gaming interactions. Huq et al. [32] found a psychological difference when it comes to processing of information, self-efficacy, and tinkering between male and female users during websites interactions.

Alkhaldi and Al-Sa'di [30] investigated the user satisfaction of a mobile banner system and revealed that female users are more concerned about user satisfaction than male users, reporting that males and females have different preferences for user interfaces design. They point a research gap, advocating that gender differences in terms of website interface design have not been properly evaluated in the literature.

Due to a large number of contextual factors that should be considered under different conditions, the relationships between perceived usability and emotional reactions still need to be unveiled. To the best of our acknowledgment, there is no work that contributes to the understanding of the relationships between perceived usability and emotional reactions respecting different contexts of use along with users distinct computer usage time and gender.

3 Research Questions

Based on the premise that the consideration of contextual features is a necessary condition for understanding UX issues and that little attention has been paid to individual differences such as gender and users habits in UX, our goal is to analyze gender and computational time usage in UX design

regarding different contexts of use. For this purpose, we investigated the users perceptions of their usability and emotions in four different types of websites: entertainment, education, e-commerce and e-bank. The research questions that lead our work are as follows:

- RQ1: How are the correlations between perceived usability and emotional valence/arousal in different contexts of use?
- RQ2: Are there different correlations between perceived usability and emotional valence/arousal regarding different genders?
- RQ3: Are there different correlations between perceived usability and emotional valence/arousal regarding users computer usage time?

4 Method

4.1 Participants and Procedures

One hundred sixty participants, being ninety-two males and sixty-eight females, were recruited from the University campus and external community (students and their relatives). We considered four different contexts: education, entertainment, e-commerce, and e-bank.

In the education category, 39 users (16 women and 23 men) participated in the study. Ages ranged from 18 to 58 years (M = 26, SD = 9). Nineteen users use the computer for more than 10 hours per week, while 20 users use the computer for less than 10 hours per week. Regarding the level of education of the participants, 3% have incomplete high school, 31% have completed high school, 15% have incomplete higher education and 51% complete higher education.

In the entertainment category, 41 users (16 women and 25 men) participated in the study. Ages ranged from 18 to 58 years (M = 26, SD = 9). Users use the computer for more than 10 hours per week, while 20 users use the computer for less than 10 hours per week. Considering the level of education of the participants, 13% have completed high school, 7% have incomplete higher education and 80% complete higher education.

In the e-commerce category, 40 users (17 women and 23 men) participated in the study. Ages ranged from 18 to 58 years (M = 26, SD = 9). Twenty users use the computer for more than 10 hours per week, while 20 users use the computer for less than 10 hours per week. Regarding the level of education of the participants, 18% have incomplete high school, 10% have completed high school, 47% have incomplete higher education and 25% complete higher education.

Table 1 The demographics for each category

Category	Total of Users	Female Users	Male Users	Age		Computer Usage	
				M	SD	<10	>10
Education	39	16	23	26	9	20	19
Entertainment	41	16	25	26	9	20	21
E-commerce	40	17	23	26	9	20	20
E-bank	40	19	21	26	9	22	18

In the e-bank category, 40 users (19 women and 21 men) participated in the study. Ages ranged from 16 to 51 years (M = 26, SD = 9). Eighteen users use the computer for more than 10 hours per week, while 22 users use the computer for less than 10 hours per week. In relation to the level of education of the participants, 5% have incomplete high school, 29% have completed high school, 42% have incomplete higher education and 24% complete higher education. The Table 1 presents the demographics for each category.

Two websites were chosen for each category. In the e-commerce category the websites chosen were www.netshoes.com and store.steampowered.com. For the education category the websites chosen were pt.duolingo.com and www.w3schools.com. In the entertainment category the websites chosen were www.twitch.tv and nightwalk.withgoogle.com. With respect to the E-bank category the websites chosen were www.nubank.com and www.due.com.

The user test performed was remote. The remote UX testing lasted two weeks. The recruited users were asked to interact with two websites from a specific category (education, entertainment, e-bank, or e-commerce) to perform two tasks according to Table 2. None of the participants had previous experience with the websites. Participants were asked to complete a consent form. Finally, users were asked to complete a UX questionnaire for each website.

4.2 Metrics and Instruments

The UX test involved 34 statements based on likert scale. We used a 5-point scale Likert items to measure users attitudes to a particular statement. The data was coded as follows: 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly agree. 14 statements concern to perceived usability and 20 statements correspond to the positive and negative affect schedule (PANAS) [33]. We performed statistical tests to answer the research questions.

Table 2 Tasks performed in each website

Website	Task
pt.duolingo.com	(1) Log in and choose a language
	(2) Perform a lesson
www.w3schools.com	(1) Choose a tutorial and start learning
	(2) Read the first class and run an example
www.twitch.tv	(1) Access a live channel
	(2) Watch a clip
nightwalk.withgoogle.com	(1) Access and interact with nightwalk in Marseille
	(2) Access and interact with Boilabaisse
www.netshoes.com	(1) Access the category hiking shoes
	(2) View offers
store.steampowered.com	(1) Start the store section
	(2) Access the learn more section
www.nubank.com	(1) Access customer feedback
	(2) Read a story
www.due.com	(1) Access basic information
	(2) Read the news on the Blog

The independent variable used in the experiment was the usability factor, measured through the following 14 statements:

1. Overall, the website is easy to use.
2. The demand for effort is low.
3. The information is well organized.
4. The amount of information is sufficient.
5. The screen layout is good.
6. The link naming is adequate.
7. The information assimilation is good.
8. It is easy to remember where things are.
9. The websites were designed for first time visitors.
10. The navigation errors are easy to correct.
11. You find the information you want.
12. At some point while browsing the website lost its identity, that is, you had the feeling of being on another website.
13. It was difficult to identify any elements of the website.

14. You identify yourself with the language of the website.

The dependent variable used in the experiment was the emotional aspect, which is based on the positive and negative valence dimensions.

For positive valence we have the following 10 statements:

1. I feel interested.
2. I feel alert.
3. I feel inspired.
4. I feel strong.
5. I feel determined.
6. I feel attentive.
7. I feel enthusiastic.
8. I feel excited.
9. I feel proud.
10. I feel active.

For negative valence we have the following 10 statements:

1. I feel irritable.
2. I feel distressed.
3. I feel nervous.
4. I feel ashamed.
5. I feel upset.
6. I feel afraid.
7. I feel guilty.
8. I feel scared.
9. I feel hostile.
10. I feel jittery.

To analyze possible relationships between usability variables and emotional aspects, first we used a factor analysis. Factor analysis is a set of statistical methods that, in certain situations, allows "explaining" the behavior of a relatively large number of statements, in terms of a relatively small number of factors. Factors may or may not be correlated. The statements are grouped by their correlations, that is, those belonging to the same group will be strongly correlated with each other, but little correlated with the variables of another group. Each group of variables will represent a factor. Factor analysis is a technique of interdependence in which all variables are simultaneously considered, each related to all the others, also employing the concept of the statistical variable, the linear composition of variables. In factor analysis, statistical variables (factors) are formed to maximize their

explanatory power over the entire set of variables, rather than to predict a dependent variable (s). For more details on factor analysis see Fabrigar and Wegener [34].

The first step in the analysis is to verify the distribution of the data set. For this, the Shapiro-Wilk multivariate normality test was used to verify the multi normality of the data. Then, the "Kaiser-Meyer-Olkin adequacy measure" (KMO) and "sample adequacy measure" (MAA) were calculated to analyze the correlation structure of the data. These analyses are important to verify if the data are appropriate to the application of Factor Analysis. High values of the KMO adequacy measure (between .5 and 1.0) indicate that factor analysis is appropriate. The sample adequacy measure, MAA, checks if there is a factorial structure in the data. However, the MAA should be calculated separately for each variable, since the objective is to verify if one given variable can be explained by the others. Low values indicate that the variable analyzed can be removed from the analysis without further damage. Another important factor to consider is commonality, which is the portion of variance that a variable shares with all other variables considered. It is also the proportion of variance explained by the common factors. The variables with the highest commonality indicate that they are the most important variables in this study, as they have the largest share of the variance shared with all other variables considered. In the construction of the model we use the eigenvalue analysis (which represents the total variance explained by each factor) to identify the number of factors to be extracted.

The applied correlation analysis is Spearman's correlation (Spearman's ρ), a non parametric statistical measure that interprets data by returning a dimensionless value ranging from -1 to $+1$. The coefficient values found indicate that the closer to these extremes, the greater the linear relationship between the variables, while the values equal to zero mean the absence of correlation between them. The Table 3 presents the interpretation of the Spearmans Correlation Coefficient [35]. Meaning (p-value) with value below .05 indicates a significant correlation.

In the four categories considered (entertainment, e-bank, education, e-commerce) when we perform the Shapiro-Wilk test we get p-value very close to zero indicating that we reject the null hypothesis of data normality. Confirming the use of the principal component method in the application of factor analysis.

For the data regarding the emotional aspects based on the positive valence dimension, we have that all MAA values are greater than .5 (in the four categories considered), so consider all 9 statements related to this topic.

Table 3 Rule of Thumb for Interpreting the Size of a Spearmans Correlation Coefficient

Size of Correlation	Interpretation
.90 to 1.00 (.90 to 1.00)	Very high positive (negative) correlation
.70 to .90 (.70 to .90)	High positive (negative) correlation
.50 to .70 (.50 to .70)	Moderate positive (negative) correlation
.30 to .50 (.30 to .50)	Low positive (negative) correlation
.00 to .30 (.00 to .30)	Negligible correlation

Regarding the data about the emotional aspects based on the negative valence dimension, we took the observations on the 3rd and 6th statements (entertainment category), 3rd and 10th statements (e-bank category), 2nd and 6th statements (education category), 2nd and 10th statements (e-commerce category). For the usability data we took the observations regarding the 6th, 9th, 11th, 12th and 13th statements (entertainment category), 2nd, 6th, 10th and 13th statements (e-bank category), 4th, 10th, 11th, 12th and 14th statements (education category), 2nd, 5th, 11th, 12th and 14th statements (e-commerce category). Comments on these statements were withdrawn as the MAA and commonality measures were less than .5.

Kaiser-Meyer-Olkin (KMO) adequacy measures for the variables emotional aspects with positive, negative valence and usability were .72, .68 and .75 (entertainment category); .85, .79 and .87, (e-bank category); .85, .74 and .88 (education category), and .73, .77 and .88 (e-commerce category). These values indicate that factor analysis is appropriate. When we analyzed the eigenvalues we observed that for the emotional aspects of positive (and negative) valence and for usability only the first three factors presented eigenvalues higher than one (categories entertainment, e-bank and e-commerce). For education category we have that only two factors presented eigenvalues greater than one.

For positive and negative valence, and usability , the factors together explained 71%, 66% and 74% of the total variance, respectively (entertainment category); 83%, 74% and 83% (e-bank category), 71%, 65% and 72% (education category), and 70%, 73% and 79% (e-commerce category). The factors presented excellent reliability, with Cronbach's alpha equal to .84 (positive valence), .77 (negative valence) and .82 (usability) in the case of the entertainment category; .95 (positive valence), .83 (negative valence) and .90 (usability) for e-bank category; .91 (positive valence), .85 (negative valence) and .90 (usability) for education category and .84 (positive valence), .80 (negative valence), and .87 (usability) for e-commerce category.

In addition to the factor analysis made to simplify the collected data we use the Spearman correlation (ρ). The use of this non-parametric method is due to the fact that the Shapiro-Wilk test rejects the hypothesis of data normality.

In Tables 4 to 7 we present the factor loads of the exploratory factor analysis after Varimax rotation [36]. The factor load indicates, in percentage, how much covariance exists between the factor and each statement [37]. The value of the factor load varies between 1.00 and $+1.00$, with a value of 0 indicating the total absence of covariance between the variable and the factor. We observed in these tables that no statement has a complex structure, that is, all factor loads above .32 [38] in all factors. In bold we have the factor loads with the highest value for the statements and their respective factors. For example, considering the numbering of the statements in Table 4, for the Entertainment category (positive valence), factor 1 is composed of statements 1, 2, 3 and 4; factor 2 is composed of statements 5 and 6 and factor 3 is composed of statements 7, 8 and 9. For negative valence we have that statements 7, 9, and 10 devise factor 1; statements 1, 2 and 8 make up factor 2 and statements 4 and 5 form factor 3.

5 Results

5.1 Answering RQ1

- RQ1: How are the correlations between perceived usability and emotional valence/arousal in different contexts of use?

The Table 8 summarizes the Spearman's Correlation for different contexts. In the last column of this table, we present the p-values of the tests performed to verify if there is a significant difference between the correlations. For this, we use Fisher's Z test to Spearman's correlation coefficients, for details see [39,40].

In the entertainment category, the Spearman correlation (ρ) for positive valence and usability is $\rho = .58$ (p-value $<.001$) and the Spearman correlation (ρ) for negative valence and usability is $\rho = .74$ (p-value $<.001$), indicating that the correlation between positive valence and usability variables is positive and between negative valence and usability variables is negative. These results indicate that as the usability score increases we have an increase in the positive emotions score and a decrease in negative emotions. According to Mukaka's interpretation [35], for the correlation coefficient, we have a high negative correlation between the usability and negative valence variables. In

Table 4 Factor loadings for EFA in entertainment context

Entertainment			
	Positive Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel interested	.512	.150	.120
2. I feel alert	.478		.101
3. I feel inspired	.367	.230	
4. I feel strong	.543	.205	
5. I feel determined	.174	.730	
6. I feel attentive	.157	.531	
7. I feel enthusiastic		.211	.417
8. I feel excited		.146	.599
9. I feel proud	.111		.662
	Negative Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel irritable		.485	.256
2. I feel distressed	.133	.593	
4. I feel ashamed			.670
5. I feel upset		.178	.552
6. I feel afraid	.533		
7. I feel guilty	.517	.178	
8. I feel scared	.247	.461	.279
9. I feel hostile	.399	.319	
1. I feel jittery	.441	.156	.301
	Usability		
Statements	Factor 1	Factor 2	Factor 3
1. Overall, the website is easy to use		.502	.176
2. The demand for effort is low	.215	.656	
3. The information is well organized	.526		
4. The amount of information is sufficient			.638
5. The screen layout is good	.113	.128	.546
7. The information assimilation is good	.586		.147
8. It is easy to remember where things are	.513		
1. The navigation errors are easy to correct		.234	.428
14. You identify yourself with the language of the website	.205	.495	.209

Table 5 Factor loadings for EFA in E-commerce context

e-Commerce			
	Positive Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel interested		.557	.155
2. I feel alert	.138	.498	.133
3. I feel inspired		.197	.429
4. I feel strong	.253	.203	.585
5. I feel determined		.583	
6. I feel attentive	.128		.642
7. I feel enthusiastic	.591		
8. I feel excited	.515		
9. I feel proud	.527	.131	.125
	Negative Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel irritable		.636	
2. I feel distressed	.282	.108	.672
4. I feel ashamed	.103		.510
5. I feel upset		.648	
6. I feel afraid	.535		
7. I feel guilty		.648	
8. I feel scared	.440	.163	.182
9. I feel hostile	.249	.131	.460
1. I feel jittery	.394	.340	.166
	Usability		
Statements	Factor 1	Factor 2	Factor 3
1. Overall, the website is easy to use	.445		
2. The demand for effort is low	.374	.135	
3. The information is well organized	.324	.215	
4. The amount of information is sufficient	.484	.326	.175
5. The screen layout is good	.545	.161	
7. The information assimilation is good		.254	.381
8. It is easy to remember where things are		.569	
1. The navigation errors easy are correct		.628	
14. You identify yourself with the language of the website	.105	.109	.903

Table 6 Factor loadings for EFA in E-bank context

e-Bank			
	Positive Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel interested	.157	.376	.136
2. I feel alert	.229	.324	.372
3. I feel inspired	.402	.132	.127
4. I feel strong	.188	.642	.157
5. I feel determined		.554	
6. I feel attentive	.145	.110	.877
7. I feel enthusiastic	.452		
8. I feel excited	.506		.155
9. I feel proud	.492		
	Negative Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel irritable		.658	.123
2. I feel distressed	.429	.345	
4. I feel ashamed	0,597	.233	.101
5. I feel upset	.480	0,153	
6. I feel afraid	.213	.149	.457
7. I feel guilty	.170	.156	.575
8. I feel scared	.391		.283
9. I feel hostile			.575
1. I feel jittery		.564	.138
	Usability		
Statements	Factor 1	Factor 2	Factor 3
1. Overall, the website is easy to use			.916
2. The demand for effort is low	.408	.133	.146
3. The information is well organized	.517	.254	.165
4. The amount of information is sufficient	.356		.126
5. The screen layout is good	.394	.129	
7. The information assimilation is good	.344	.100	
8. It is easy to remember where things are	.383	.233	.276
1. The navigation errors are easy to correct	.135	.501	
14. You identify yourself with the language of the website		.762	

Table 7 Factor loadings for EFA in education context

Education			
	Positive Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel interested		.557	.155
2. I feel alert	.138	.498	.133
3. I feel inspired		.197	.429
4. I feel strong	.253	.203	.585
5. I feel determined		.583	
6. I feel attentive	.128		.642
7. I feel enthusiastic	.591		
8. I feel excited	.515		
9. I feel proud	.527	.131	.125
	Negative Valence		
Statements	Factor 1	Factor 2	Factor 3
1. I feel irritable		.636	
2. I feel distressed	.282	.108	.672
4. I feel ashamed	.103		.510
5. I feel upset	.461		
6. I feel afraid	.535		
7. I feel guilty		.648	
8. I feel scared	.440	.163	.182
9. I feel hostile	.249	.131	.460
1. I feel jittery	.394	.340	.166
	Usability		
Statements	Factor 1	Factor 2	Factor 3
1. Overall, the website is easy to use	.445		
2. The demand for effort is low	.374	.135	
3. The information is well organized	.324	.215	
4. The amount of information is sufficient	.484	.326	.175
5. The screen layout is good	.545	.161	
7. The information assimilation is good		.254	.381
8. It is easy to remember where things are		.569	
1. The navigation errors are easy to correct		.628	
14. You identify yourself with the language of the website	.105	.109	.903

Table 8 Spearmans correlations between perceived usability and emotional valence in different contexts of use

	Spearmans Correlation				
	Positive Valence and Usability		Negative Valence and Usability		Test for Differences Between Correlations
Context	ρ	p-value	ρ	p-value	p-value
Entertainment	.58	$<$.001	.74	$<$.001	$<$.001
education	.52	.015	.61	.004	$<$.001
E-commerce	.44	.012	.36	.090	$<$.001
E-bank	.55	.002	.33	.40	$<$.001

addition, we have a moderate positive correlation between the usability and positive valence variables.

Regarding the e-bank category we have $\rho = .55$ (positive valence) and $\rho = .33$ (negative valence). Spearman's correlation test indicates that the correlation between positive valence and usability is positive (p-value $= .002$) and the correlation between negative valence and usability is negative (p-value $= .040$) at the 5% significance level. These outcomes show that as the usability score increases we have an increase in the positive emotions score and a decrease in negative emotions.

For the education category we have $\rho = .52$ (positive valence) and $\rho = .61$ (negative valence). Spearman's correlation test results in a moderate negative correlation between the usability and negative valence variables. Also, we have a moderate positive correlation between the usability and positive valence variables.

In the e-commerce category, considering the significance level of 10%, we have a positive correlation between usability and positive valence and a negative correlation between usability and positive valence.

5.2 Answering RQ2

- RQ2: Are there different correlations between perceived usability and emotional valence/arousal regarding different genders?

The Table 9 summarizes the Spearmans Correlation for different contexts and different sexes.

Concerning female users and entertainment category, the Spearman's correlation (ρ) for positive valence and usability is $\rho = .67$ and p-value $= .004$ and the Spearman's correlation (ρ) for negative valence and usability is $\rho = .81$ and p-value $<.001$, indicating that the correlation between positive

Table 9 Spearmans correlations between perceived usability and emotional valence in different contexts of use and different sexes

		Spearmans Correlation				
		Positive Valence and Usability		Negative Valence and Usability		Test for differences between correlations
Context	Sex	ρ	p-value	ρ	p-value	p-value
Entertainment	female	.67	.004	.81	$<$.001	$<$.001
	male	.45	.004	.63	.003	$<$.001
Education	female	.59	.009	.65	.009	$<$.001
	male	.37	.008	.49	.011	$<$.001
E-commerce	female	.62	.009	.52	.009	$<$.001
	male	.31	.008	.30	.042	.053
E-bank	female	.63	.035	.50	.028	$<$.001
	male	.48	.004	.30	.042	.015

valence and usability variables is positive and between negative valence and usability variables is negative. These results indicate that as the usability score increases we have an increase in the positive emotions score and a decrease in negative emotions. According to Mukaka's interpretation, for the correlation coefficient, we have a high negative correlation between the usability and negative valence variables. In addition, we have a moderate positive correlation between the usability and positive valence variables.

In the entertainment category, for male users, the Spearman's correlation (ρ) implies that as the usability score increases we have an increase in the positive emotions score and a decrease in negative emotions.

With regard to the education category and female users, we have a moderate positive correlation between the usability and positive variables. In addition, we have a moderate negative correlation between the usability and negative valence variables.

For male users and education category, the results unveiled no correlations between positive valence and usability variables and between negative valence and usability variables.

In the e-commerce category, for female users, the Spearman's correlation (ρ) for positive valence and usability is $\rho = .62$ and p-value $= .009$ and the Spearman's correlation (ρ) for negative valence and usability is $\rho = .52$ and p-value $= .009$, indicating that both correlations between positive valence

and usability variables and between negative valence and usability variables are positive.

With respect to e-commerce category, for male users, we have a low negative correlation between the usability and negative valence variables. Furthermore, we have a low positive correlation between the usability and positive valence variables.

In the e-bank category, for female users, the Spearman's correlation (ρ) for positive valence and usability is $\rho = .63$ and p-value $= .035$ and the Spearman's correlation (ρ) for negative valence and usability is $\rho = .50$ and p-value $= .028$, indicating that there is no correlation between positive valence and usability variables and between negative valence and usability variables. According to Mukaka's interpretation, for the correlation coefficient, we have a moderate negative correlation between the usability and negative valence variables. Also, we have a moderate positive correlation between the usability and positive valence variables.

For male users and e-bank category, the Spearman's correlation (ρ) for positive valence and usability is $\rho = .48$ and p-value $= .004$ and the Spearman's correlation (ρ) for negative valence and usability is $\rho = .30$ p-value $= .042$, indicating that the correlation between positive valence and usability variables is negative and between negative valence and usability variables is positive.

5.3 Answering RQ3

- RQ3: Are there different correlations between perceived usability and emotional valence/arousal regarding users computer usage time?

The Table 10 summarizes the Spearmans Correlation for different contexts and different computer usage time (hours per week).

In the entertainment category, for users that use the computer more than 10 hours per week, the usability score increases we have an increase in the positive emotions score and a decrease in negative emotions. So, we have a high negative correlation between the usability and negative valence variables. Besides, we have a moderate positive correlation between the usability and positive valence variables.

With reference to education category, for users that use the computer more than 10 hours per week, the correlation between positive valence and usability variables is positive and between negative valence and usability variables is also positive. For users that use the computer less than 10 hours per week,

Table 10 Spearmans correlations between perceived usability and emotional valence in different contexts of use and different computer usage time (hours per week)

		Spearmans Correlation				
		Positive Valence and Usability		Negative Valence and Usability		Test for Differences Between Correlations
Context	Computer Usage Time	ρ	p-value	ρ	p-value	p-value
Entertainment	> 10	.42	.010	.67	$<$.001	.134
	< 10	.61	.004	.79	.003	$<$.001
Education	> 10	.34	.009	.44	.009	.019
	< 10	.60	.008	.59	.011	$<$.001
E-commerce	> 10	.43	.006	.30	.041	.029
	< 10	.54	.036	.60	.042	$<$.001
E-bank	> 10	.33	.035	.30	.017	.083
	< 10	.58	.049	.56	.027	$<$.001

we have a moderate negative correlation between the usability and negative valence variables. Moreover, we have a moderate positive correlation between the usability and positive valence variables.

Concerning the e-commerce category, for users that use the computer more than 10 hours per week, the Spearman's correlation (ρ) for positive valence and usability is $\rho = .43$ and p-value $= .006$ and the Spearman's correlation (ρ) for negative valence and usability is $\rho = .30$ and p-value $= .041$, indicating that both correlations between positive valence and usability variables and between negative valence and usability variables are positive. These results indicate that as the usability score increases we have an increase in the positive emotions score and also an increase in negative emotions. According to Mukaka's interpretation, for the correlation coefficient, we have a low positive correlation between the usability and positive valence variables. In addition, we have a low negative correlation between the usability and negative valence variables. For users that use the computer less than 10 hours per week, the Spearman's correlation (ρ) for positive valence and usability is $\rho = .54$ and p-value $= .036$ and the Spearman's correlation (ρ) for negative valence and usability is $\rho = .60$ p-value $= .042$, indicating that there is no correlation between positive valence and usability variables and there is negative correlation a between negative valence and usability variables. These results indicate that as the usability score increases we have a decrease in negative emotions. According to Mukaka's interpretation, for the correlation

coefficient, we have a moderate negative correlation between the usability and negative valence variables. Furthermore, we have a moderate positive correlation between the usability and positive valence variables.

Regarding e-bank category, for users that use the computer more than 10 hours per week, According to Mukaka's interpretation, for the correlation coefficient, we have a low negative correlation between the usability and negative valence variables. Also, we have a low positive correlation between the usability and positive valence variables. For users that use the computer less than 10 hours per week, we have a moderate positive correlation between the usability and positive valence variables. Besides, we have a moderate negative correlation between the usability and positive valence variables.

Concluding, we used Fisher's Z test to check if there is a significant difference between the correlations of positive and negative valences. At the 5% level, only in two cases the differences between the correlations were not significant, namely: (i) in the entertainment category, for users who use the computer more than 10 hours a week, we have p-value $= .134$. In this case, it is not recommended to apply the Z-Fisher test to Spearman's correlation coefficients, as the sample size is less than 10 ($n = 6$), see Zar [40]. (ii) in the e-bank category, also for users who use the computer more than 10 hours a week, we have p-value $= .083$. We note, in this case, that at the 5% level the difference between the correlations is not significant, but at the 10% level this conclusion.

We also applied Fisher's Z test to Spearman's correlation coefficients to verify if there is a signicant difference between the correlations for each group (sex and computer usage time) in each valence (positive and negative). In all cases, we find that the correlations are not statistically different (p-values $>$ .05). For details of the Fisher's Z test see [39, 40].

6 Discussion

In summary, by Mukaka's [35] interpretation of the correlation coefficient we have a moderately positive correlation between the usability and positive valence variables in the entertainment, e-bank and education categories and a low positive correlation between the usability and positive valence variables in the e-commerce category. Additionally, we have a high negative correlation between usability variables and negative valence in the entertainment category. In addition, we have a low negative correlation between usability and negative valence variables in the e-commerce and e-bank categories. Finally,

we have a moderate negative correlation between usability and negative valence variables in the education category.

From the responses of participants, the relationships between perceived usability and emotional valence were found to differ according to different contexts of use. Significant differences in the relationships between perceived usability and emotional responses were found among different contexts of use of websites. These results indicate that as the usability score increases we have an increase in the positive emotions score and a decrease in negative emotions for all contexts investigated: entertainment, educational, e-commerce and e-bank. Only the intensity of the correlations vary among different contexts.

Summarizing the results for female users, according to Mukaka's interpretation, for the correlation coefficient, we have a high negative correlation between the usability and negative valence variables for entertainment category. Moreover, we have a moderate negative correlation between the usability and negative valence variables for education, e-commerce, and e-bank categories. In addition, we have a moderate positive correlation between the usability and positive valence variables for all categories.

Summarizing the results for male users, according to Mukaka's interpretation, for the correlation coefficient, we have a moderate negative correlation between the usability and negative valence variables for the entertainment category. Besides, we have a low positive correlation between the usability and positive valence variables for the entertainment category. Furthermore, we have a low positive correlation between the usability and positive valence variables and a low negative correlation between the usability and negative valence variables for education, e-bank, and e-commerce categories.

Comparing the results between female and male users, despite female participants showed stronger positive correlations between perceived usability and positive emotions and stronger negative correlations between perceived usability and negative emotions against the male counterparts, no significant difference between correlations was found.

Summarizing the results for for users that use the computer less than 10 hours per week, according to Mukaka's interpretation, for the correlation coefficient, we have a high negative correlation between the usability and negative valence variables for entertainment category. Moreover, we have a moderate negative correlation between the usability and negative valence variables for education, e-commerce, and e-bank categories. In addition, we have a moderate positive correlation between the usability and positive valence variables for all categories.

Summarizing the results for for users that use the computer more than 10 hours per week, according to Mukaka's interpretation, for the correlation coefficient, we have a moderate negative correlation between the usability and negative valence variables for the entertainment category. Besides, we have a low positive correlation between the usability and positive valence variables for the entertainment category. Furthermore, we have a low positive correlation between the usability and positive valence variables and a low negative correlation between the usability and negative valence variables for education, e-bank, and e-commerce categories.

The results showed that the strength of the correlations between perceived usability and emotional responses do not differed according to participants habits, and presented the same response pattern regardless of various design properties of websites for different contexts.

Besides the differences of the degree of the correlation between perceived usability and emotional responses in different contexts of use, our study highlights the importance and effect of usability in UX, being consistent with the earlier ones [10] in showing the same patterns of correlation between perceived usability and emotional valence, even when dividing the users on sex and usage time classes. Perceived usability and positive emotional responses were positively correlated and perceived usability and negative emotional responses were negatively correlated in all cases considered in our research.

With respect to different cntexts of use, the findings are consistent with the experimental results presented in [23]. In addition, an association between user perception of usability and emotional responses were always present despite the context of use, being in agreement to previous studies [7], [8]. Concerning the gender data and computer usage time, previous studies that show that the user experience is dependent on personal, social and cultural characteristics [17], attesting the investigation of user-related contextual factors as essential for a better understanding of UX [7].

7 Conclusion

Previous studies in HCI unveiled the need for deeper investigations of the relationships between user perceived usability and their emotional responses. It is worthwhile to provide some insights on user perceptions of usability and emotional responses concerning different contexts of use, gender and users habits should be investigated, in order to provide a better understanding to designers.

To address these issues, 160 (one hundred and sixty) users, were recruited from the University campus and external community (students and their relatives) to participate in a study involving gender differences and users habits peculiarities in four different contexts: education, entertainment, e-commerce, and e-bank.

The results provided evidence that a good usability was positively correlated to positive emotions, for both sex and usage time. Moreover, there was no significant difference on correlations between usability and emotional reactions, when comparing less and more frequent users and different genders. However, we found differences of the degree of the correlations between perceived usability and emotional responses in different contexts of use, when dividing the users on gender and usage time classes, but the correlations between usability and positive emotions persisted positive.

This research adds to the body of knowledge of HCI, confirming the patterns of correlation between perceived usability and emotional responses consistently with previous research and encompassing information concerning gender and users time usage. Our study reinforces the importance of usability as a contributing factor to UX and highlights two populations where usability plays a greater role regardless the context of use investigated.

Given the particularity of the user contexts in UX, substantiated in this research, and the dinamism and profusion of web trends, it is worthwhile for future works to investigate differences and similarities among distinct classes of users in an specific context of design, including a study of generations X,Y, and Z UX aspects in brutalist websites.

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