

# The Emotion Component on Usability Testing Human Computer Interface of an Inclusive Learning Management System

Vânia R. Ulbricht, Carlos Henrique Berg, Luciane Fadel, and Silvia R.P. Quevedo

Campus Universitário Reitor João David Ferreira Lima  
Florianópolis, Santa Catarina, Brasil, 88040-900

{vrulbricht, liefadel}@gmail.com, henrique.berg@terra.com.br,  
silviareginaquevedo@hotmail.com

**Abstract.** Learning Management Systems –LMS supported by the Information and Communication Technologies to distribute knowledge at any time and to any place, to most different kind of people with different backgrounds. Human Computer Interface – HCI, use known metaphors that makes the mediation between human and machine. Because humans define the metaphors, final users can find some barriers to the comprehension of them. To evaluate LMS's HCI, there are few paradigms available, but the only one who uses final users is the Usability Test – UT. These tests focus on evaluate the efficiency and efficacy of an interface, but seldom evaluate the user's emotions. In order to do that, new researches point out the importance of having the emotions evaluated. This paper aims to describe methods and techniques used to evaluate HCI using Usability Tests UT with emotions and validate one of them in the WebGD LMS at <http://egc.ufsc.br/webgd/login/index.php>.

**Keywords:** Learning Management System, Human Computer Interface, Usability Tests with Emotion.

## 1 Introduction

### 1.1 Research Problem

Communities of people with some kind of impairment use the World Wide Web – WWW for information, knowledge, education, leisure and so on, and these impairments must be considered during the designing of an LMS. To allow these communities to use the WWW, and its benefits the Human Computer Interface - HCI must be accessible, and identifying barriers to the accessibility is an important issue. For that purpose the HCI Evaluations can be used.

Some authors argue that are four mainly evaluation paradigms. Nielsen and other researches (1990, 1993, 1995, 2007) [7, 8, 9, 4], establish these four paradigms as Computing Procedures, Heuristic Evaluations, Inspections with Experts and Usability Tests. The Usability Tests – UT are the only one that can be applied with users and

can be a powerful tool to find more about the possible problems of the interface and lead? to new findings.

Traditional UT are based on techniques of measurement with timing and errors logs to establish the performance of an user. In addition, concomitantly, researchers apply satisfaction queries and take notes during the evaluation. The results from a traditional UT are statistics evaluation from the measure of timing and errors which can be analyzed by a subjective human focus. Furthermore, analyze the query and researcher notes are made with the same subjective focus.

In a Systematic Review of Literature (BERG, 2013) [3], Agarwal and Meyer [1] show that the emotions have important issues in the central questions for HCI. For example, these authors claim that the human being is more efficient and creative in solve a problem when they are happy. Sauer e Sonderegger (2008) [12] add to the discourse the concepts of joy, pleasure, fun and the satisfaction of the finished task, which also must be included in the HCI issues. Tzvetanova, Tang, e Justice (2007) [16] declare that positive emotions affect the memory, motivation and the feeling with the commitment.

These findings lead the researchers to theorize that using emotions to evaluate HCIs can improve its accessibility. Then, in another Systematic Review of Literature (BERG, DATA) [3], seeking for UTs that use emotions found some methods and technics in which can evaluate HCI, as the section 1.2 Methodology explains.

## 1.2 Methodology

This paper uses a Mixed Method approach (quantitative and qualitative research methods) as recommended by Creswell (2003). This approach considers using a combination of the two techniques to support reliance to the research, as the result of one might validates the second group of results and vice versa. In order to do so, the research will use systematic reviews as recommended by Cochrane Collaboration, (COCHRANE COLLABORATION, 2013) [14]. The systematic review allows identifying the most relevant articles about some theme using indexed articles data banks. The articles data banks used were Scopus and Web of Knowledge.

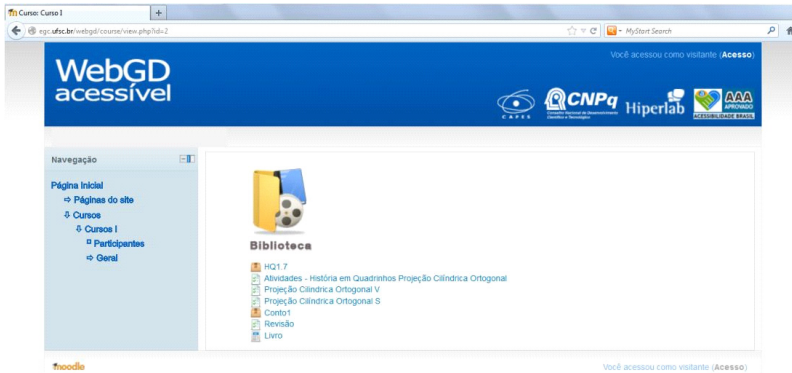
The results of the review lead to the second step which is to choose one UT This was done by evaluating and comparing each UT to the other. The selection focused on the cheaper and faster method. This was necessary because of a low budget and just few researchers were available.

The research was planned using the DECIDE framework (PREECE, ROGERS and SHARP, 2002) [11] which is a helpful tool to plan Social Science researche. After the planning, the UT will be applied in the WebGD LMS with deaf and hearing subjects to validate the UT and evaluate the LMS

The results of the validation of the UT and the HCI evaluation will be present using descriptive narratives and with the support of a data miner, to cluster using a K-Means algorithm and with graphic representations by density. The final regards will trace two conclusions: if the UT works, if the HCI of the LMS WebGD is accessible.

### 1.3 WebGD Learning Management System Accessible

There are needs to allow the access of the blind and deaf people in the internet. Then, researchers from the Federal University of Santa Catarina – Brazil, are developing a Learning Management System accessible to blind, deaf and hearing people. Named WebGD the LMS has contents of Descriptive Geometry and is supported by Moodle (moodle.org, 2013) [6]. The LMS was created using the Universal Design, and by using rules and recommendations following the W3C (w3c.org, 2014) [18]. Fig. 1 shows the WebGD home page.



**Fig. 1.** Print Screen from the WebGD main entrance [egc.ufsc.br/webgd](http://egc.ufsc.br/webgd), 2013

The environment WebGD was positive evaluated by different evaluation paradigms, by expert inspections, computing procedures and traditional usability test. The results of the evaluations could identify some barriers, and the researches could fix them. The next step is to improve accessibility.

## 2 Systematic Review

Considered with great scientific importance, a systematic review is one of the methods used in most publications of a scientific nature in different areas (SCIVERSE SCOPUS, 2012) [13]. Then, to make the systematic review in Scopus and Web of Knowledge (THOMSON REUTERS, 2013) [15] the review use five words combinations: usability, “emotional design”, “human computer interface”, “interface usability” and “emotional design”.

The constrictions that were made were two: articles with CAPES imprint and by relevancy. In Brazil, there is the CAPES (Coordination for the Improvement of Stricto Sensus High Grade Personal) which has an agreement with international publications to give free access to the Brazilian researchers. By this way, a research done with this endorsement can be traceable and is possible to confirm the research. Choosing the articles signed by CAPES, the result is 19 papers.

The second is to rank the results from the most relevant to less relevant, by the newest to the oldest and by number of citations and extract the five first one from relevancy, date and citations, resulting in eight most relevant articles. The table 1 shows the title, first author and year of publication.

**Table 1.** Titles, first author and publication year

Title	#1 author	Year
Beyond usability: Evaluating emotional response as an integral part of the user experience	Anshu Agarwal	2009
Designers of different cognitive styles editing e-learning materials studied by monitoring physiological and other data simultaneously	Károly Hercegf	2009
How is it for you? (A case for recognizing user motivation in the design process)	Shane Walker	2008
Interactive graphics for expressing health risks: Development and qualitative evaluation	Jessica S. Ancker	2009
Mobility, emotion, and universality in future collaboration	Thomas Kleinberger	2007
Participatory design with children in the development of a support system for patient centered care in pediatric oncology	Cornelia M. Ruland	2008
Virtual reality exposure therapy: 150-Degree screen to desktop PC	Jennifer Tichon	2006
Emotional Web Usability Evaluation	Sylvia Tzvetanova	2007

Font: BERG, 2013

## 2.1 The Influence of the Emotion on Usability

By reviewing the articles, it was possible to identify some concepts about the influence of the emotions on usability. From Agarwal [1], they affirm that humans have qualitative emotions experiences when they use a product or an interface. These emotions are central when users judge the totality of the experience and this can affect the perception of the usability [1]. Researches demonstrate that the motivated users have less anxiety, more perception of your self-efficacy and have more positive attitude when using software (WALKER; PRYTHERCH, 2008) [17].

Developing interfaces with more positive emotional responses is a necessity to the accessibility and achieving this requires that models must bring more friendly interface, becoming as near as humans communicate with each other (TZVETANOVA; TANG; JUSTICE, 2007) [16]. The cognitive theory proposed by Ortony, Clore e Collins (in TZVETANOVA; TANG; JUSTICE, 2007) [16] define emotions as reactions with positive and negative valences to situations as events, actors and objects. Similarly, Ancker, Chan e Kukafka (2012) [2] describe emotional responses as positive, negative or mixed valences (ANCKER; CHAN, e KUKAFKA, 2012) [2]. Tzvetanova; Tang; Justice (2007) [16], affirm that the adaptive interfaces has more positive emotions valence then others.

This research identifies also, some usability test to evaluate interfaces with emotion component. The usability test include verbal and nonverbal technics and psychological metrics (AGARWAL; MEYER, 2009) [1]. Verbal methods consist of self-report, notes from testimonies (AGARWAL; MEYER, 2009) [1] and questionnaires in which the users give personal impressions with their own words (TZVETANOVA; TANG; JUSTICE, 2007) [16]. Just Agarwal e Meyer (2009) [1] do not use questionnaires, the

rest of authors cited the questionnaires as use full tool. These techniques have a limitation: the dependence of the language, detain a transcultural use (AGARWAL; MEYER, 2009) [1].

More common nonverbal metrics include visual representation of the emotions that characterize feelings, like for example facial expressions. (AGARWAL; MEYER, 2009) [1]. Psychological metrics compare heartbeats with skin resistivity. (HERCEGFI et al., 2009) [5]. The advantage of this nonverbal approach is that the user do not need to use cognitive effort, and the responses can be more near to user though. The table 2 show the identified tests for HCI evaluation with emotions.

**Table 2.** Tests, resume, kind and authors identified

Test	Description	Type	Authors
PAD Semantic Scale	measure three important emotion aspects: pleasure, excitation and domain	Verbal	Agarwal e Meyer, 2009
Emocard	consist in the selection of <i>emoticons</i> using two different emotions dimensions	Nonverbal	Agarwal e Meyer, 2009
INTERFACE	investigate simultaneously heartbeats and skin resistivity when changing moods	Psychological	Hercegfi et al., 2009
SISOM	self-reporting on symptoms and management	Verbal	Ruland, Starren e Vatne, 2007
VRET	allow the recreation of an anxiety situation, which evocate a similar emotional response as the in live therapy	Verbal	Tichon e Banks, 2006

BERG, 2013

The next section, DECIDE Framework, the work will define which one will be used in the research.

### 3 DECIDE Framework

As proposed in the methodology, this research will use the DECIDE framework, a helpful tool to plan social researches. DECIDE was suggested by Preece, Rogers e Sharp (2002) [11], and is the acronyms of Determinate, Explore, Choose, Identify, Decide and Evaluate.

**Determinate Goals.** The goal is test the WebGD LMS with deaf and hearing people using Usability Test (UT) with emotion component to identify for accessibility barriers.

**Explore the Questions.** The Web Accessibility Initiative (WAI, 2013) defines four characteristics of a website: perceptible, operable, understandable and robust. This paper will try to identify the perceptible characteristic of the WebGD LMS. The main question to evaluate is related to the emotional valences from WebGD's interface, and the questions of this research is about design and colors. The questions are:

- *What did you feel about the colors of the environment?*
- *What did you feel about the design of the environment?*

### 3.1 Choose the Evaluation Paradigm

The PAD Semantic Differential Scale, SISOM and VRET tests use verbal approaches (BERG, 2013) [3]. Verbal approaches means that a language is used, and language is one of the form that humans can try to represent one idea. In addition, languages imply in observe some codes, rules, and it is embodied of moral and ethics. Throughout this, to use language implies in some cognitive effort, to convert ideas to language, the human must search in your mind the rules, codes, moral and ethics to express yourself.

By the other hand, the EMOCARD and the INTERFACE (Integrated Evaluation and Research e Facilities for Assessing Computer-users' Efficiency) are nonverbal methods. EMOCARD consist in the selection of one emoticon in a chart, with two important emotions aspects: „pleasantness” and „arousal”. The INTERFACE investigate psycho physiologic behavior by crossing heartbeats and skin resistivity on line to identify mental efforts. This nonverbal approach don't uses verbal constructions and by this way, it avoids the cognitive effort on translating the idea in language, bringing up a more internal response, without rules, codes, morals and ethics.

Then, in the research, it would be used the nonverbal approach, to allow to the user to express. The INTERFACE require specific and expansive equipment, and an expert to do the investigation process. As the research has low budget and a few participants, this tool could not be used. Otherwise, the EMOCARD tool offer simplicity, do not need any expensive cost, and can be done with two or three experts. Because of that, the research will use the EMOCARD to evaluate the WebGD LMS.

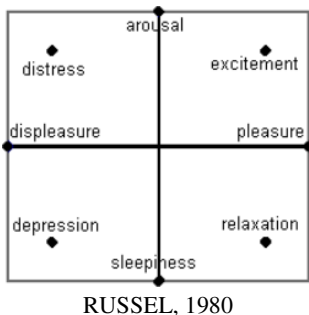


Fig. 2. Russell's Circumflex of Affect

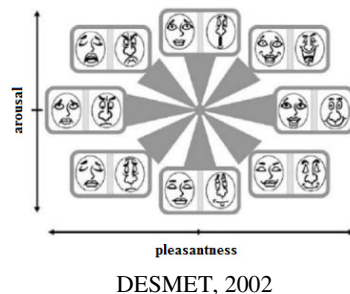


Fig. 3. EMOCARD

**Emocard.** The EMOCARD, was developed by Desmet (2003) [4] and consist in the selections of drawing faces expressing emotions between two emotional aspects: „pleasantness” and „arousal” (AGARWAL; MEYER, 2009) [1], allowing nonverbal evaluation. The EMOCARD was developed based on 1980 Russell's circumflex of affect, in Fig 2. Desmet (2003) [4] developed a nonverbal self-report method in the aim to identify emotions in products or interfaces and call them EMOCARD. This method is based in a chart, with drawings of eight human faces, each one representing one emotion. The drawings allow evaluating the valences felt during a HCI use, Fig. 3 shows the Desmet's EMOCARD. At this point, the research has defined the Usability

Test EMOCARD that uses emotion to evaluate Human Computer Interface in Learning Management System accessible WebGD. The decision after identifying methods using a systematic review, selecting nonverbal methods to avoid cognitive effort and, finally, selecting in accordance to the restrictions of research the EMOCARD DESMET, 2003 [4].

### 3.2 Identify the Practical Issues

Two practical issues will be considered here, the first one is related to the timing and the second one is define the research subjects.

**Timing.** The timing will use five weeks since the subject definition to the results. The table 3 shows the stages and the dates of the research

**Research Subjects.** To choose the research subjects, the characteristics shall be balanced as in gender, as deaf and hearing people to make reliable comparisons. The deaf people selected must know the LIBRAS (Brazilian Sign Language) because the LMS has LIBRAS contents, and this have to be evaluated.

**Table 3.** Timing chart

Action	2013				
	JAN		FEV		
	15 – 22	23 – 31	1 – 7	8 – 15	16 – 23
Identification of the research subjects	X				
Scheduling the research subjects	X				
Research		X	X		
Data tabulation			X		
Data analyses				X	
Results					X

BERG, 2013

About the skills of the research subjects, all of them, must be experienced in internet navigation, as Nielsen e Loranger (2007) [10] premises. This is the use of the internet for more than four years, more than ten hours by week and have a third of internet advanced behaviors: chat use, change favorite names, update browsers, create their own homepages and follow technologies trends.

**Table 4.** Research Subjects

Type	Gender	
	Man	Woman
Deaf	3	3
Hearing	3	3

BERG 2013

To determinate the amount of research subjects it was considered the recommendations from several authors. Preece, Rogers e Sharp (2002) [11], recommended six or seven subjects. Dumas e Redish (1999) [8], claim the ideal amount varies since five to twelve subjects. The reasons to choose this amount is the low budget (NIELSEN e LORANGER, 2007) [10], timing (PREECE, ROGERS e SHARP, 2007) [11], as well

as avoid repeating of the results (NIELSEN e LORANGER, 2007) [5]. Because of these recommendations, twelve research subjects was choose as table 4 show.

Then, it was choose twelve research subjects, six deaf and six hearing people, from the both genders and with high internet skills.

### 3.3 Deciding How to Deal with the Ethics

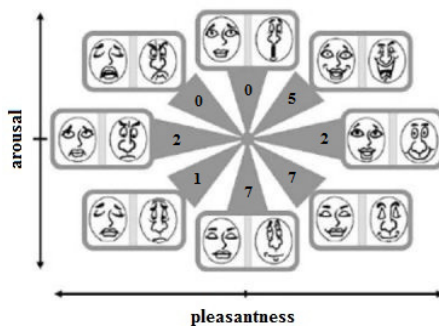
The first ethic issue is about the anonymity of the subjects. No one was identified by personal data or social questions as religion, ethnics or political affiliation, just by the profile. The second issue, researchers make the subjects know that is the environment is in evaluation and not them. The third issue is that the answers could not identify the subject.

### 3.4 Evaluating

The last DECIDE step is to apply the research. To evaluate the Human Computer Interface - HCI of the Learning Management System - WebGD LMS accessible the subjects could navigate in the environment to do be familiar with. After this familiarization it was asked to answer the two questions. The answers should be signed in the EMOCARD. At the end of the research, the EMOCARD was collected and the subjects were dismissed. The EMOCARDS with the answers are tabulated and prepared for analysis.

## 4 Results and Comments

After the evaluation, the tabulation was made and in this section the data will be analyzed. The questions “What did you feel about the colors of the environment?” and “What did you feel about the design of the environment?” was answered signing in the EMOCARD the emotion felt. All twelve-research subjects had answered the two questions. The first analyze is the general results, in which the figure 4 show.



The authors, 2014

Fig. 4. General Results of the reseach



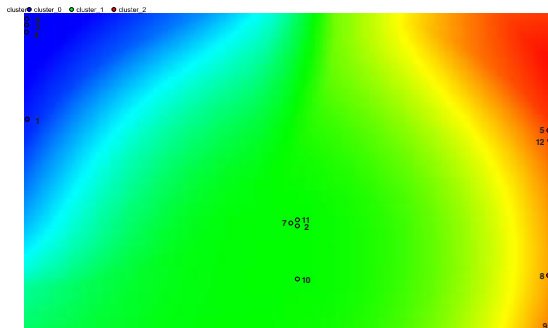
The two emotions more signed was relaxation and sleepiness, both with seven signs (29%). The excitement was five times signed (20%), pleasure and displeasure was two times signed (9%) and depression was one time signed (4%). No one of the subjects has signed arousal and distress emotions. As general result, the positive valences domain the WebGD HCI.

#### 4.1 Analyzing Questions

The analysis of each question shows different results. To do this analysis it was used The Rapid Miner to process the data and generate a specific kind of representation. The data was tabulated in the Microsoft Excel and mining to do a clusterization of them. This clusterization allows to generate a nonusual graphic representation and was elaborated using three steps, using the following tools: Read Excel, Select Attribute and Clustering with K-Means. In this paper the authors will not try to explain all functions of the Rapider Miner, just the procedures.

After the execution of the clustering process it was chosen the density graphic representation. This density graphic representation allows the visualization of the clusters and the inter-relationship among the results. This algorithm uses color density and it is quite simple: each data point contributes to all pixels depending on the distance of the pixel data point. The color is calculated as distance – average weight of all points of each pixel, showing the dependency between the three dimensions of a cluster.

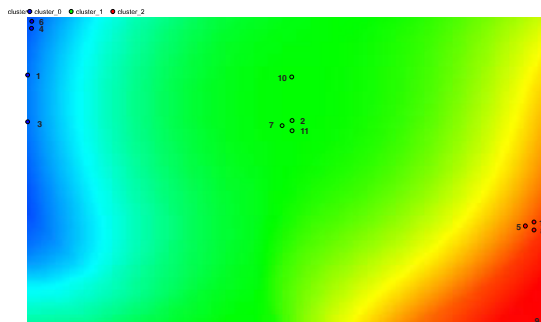
**Color Results Analyzes.** The answers of the question “What did you feel about the colors of the environment?” were analyzed and identified the most signed emotion as the sleepiness. Relaxation and excitement was three times signed, depression and displeasure was signed once. None of the research subjects has signed distress, arousal and pleasure. The dominant emotions as suggest this result are neutral to positive balanced. Processing the data in the data miner, after clustering the results, was generating the color density graphic representation as shown in fig. 5.



The authors, 2014

**Fig. 5.** Color density graphic representation from the question “What did you feel about the colors of the environment?”

This color density graphic representation can give new interpretation of the results. The process has allocated the answers valenced as positive, negative or neutral. The positive valences are the blue color, the red is neutral and the green color is negative. In this case, the predominant color is green, that represent the negative valences. As can be seen at the figure 5, the blue color (positive valences) and the red color (neutral valences) have smaller area then the green color. Therefore, the question about the colors from the WebGD, regarding this graphic representation using color density, lead to the conclusion that the Human Computer Interface of the Learning Management System has negative valences.



The authors, 2014

**Fig. 6.** Color density graphic representation from the question “What did you feel about the design of the environment?”

**Feeling Result Analyzes.** The answers for the question “What did you feel about the design of the environment” show the most signed emotion as the relaxation with four signs, de second one was sleepiness three times signed. Pleasure and excitement was signed two times and displeasure was signed once. None of the research subjects has signed distress, depress and arousal. this result suggest that the dominant emotions are positive to neutral balanced. After processing of the data, it was also generated the color density graphic representation as shown in figure 6.

In this turn, the clustering process and the color density graphic representation define different colors. The blue color is still representing the positive valences, but the green color concentrate now the neutral valences and the red area the negative valences. In this graphic representation, the predominant area is the green – neutral valences, and the smaller areas, blue and red, the negative and positive valences.

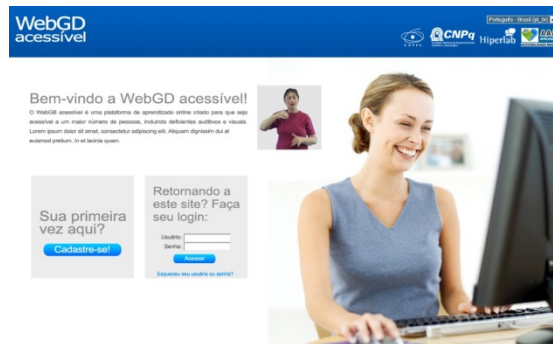
## 5 Final Regards

This paper has presented a research of Usability Test it’s use to evaluate some designs questions from the WebGD LMS, an accessible Learning Management System, created to teach descriptive geometry to people with hearing and visual impairment, and people without impairment. The research identified, through a Systematic Review

of the Literature, five Usability Tests that use emotional responses. To select one tool to do the evaluation, verbal methods was discarded because they require some cognitive effort. Then, the INTERFACE and the EMOCARD, as nonverbal methods, were examined and it was chosen the EMOCARD because it is fast to use and need few resources. The planning of the evaluation was made with the DECIDE framework following the Preece, Rogers and Sharp (2002) [11] recommendations, where was defined practical issues about the objective, questions, timing, research subjects, evaluation paradigm and ethical questions. The evaluation was performed and all of the twelve research subjects answered the two research questions about color and feelings from the WebGD's interface.

In the first moment the analysis the rough numbers from the question “What did you feel about the colors of the environment?” show some neutral – positive valences, but, the result using color density with data clusterization give a negative valence perspective. As the same way, the initial results of the “What did you feel about the design of the environment?” question leaded to a positive to neutral valences, but, again, the graphic representation with color density show that the LMS has neutral feelings. Independently the method used to analyze the results, the environment was valenced differently. The general results show that the overall HCI is positive valence, but, looking in each question separately, the results show that the environment is negative valence for colors and neutral valence for the feeling about the HCI. Then, it is possible to conclude that the Human Computer Interface from the Learning Management System accessible WebGD has some barriers to the accessibility in the colors with the negative valence and the feeling with neutral valence.

Detecting these barriers leaded the developers to create a new proposition, beyond the rules and recommendations. At this time the developers and designers considered the human emotion to build a new HCI. Figures 7 show the new lay out of the front page of the WebGD LMS.



Silvia Quevedo, 2013 (Videobes)

**Fig. 7.** New WebGD Interface

The developers of the WebGD LMS now are implementing this recommendations. This paper showed how evaluating a Human Computer Interface can give new solutions from HCI problems. In the next step of the research is to set a new evaluation process in the new interface in the aim to validate it.

## References

1. Agarwal, A., Meyer, A.: Beyond Usability: Evaluating Emotional Response as an Integral Part of the User Experience. In: CHI 2009, pp. 2919–2930. ACM, Boston (2009)
2. Ancker, J.S., Chan, C., Kukafka, R.: Interactive Graphics for Expressing Health Risks: Development and Qualitative Evaluation. *Journal of Health Communication: International Perspectives* 5(14), 37–41 (2012)
3. Berg, C.H.: Avaliação De Ambientes Virtuais De Ensino Aprendizagem Acessíveis Através De Testes De Usabilidade Com Emoções. 2013. 80 f. Dissertação (Mestrado) - Curso de Mídia do Conhecimento, Departamento de Engenharia e Gestão do Conhecimento, Universidade Federal de Santa Catarina, Florianópolis, Cap. 6 (2013)
4. Desmet, P.M.A.: Measuring emotion: Development and application of an instrument to measure emotional responses to products. In: Blythe, M.A., Monk, A.F., Overbeeke, K., Wright, P.C. (eds.) *Funology: From Usability to Enjoyment*, pp. 111–123. Kluwer Academic Publishers, Dordrecht (2003)
5. Hercegfí, K., Csillik, O., Bodnár, É., Sass, J., Izsó, L.: Designers of Different Cognitive Styles Editing E-Learning Materials Studied by Monitoring Physiological and Other Data Simultaneously. In: Harris, D. (ed.) *EPCE 2009, HCII 2009. LNCS (LNAI)*, vol. 5639, pp. 179–186. Springer, Heidelberg (2009)
6. MOODLE (Australia). Welcome to the Moodle community (2013), <https://moodle.org/> (access in: March 10, 2013)
7. Nielsen, J., Mollich, R.: Heuristic evaluation of User interfaces. In: CHI 1990 Proceedings, pp. 249–256 (1990)
8. Nielsen, J., Mollich, R.: *Usability Engineering*. Academic Press Limited, London (1993)
9. Nielsen, J., Mollich, R.: Technology Transfer of Heuristic Evaluation and Usability Inspection. In: IFIP INTERACT 1995, Lillehammer, pp. 1–9 (1995)
10. Nielsen, J., Mollich, R., Loranger, H.: *Usabilidade na Web: projetando websites com qualidade*, 406 p. Elsevier, Rio de Janeiro (2007)
11. Preece, J., Rogers, Y., Sharp, H.: *Interaction Design: Beyond Human- Computer Interaction*, 552 p. Univ. of Maryland, Maryland (2002)
12. Sauer, J., Sonderegger, A.: The influence of prototype fidelity and aesthetics of design in usability tests: Effects on user behaviour, subjective evaluation and emotion. *Applied Ergonomics* (40), 670–677 (2008)
13. Scopus (Brazil) (Ed.). An eye on global research (2013), <http://www.elsevier.com/online-tools/scopus> (access in: March 10, 2013)
14. The Cochrane Collaboration (UK) (Ed.). *Cochrane Review* (2013), <http://www.cochrane.org/cochrane-reviews> (access in: March 10, 2013)
15. Thomson Reuters (Germany). *Web of Science* (2013), <http://apps.webofknowledge.com> (access in: March 10, 2013)
16. Tzvetanova, S., Tang, M.-X., Justice, L.: Emotional Web Usability Evaluation. In: Jacko, J.A. (ed.) *HCI 2007. LNCS*, vol. 4553, pp. 1039–1046. Springer, Heidelberg (2007)
17. Walker, S., Prytherch, D.: How Is It for You (A Case for Recognising User Motivation in the Design Process). In: Peter, C., Beale, R. (eds.) *Affect and Emotion in HCI. LNCS*, vol. 4868, pp. 130–141. Springer, Heidelberg (2008)
18. World Wide Web Consortium (Brazil). *W3C Brasil* (2013), <http://www.w3c.br/Home/WebHome> (access in: March 10, 2013)