INTEGRATING SEMIOTICS PERCEPTION IN USABILITY TESTING: A LIGHT WEIGHTED EXPERIMENT ON AN E-HEALTH APPLICATION

Muhammad Nazrul Islam[1], Franck Tétard[2], Pekka Reijonen[3] and Kimmo Tarkkanen[3]
[1]*Turku Centre for Computer Science,* [1,2]*Dept. of Information Technologies, Åbo Akademi University, Turku, Finland.*
[3]*Information Systems Science, University of Turku, Turku, Finland.*

ABSTRACT

Interface signs (e.g., navigation links, buttons, icons, thumbnail, etc.), i.e. any element of a user interface, are crucial components to achieve satisfactory usability for web applications. End users typically get the system's logic through interface signs as the system's content and functions are usually directed by these. Consequently, interface signs need to be intuitive to the end users to improve the usability of web applications. Therefore, a clear need is depicted to assess interface signs' intuitiveness to the end users in usability testing. In order to assess this intuitiveness, a lightweight experiment was conducted on an e-health application's paper prototype. The study outcomes showed that integrating semiotics perception in usability testing yielded a number of benefits that contributed to the usability evaluation of the application. For instance, it (i) provided an overall idea on users' intuitiveness to interpret the intended/referential meaning of interface signs, (ii) conveyed the understandability (improving the users' interpretation accuracy) of interface signs, (iii) assisted to find the usability problems and also to recommend possible solutions, and (iv) received customer's contentment, and the like.

KEYWORDS

Semiotics, user interface, usability testing, paper prototype

1. INTRODUCTION

From the perspective of user who needs to use interactive as well as information intensive web applications, usability is considered as a key quality for these applications. Usability is also considered as a vital aspect of web applications since a high-quality and successful computer application always showed a good level of usability. Usability is defined by the ISO standard (ISO 9241-11, 1998) as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Thus a number of usability testing techniques are emerged and developed in usability research and practice. Usability testing could be defined as the technique to discover the usability problems of a computer application to refine it, with the help of experiments, involving real users.

Web interface signs act as the medium of users' interaction and communication with the web applications (Islam, 2012). Interface signs' intuitiveness affects communicability, and communicability subsequently affects application's usability. As Salgado et al. (2009) stated: "Communicability problems tend to lead to usability problems, since usability tacitly requires that users 'get the system's logic through interface signs' before they can possibly learn to use them, retain them, and be satisfied with interaction" (Salgado et at. , 2009). Designing intuitive interface signs for the users is essential to maintain the user satisfied, to ensure understanding, and to provide the means to communicate, e.g., (Bolchini et al, 2009; Speroni, 2006; de Souza, 2005a, 2005b; de Souza et al, 2001; Islam et al, 2010). In other words, designing intuitive interface signs for the users is essential for boosting web usability. These design principles focus on sense making and interpretation and thereby involve semiotics, the doctrine of signs, that is, the science of signs (Peirce, 1932-58). Nevertheless, semiotics research on web interface in particular focuses mainly on the language of the web interface and its usability.

Therefore, this research focuses on interface signs' intuitiveness to assess the value of integrating semiotics perception in usability testing. The fundamental research question of the research was "How

applicable is the integration of semiotics perception in usability testing?" To answer this research question, a lightweight experiment was conducted on an online based e-health application's paper prototype. The results showed that integrating semiotics perception in usability testing yielded a number of benefits that contributed to the usability evaluation of the application

This paper is structured as follows. Semiotics and interface sign are discussed to provide a brief overview of the research background in section 2. In section 3, the studied application and the experimental procedures are presented and explained. Study results are discussed in sections 4. The conclusion and ideas for future work are provided in the final section.

2. SEMIOTICS AND INTERFACE SIGN

The shortest definition of semiotics is that it is the study of sign and its process of signification. Semiotics is concerned with how human mind generates, communicates and codifies the meaning of a sign. Semioticians are studying the '*what*, *how*, and *why* of Signs' (Danesi, 2007). A complete definition of semiotics could be presented as "the study of signs, signification, and signifying systems" (Robert et al, 1992).

Therefore, the notion of the sign is central in semiotics. Sign is loosely defined as a pattern of data which, when perceived, brings to mind something other than itself (Net resource, 2012). Though there is no restriction to choose the notion of a sign to adopt but it generally take the "form of words, images, sounds, odours, flavours, acts or objects and even gestures" (Chandler, 2002). These things are not considered as a sign unless it provides intrinsic meaning to somebody in some respect or capacity. Thus a sign becomes sign only when we (designer) invest them with meaning (Chandler, 2002; Morris, 1938).

Two models of semiotics, provided by the two fathers of semiotics: Ferdinand de Saussure and Charles S. Peirce, are presented here to provide a concise idea about semiotics. De Saussure's (1965) semiotic model comprised of a *signifier* and a *signified* in the form of a dyad. The signifier is the form the sign takes, whereas the signified is the concept in somebody's mind. According to the Peirce's model (Peirce, 1932-58), semiotics is based on the notion of signs as triadic relations between the following three entities:

- the *representamen* - the form the sign takes to stand to somebody for something in some respect,
- an *interpretant*- is the sense made of the sign created in the mind of the perceiver, and
- an *object* – is the actual thing to which the sign refers.

The traffic light sign for 'stop' exemplifies the semiotic model of (i) de Saussure as it consist of a red light facing traffic at an intersection as *signifier*, whereas the driver obtains the concept in the form of the obligation to stop the car as *signified*; and (ii) Peirce as it consist of a red light facing traffic at an intersection as the *representamen*, car stopping as the *object*, and the idea obtained by the driver that a red light indicates that vehicles must stop as the *interpretant*.

A user interface of a computer application encompasses a number of interface signs. Designers design the interface signs as an encoded form to provide the information/services and end user needs to decode these signs to obtain the desired information/services. Thus, users can perform the desired task properly when the end user's interpretant matches the referential object of the interface signs with the designer's interpretant, and incorrectly otherwise. Islam (2011a, 2011b) classified the users' interpretations of interface signs (see figure 1) into the following categories based on the accuracy level of user interpretation with respect to the designer's interpretation for an interface sign: (a) accurate- user's interpretation completely matches the designer's interpretation and this category reflects the semiotics theory, (b) moderate- user's felt more than one distinct object, one of which was the right one about the interface signs and probability to obtain the right object at the first attempt may be less than the accurate interpretation (for example, if a user proceeds with a sign to obtain a particular object but the sign does not really stands for that), (c) conflicting- user's felt more than one distinct object in his/her mind about the interface signs and user felt confused about choosing the right object that will match to the designers intention, (d) erroneous- user's interpretation referred to a completely different object other than the designer's interpretation, and (e) incapable- user could not able to interpret the interface sign at all. This categorization was adopted in this experiment to analyze and synthesize the study data.

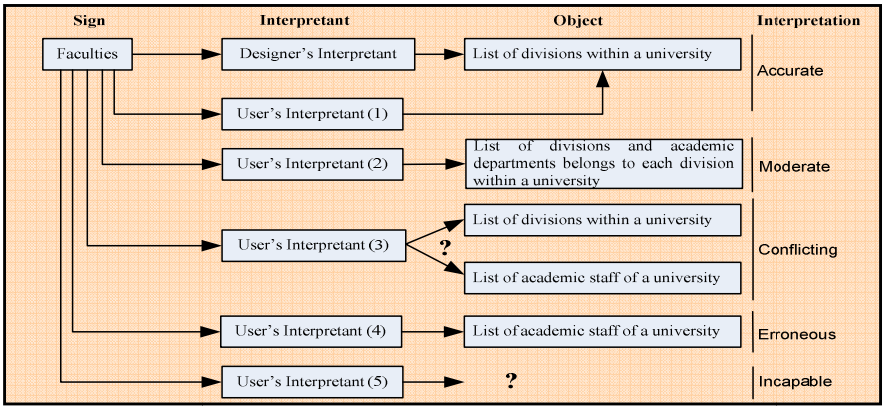

Figure 1. Possible Interpretation of a web interface sign 'Faculties', retrieved from a university website (www.buet.ac.bd) on March, 2012

3. EXPERIMENT DESIGN

A light weighted experiment was designed and conducted on an online based e-health application. This section briefly discusses the studied application as well as the methodology to perform the experiment.

3.1 Studied E-Health Application

In order to attain this research goal, a lightweight experiment was conducted on an e-health application. This application is designed as a support tool for daily use in homecare in Finland. Homecare nurses can access the application during their visits to clients to access updated information, record their realizations in real time, planning and tracking their work progress, as well as to gather actual statistical data about the treatments and services that clients receive. The primary beneficiary of the system is the client, who will receive better treatment and service. The objective of the project is to make a usability evaluation of the application as part of a larger effort to ensure that the application meets usability quality standards.

3.2 Experiment Procedure

In this experiment, two user tests were conducted: (i) one was conducted to understand the users' interpretations of interface signs and their interpretation accuracy to understand the referential/intrinsic meaning of the interface signs. The test is named here as interface sign intuitive test (ISIT), and (ii) another one was a usability test performed following a think-aloud (Hertzman & Jacobsen, 2003; Nielsen, 1993) method to observe how users perform the given tasks and to find the usability problems. The interface sign intuitive tests (ISITs) were carried in conjunction with a usability test performed on a paper prototype of a health care application to be run on a tablet computer.

The main objective of this experiment was to assess the value of considering semiotics perception in usability testing to improve the usability evaluation of the studied application. A structure of our experiment is presented in figure 2. The experiment was carried out with test subjects in Finland and followed a strict experiment methodology to ensure the validity and reliability of our research outcomes. Four health care professionals served as subjects. The subjects were all female, home care nurses from 30 to 45 years old, and they had been using patient record system in their work from 2 to 10 years and all had used a touch screen mobile telephone for at least one year. The test session was organized so that the subjects first took the first sign test (ISIT1), then participated in the paper prototype test, and then took the sign test for the second time (ISIT2). The subjects were not told in advance that the sign test will be presented to them a second time. For the sign test (ISIT1 and ISIT2), we chose heuristically a total of 24 interface signs appearing in the tested paper prototype that seemed most important in evaluating the application's usability. In ISIT, the selected interface signs were printed on separate cards in natural size and they were presented to the subjects one by

one. The subject was told that she will be presented some signs that appear in the prototype and her task was to tell for every sign: (Q.i) what they thought the sign meant or what would happen from it, (Q.ii) why they thought as they thought, and (Q.iii) how certain they were of their assessment. It is worth to mention here that we only use the data of users' responses for the question Q.i in this paper. Both test sessions (ISIT1 and ISIT2) were executed in the same manner and the test lasted for 5-8 minutes per test session. In paper prototype usability testing, users were asked to perform a number of tasks. This test lasted 60-70 minutes per test session. The tests were audio-video recorded and the data were analysed from the audio-video recording.

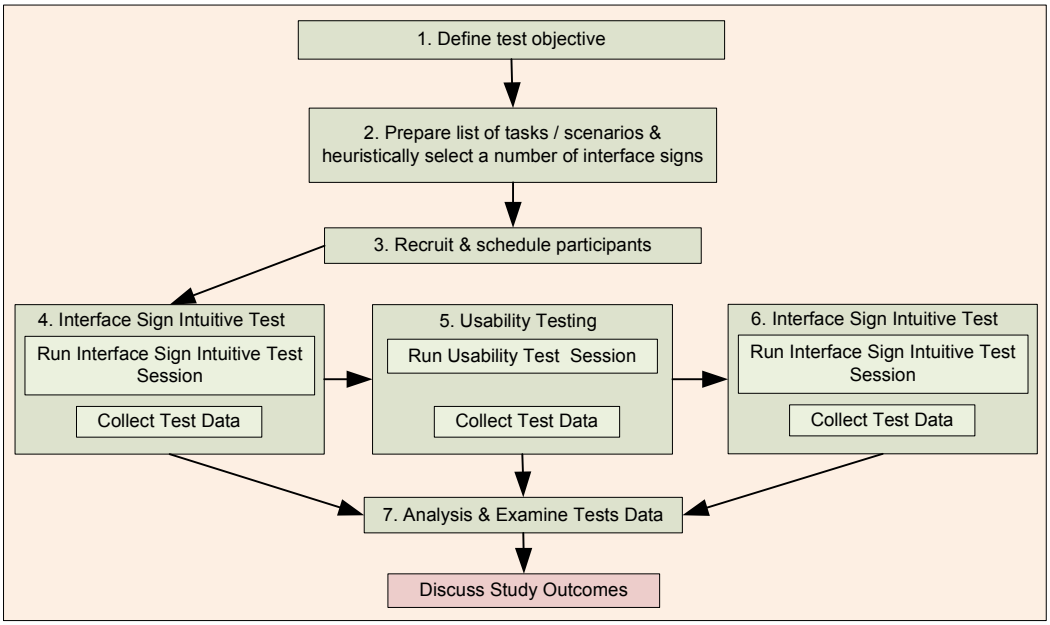

Figure 2. Structure of the experimental method.

4. DISCUSSION OF THE RESULTS

The study outcomes showed that integrating semiotics perception in usability testing yielded a number of benefits that contributed to the usability evaluation. Following paragraphs discusses these resultant outcomes:

Table 1. Participants' interpretations of the interface signs

P	Accurate		Inaccurate								Accurate (%)		Inaccurate (%)	
			Mo		C		E		I					
	T1	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*
P1	4	12	8	4	7	6	5	0	0	2	16.67	50.00	83.33	50.00
P2	4	9	8	7	8	5	2	2	2	1	16.67	37.50	83.33	62.50
P3	8	11	6	4	5	4	2	1	3	4	33.33	45.83	66.67	54.17
P4	9	11	4	4	5	7	1	2	5	0	37.50	45.83	62.50	54.17
M	6.25	10.5	6.5	4.75	6.25	5.5	2.5	1.25	2.5	2	26.04	43.75	73.96	56.25

P: Participants; T1:ISIT1; T2: ISIT2; Mo: Moderate;
C: Conflicting; E: Erroneous; I: Incapable; M: Mean

Users' interpretations of the interface signs were classified into: accurate, moderate, conflicting, erroneous, and incapable, based on the accuracy level of user interpretation with respect to the designer's interpretation for an interface sign. An example of users' interpretations of an interface sign and its accuracy classification is showed in figure 3. The example data is obtained from the ISIT1. This accuracy classification showed how users' interpretations varied compared to the original (designer's) meaning. A complete synthesized view of data related to the users' interpretation of interface signs in both the ISIT1 and ISIT2 tests are presented in Table 1. A number of observations came out from this synthesized data related to the interface signs intuitiveness to the end users. For instance, this study showed that in an average about one fourth of total signs (26.04%) were accurately interpreted by the test participants before the UT. The difference between the inaccurate interpretations of interface signs for the test ISIT1 and ISIT2 were comparatively higher for the first two participants (P1 & P2). Users were unable to interpret the meaning of interface signs in both tests for very limited number of signs ($m = 2.5$ in ISIT1 and $m = 2$ in ISIT2). Almost a similar outcome is observed for the *Erroneous* interpretations of interface signs. For the users inaccurate interpretations of interface signs, the maximum number of interpretations were belonged (i) to the *Moderate* ($m = 6.5$) and *Conflicting* ($m = 6.25$) in ISIT1, and (ii) to the *Conflicting* ($m = 5.5$) in ISIT2. Thus the integration of semiotics perception in UT provides an overall idea of interface signs' intuitiveness to the end users to interpret the intended/referential meaning of interface signs.

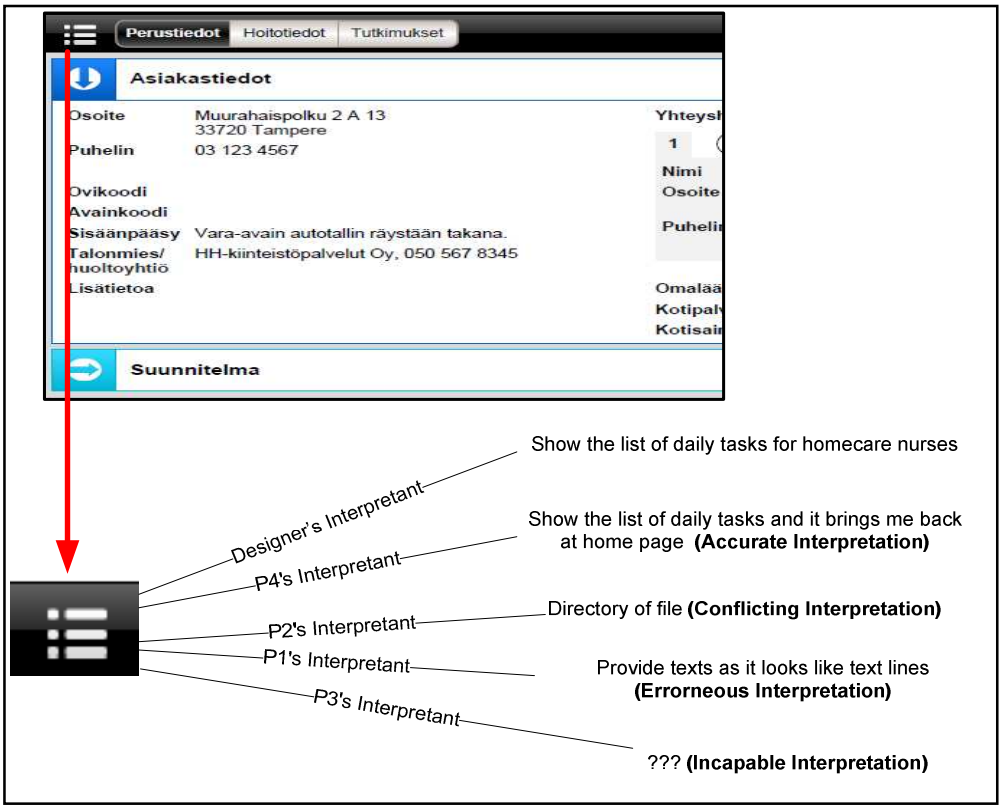

Figure 3. An example of user's interpretations of an interface sign and its categorizations

A comparative outlook between the users' interpretations accuracy in ISIT1 and ISIT2 showed the improvement in interpreting the referential meaning of interface signs. We synthesized the study data to observe this improvement of interface signs through two viewpoints. These were:

- Interpretations' inaccuracy changed (see figure 4) - The changes were grouped into three routes: (i) improved (e.g., interpretations accuracy changed from *Conflicting* to *Moderate*, (ii) consistent (e.g., interpretations accuracy for an interface sign remains consistent in both ISIT1 and ISIT2, like *Conflicting*; accuracy changed from *Erroneous* to *Incapable* and vice versa), and (iii) decreased (e.g., interpretations accuracy changed from 'moderate' to 'conflicting'). This study observed that

inaccurate interpretations averagely improved by 42%, remain consistent by 47%, and decreased by 11%.

- Interpretations' accuracy changed (see figure 5) - the changes increased the users' interpretations accuracy in ISIT2 comparing to the users' interpretations in ISIT1. This study observed that accurate interpretations increased from 26% to 47% in average.

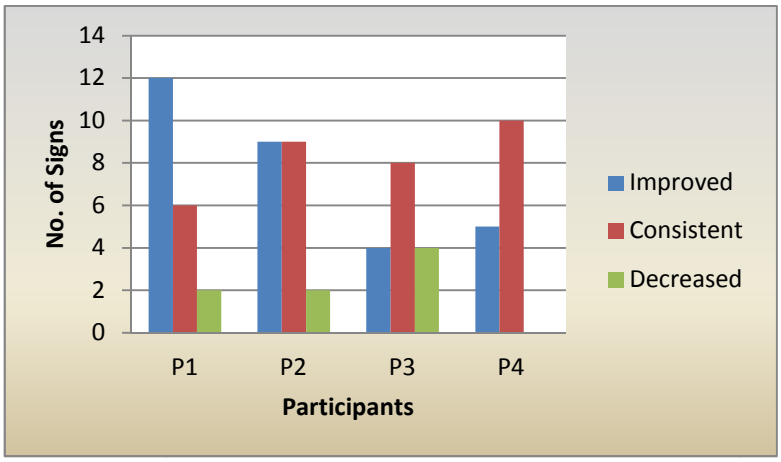

Figure 4. Learning effect: interpretations' inaccuracy changes.

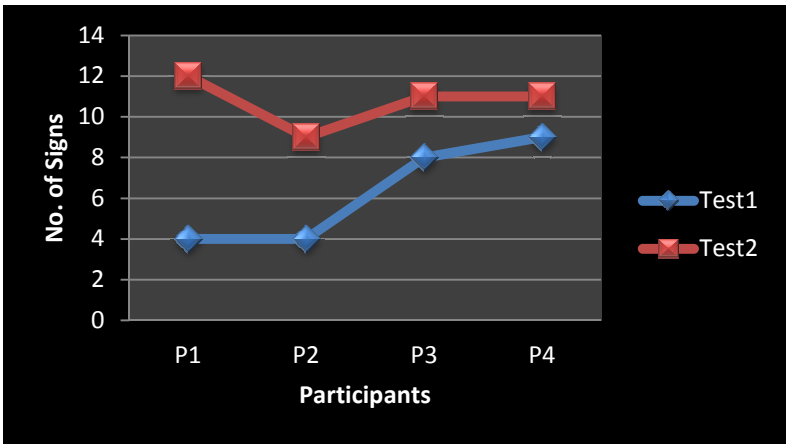

Figure 5. Learning effect: increased interpretations' accuracy.

User interface mainly encompasses a number of interface signs that act as communication artefacts to interact with the application. End users need to understand and interpret the interface signs properly before they can obtain the application's logic, learn how to use it, and also be satisfied in interaction with the application (Salgado et at., 2009; de Souza et al., 2006; de Souza and Cypher, 2008). Moreover, the learnability is defined as the capability of application's user interface to enable end users to learn it quickly and effectively with learning time as the typical measure (Usability first, 2012). Thus, the integration of semiotics perception in UT conveys the understandability (improving the users' interpretations accuracy) of interface signs for a particular application and as a consequence it also provides the indication of applications learnability to the real users. In other words, it showed the easiness as well as efficiency to learn the communication artefact (interface sign) within a very short time.

Interface signs, for which most of the users' inaccurate interpretations remained consistent or reduced, need to be considered as critical signs. Critical signs can lead users to potential usability problems (e.g., dissatisfaction to interact with the system, longer time to learn the system's functionality, failure in task completion, etc.). The resultant data obtained from this experiment provided a clear indication of a critical interface sign, which needs to be redesigned to improve users' understandability, satisfaction, task completion performance, i.e., application's usability. Let us put an example of a critical interface sign that

was observed in our experiment. Users' interpretations accuracy for the sign "  " was (i) consistent, i.e., *Conflicting* by the participants P1 and P4; and (ii) decreased, i.e., *Conflicting* to *Incapable* and *Moderated* to *Conflicting* by P2 and P3 respectively. Thus, the integration of semiotics perception in UT assisted to find potential usability problems and also to recommend possible solutions.

The usability testing report produced based on this method's outcome was received by the project customer of the application with content. One representative of the project customer was part of the testing team and saw how semiotics was applied in the usability test. We asked the project customer for feedback on the importance of using semiotics evaluation as part of the usability test; for instance, the project customer stated that *"… mielestäni ikonien testaaminen oli hieno lisä tähän käytettävyyden arviointiin…."* ("… I think sign testing was a great addition to the usability evaluation….). From a practitioner's point of view, this demonstrated that sign testing was an applicable method in the given context.

5. CONCLUSION AND FUTURE WORK

This research conducted an experiment on an e-health application's paper prototype to observe the value and the applicability of integrating semiotics perception in usability testing. The results of this experiment showed the possibility to obtain a number of benefits that contributed to the usability evaluation. In a nutshell, this experiment of integrating a semiotics perception in usability testing:

- provides an overall idea of interface signs' intuitiveness to the end users to interpret the intended/referential meaning of interface signs,
- conveys the understandability (improving the users' interpretations accuracy) of interface signs and as a consequence it also provides the indication of applications learnability to the real users,
- assists in finding usability problems and also to recommend possible solutions,
- receives customer's contentment, and the like.

Moreover, this experiment also showed two directions for conducting future research. On one hand, a semiotic-based conceptual tool/framework for interface design and evaluation is essential to obtain benefits of integrating a semiotics perception in usability testing. On the other hand it provides to the usability practitioners a methodological approach that can be used and applied in other domains for further research.

There were a few limitations in the present study. Firstly, the experiment was conducted only on a web application; secondly, the number of participants was rather small; thirdly, a few other aspects (e.g., cultural, emotional, etc.) were not considered in the experiment; and fourthly, experiment was based on a paper prototype thus the interactivity of interface signs was not properly observable to the test participants. The authors hope to consider these issues in future tests.

ACKNOWLEDGEMENT

We would like to thank anonymous reviewers for their constructive feedback. We are also grateful to all the participants for their time and effort in taking part in this experiment.

REFERENCES

Bolchini, D. et al, 2009. Developing heuristics for the semiotics inspection of websites, in *Proc. of the 27th ACM international conference on Design of Communication (SIGDOC 2009)*. ACM Press, Indiana, USA, pp. 67-71.DOI: http://doi.acm.org/10.1145/1621995.1622009

Chandler,D., 2002. *Semiotics:The Basics*. London, UK:Routledge.

Danesi, M., 2007. *The Quest for Meaning: A Guide to Semiotic Theory and Practice.* Toronto, University of Toronto press.

De Saussure, F.,1965. *Course in General Linguistics* (trans. W.Baskin). New York, NY: McGraw-Hill.

de Souza, C. S. et al, (2001) A semiotics engineering approach to user interface design. In *Journal of Knowledge Based System*, 14(8), pp. 461-465. DOI: 10.1016/S0950-7051(01)00136-8.

de Souza, C. S. et al, 2006. The Semiotic Inspection Method. In *Proc. of VII Brazilian symposium on Human Factors in Computing Systems (IHC 2006)*, pp. 148-157, Natal, RN, Brazil, ACM press. DOI: http://doi.acm.org/10.1145/1298023.1298044

de Souza, C.S., & Cypher, A., 2008. Semiotic Engineering in Practice: Redesigning the CoScripter Interface. In *Proceedings of the working conference on Advanced Visual Interfaces (AVI 2008)*, Napoli, Italy: ACM press, pp. 165-172. DOI:http://doi.acm.org/10.1145/1385569.1385597.

de Souza, C.S., 2005b. Semiotic engineering: bringing designers and users together at interaction time. In *Interdisciplinary Journal of Human-Computer Interaction - Interacting with Computers*, 17(3), pp. 317-341. DOI: 10.1016/j.intcom.2005.01.007.

de Souze, C.S., 2005a. *The Semiotic Engineering of Human-Computer Interaction*. Cambridge, Mass: The MIT Press.

Hertzum, M., and Jacobsen, N. E., 2003. The Evaluator Effect: A Chilling Fact about Usability Evaluation Methods. In *International Journal of Human-Computer Interaction* (15:1), pp 183-204.

Islam, M.N. et al, 2010. Semiotics Explorations on Designing the Information Intensive Web Interfaces. In *International Arab Journal of Information Technology*, 7(1), pp. 45-54.

Islam, M.N., 2011b. Beyond Users' Inaccurate Interpretations of Web Interface Signs: A Semiotic Perception. I*n Proc. of the IFIP 13th International Conference on Informatics and Semiotics in Organizations (ICISO 2011)*, Leeuwarden, Netherlands, pp. 31-40.

Islam,M.N., 2011a. A Semiotics Perspective to web Usability: An Empirical case Study. In *Proc. of IADIS Internationa Conference on Interface and Human Computer Interaction (IHCI 2011)*, IADIS publisher ,Rome, Italy, pp. 19-28.

Islam,M.N., 2012. Towards Designing Users' Intuitive Web Interface. In *Proc. of the 6th International Conference on Complex, Intelligent, and Software Intensive Systems (CISIS-2011)*, IEEE Computer Society's Conference Publishing Services, Palermo, Italy.

ISO 9241-11,1998. *Erogonomic Requriements for Office Work with Visual Display Terminals (VDTs) – Guidance on Usability*. ISO 9241-11.

Morris,C., 1938. *Foundations of the Theory of Signs*. International Encyclopedia of Unified Science, 1(2), University of Chicago Press.

Net resources. 2012. available at http://www.rdillman.com/HFCL/TUTOR/Semiotics/sem1.html , accessed on May 2012.

Nielsen, J., 1993. *Usability Engineering*. Academic Press, Inc., London, UK.

Peirce,C.S., 1932-52. *Collected Writings (8 Vols.)*. In Ed. Charles Hartshorne, Paul Weiss & Arthur Burks, Harvard University Press.

Robert, S. et al, 1992. *New Vocabularies in Film Semiotics: Structuralism, Post-Structuralism and Beyond*, London: Routledge, Taylor & Francies.

Salgado L.C. et al, 2009. *A semiotic inspection of ICDL*. Monografias em Ciência da Computação, No. 31/09, Ed. Prof. Carlos José Pereira de Lucena, ISSN: 0103-9741, Brazil.

Speroni, M., 2006. *Mastering the Semiotics of Information-Intensive Web Interfaces. u*npublished doctoral dissertation, Faculty of Communication Sciences, University of Lugano, Swizerland.

Usability first, 2012. available at http://www.usabilityfirst.com/glossary/learnability/, accessed on March, 2012.