

Understanding the Semantics of Web Interface Signs: A Set of Ontological Principals

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Abstract. Interface signs are the communication artifacts of web interfaces, with which users interact. Examples of interface signs are small images, navigational links, buttons and thumbnails. Although, intuitive interface signs are crucial elements of a good user interface (UI), prior research ignored these in UI design and usability evaluation process. This paper argues that ontology (the set of concepts and skills for understanding the referential meaning of an interface sign) mapping is critical for intuitive sign design. A light weighted experiment with six participants and twelve signs has been carried out in order to demonstrate the importance of ontology mapping in understanding the semantics of interface signs. The paper concludes with some practical implications and suggestions for future research.

Keywords: Ontology · Web interface sign · Web usability · User interface design · Usability evaluation

1 Introduction

Interface signs are the key elements of web user interface (UI). These signs act as the communication artifacts between the users and designers/systems. Examples of interface signs are navigational links, thumbnails, small images, command buttons, symbols, icons, etc. The semantic of interface signs refers to the meaning (referential or intrinsic) of an interface sign, i.e., for what purpose the sign stands in the UI. For example, the semantic of the 'HOME' sign in a webpage refers to 'getting the main/home page of the website'.

End users are required to interpret the web interfaces in order to interact with them. Interaction between users and web interfaces is mediated via interface signs since the content and functions of web systems are directed primarily through interface signs. Thus, at low level, users interpret the 'interface signs' of user interfaces (e.g., navigational links, symbols, icons, etc.) to understand the system's logic and to perform tasks [3]. It is thus important to design user-intuitive interface signs so that users can interpret the meaning (semantic) of the interface signs easily and accurately.

Understanding the semantics/meanings of interface signs properly allow users to go directly to the content of interest. For a user-intuitive interface sign, users do not need to click on the interface sign to see the referential content in order to understand the meaning of the sign in question. Thus, designing user-intuitive interface signs and evaluating the intuitiveness of interface signs become essential in UI design and usability evaluation process [2, 6]. Consequently, Bolchini et al. [1] suggested ‘interface sign’ as one of the major dimensions of web UI design and usability evaluation. However, very few studies explicitly focused on interface signs in UI design and evaluation [10]. In this paper, we describe a set of ontological principals that users use for understanding web interface signs.

The term *ontology* is defined as the set of concepts and skills for understanding the referential meaning of an interface sign [9]. From the users’ perspective, ontology refers to the knowledge or concepts that users use to understand and interpret the meaning of an interface sign properly. From the designers’ perspective, ontology refers to the knowledge or concepts presupposed and referred to by an interface sign. For example, an interface sign ‘Junk’ in an email application may be well designed in terms of color, layout, position, etc. but will not make any sense to the users who do not know what the concept of ‘Junk’ refers to.

2 Related Works

We have conducted a literature review on ontology in relation to interface signs in UI design and evaluation. The prior work carried out on ontology is briefly presented in Table 1.

Table 1. Related work

	Contributions
Speroni [9]	Introduces the concept of ontology and proposes seven ontologies for information intensive websites
Speroni et al. [10]	An expert inspection is carried out based on Speroni’s [9] set of ontologies in order to evaluate the web interfaces
Bolchini et al. [1]	A number of heuristics to design and evaluate web interface signs grounded on Speroni’s [9] ontology is proposed. The heuristics includes: avoid ontology conflict to design interface signs, and design interface signs based on the users’ familiarity with ontologies
Islam et al. [5]	The interface signs of museum websites are analyzed to explore users’ perceived difficulty in interpreting the meaning of interface signs that belong to different ontologies proposed by Speroni’s [9]
Sharp [8]	Describes the importance of ontologies in information systems development based on Islam’s [5] and Speroni’s [9] work
Islam [4]	The interface signs of museum and university websites are analyzed to observe how interface sign re-design changes the ontology/ontologies referred to by an interface sign, and users’ difficulty in interpreting the meaning of interface signs based on Speroni’s [9] work

The literature review suggests that very few studies have been conducted on interface sign ontology. The studies have been carried out by considering the Speroni's [9] ontologies and focused on information intensive web interfaces. Speroni [9] proposed an example list of most common ontologies used in information intensive web UI. He further stated that the set of ontologies can be different depending on different websites. This suggests further research possibilities on (i) revealing a complete list of ontologies that goes beyond information intensive websites and is more general for web interfaces; and (ii) exploring the principles of ontologies in depth in order to design and evaluate user-intuitive web interface signs.

In response to the above research opportunities, Islam [7] proposed a list of twelve ontologies for web interface signs, and a set of principles for ontology mapping in interpreting the meaning of web interface signs. He conducted an extensive empirical study through semi-structured interviews and questionnaires for finding a list of ontologies and principles of ontology mapping for web interfaces. He identified the following set of ontologies to interpret the meaning of interfaces signs. Ontologies marked by * are also proposed by Speroni [9].

- *Internet Ontology (IO)**: The knowledge of World Wide Web, web browsing and its concepts and conventions.
- *Real World Ontology (RWO)*: The knowledge of the real world experiences and concepts.
- *System Ontology (SO)*: The knowledge of the (studied) system, its functionalities and concepts.
- *Computer Ontology (CO)*: The knowledge of computer and its use.
- *Mobile Ontology (MO)*: The knowledge of mobile and mobile application use.
- *Current Web Domain Ontology (CWDO)**: The knowledge concerning web interface signs, which are specific enough to the current web domain (e.g., educational web domain, email application domain).
- *Other Web Domain Ontology (OWDO)*: The knowledge of web interface signs which are specific enough to a particular web domain other than the web domain where the sign is currently available.
- *Common-Sense Ontology (CSO)**: The knowledge of concepts belonging to a common background of users and that uses common sense.
- *Topic Ontology (TO)**: The knowledge of a particular subject or topic the website talks about.
- *Organization Ontology (OO)**: The knowledge of web interface signs that refer to the institution or organization that owns a website.
- *Cultural Ontology (CuO)*: The knowledge of interface signs which are specific to a particular cultural context.
- *Website Ontology (WO)**: The knowledge of web interface signs which are specific to a particular website.

Islam [7] also found the following principles of ontology mapping in interpreting the meaning of interface signs:

- I. Users use single or multiple ontologies to interpret the semantic of the interface sign. An interface sign may belong to a single or multiple ontologies.

- II. A proper matching between ontology/ontologies referred to by an interface sign and one(s) owned by the participants leads users to interpret the semantic of interface sign correctly.
- III. Ontology conflict (i.e., users are confused with ontology/ontologies that need to consider to interpret a sign) increases the users' perceived interpretation difficulty and decreases the accuracy of sign's interpretation.
- IV. When multiple ontologies are referred to by an interface signs, a familiar ontology supports an unfamiliar ontology to understand the semantic of the interface sign.

This study is built on Islam's [7] work. In principle, this research carries out a light weighted experiment to investigate if the principles of ontology mapping are applicable to understand the meaning of web interface signs.

3 Study Design

A light weighted experiment was carried out in a usability testing lab and followed the followings procedure. First, 12 interface signs (see Fig. 1) were selected from home pages (English version) of two university websites (Universität Trier and RWTH Aachen University) and two museum websites (Drents Museum and Hunebed Centrum Museum). Second, 5 undergrads and 1 graduate student were recruited as test participants. They were aged 20–30 years (Mean = 25.33; standard deviation = 2.62). Third, a sign test was carried out with each participant via semi-structured interviews. The following activities were followed in each test session with each participant: (i) test subjects filled in pre-test questionnaires, that addressed their socio-biographical profile, experience with the use of computer, mobile and internet, and familiarity with the websites under investigation, (ii) a short introduction was given to inform the participants about the test in general: the test procedure, their role, etc., and (iii) the participants were asked to answer the following set of questions for each interface sign without clicking on the signs:

1. What could be the referential meaning of this sign?
2. Why do you think this is the meaning of this sign?
3. When interpreting this sign how intuitive it is to you (answer choices ranged from 1: not intuitive – 9: extremely intuitive)?



Fig. 1. Set of interface signs

Table 2. Model of the profiles of test-participants

Ontologies	Users familiarity with ontologies			
	<i>Nil</i>	<i>Less</i>	<i>Average</i>	<i>High</i>
IO				□ #
RWO			□ #	
SO		□		#
CO				□ #
MO				□ #
CWDO		□		#
OWDO			□ #	
CSO			□ #	
TO		□	#	
OO			□	#
CuO	□ #			
WO	□ #			

Context: □ - museum website and # - University website.

4. Do you have any suggestion for redesigning this sign that would make the sign more intuitive in terms of interpreting its meaning?

Each interview session lasted about 25–35 min and was audio-video recorded. Finally, the interview data was transcribed and then analyzed, using qualitative analysis and descriptive statistics.

We followed the following steps to analyze the study data:

- First, we modeled the users' profiles based on their familiarity with ontologies. The profiles are shown in Table 2. A set of pre-test questionnaires were used to understand users' familiarity with ontologies. For example, a question 'how long have you been using the internet?' gave an indication of users' familiarity with *Internet Ontology*.
- Second, we identified the ontology/ontologies referred to by the interface signs (i.e., designer ontology). For example, *Internet Ontology* is referred to by the 'FAQ' and 'Online shop' signs and *Website Ontology* is referred to by the 'L²P' sign.
- Finally, we analyzed the data to observe whether the principles of ontology mapping play key roles in understanding the semantics of interface signs.

4 Results and Discussions

Our data analyses results show that the principles of ontology mapping are useful for interpreting/understanding the semantic/meaning of web interface signs. Next, we discuss the study findings briefly in relation to each principle:

Principle I, II & IV: The 'Exhibition', 'FAQ', 'Online shop', and 'Departments' signs were highly intuitive (mean intuitiveness scores were 8.50, 9.00, 8.50 and 9.00 respectively) and were interpreted correctly by all participants. Here, the

ontology/ontologies referred to by these signs and the one(s) owned by the users were matched. For example, ‘FAQ’ and ‘Online shop’ signs point to *Internet Ontology* and all participants were highly familiar with this ontology (see Table 1).

The ‘Exhibition’ sign in a museum website and the ‘Departments’ sign in a university website are built on multiple ontologies such as *Current Web Domain Ontology*, *System Ontology*, and *Real World Ontology*. Participants interpreted the meaning of these signs accurately because of their familiarity with a few or all of these Ontologies. Here, a familiar ontology supports an unfamiliar ontology for understanding the meaning of the sign. One participant responded the following while interpreting the meaning of ‘Exhibition’ sign:

“...I am familiar with this term [exhibition] from the outside world and also in museum visit....”

Principle III: Three participants found it difficult to interpret the meaning of the ‘Students’ sign in a university website. They thought that it could be either (i) for alumni students, because of the appended graduate hat icon, or (ii) for current students, because of the sign ‘Prospective Students’, which was placed to the left of this sign. One user responded the following in the regard:

“...This sign may be for alumni or those who will graduate...Oh! It may be for local students, as the neighboring sign is for prospective students....I don’t know! It may be for alumni due to the graduation hat sign....”

Here, the sign is built on the *Website Ontology*, since the ‘Student’ sign with the graduate hat is specific to this website for providing information for the current student. Three out of six participants treated this sign as built on *Current Web Domain Ontology*, *System Ontology*, and *Real World Ontology* to provide information for the alumni or for students who will graduate soon. They were familiar with this sign through the university, its websites, and real-world experience. As a result, an ontology conflict occurred that led them interpret the meaning of this sign inaccurately.

Ontology conflict occurred also in interpreting the meaning of the ‘Range of Courses’, ‘Other Target Groups’, ‘plus icon’ and ‘Peter Winandy’ signs in university websites. Participants reported higher level of difficulty in interpreting the meaning of these signs (mean intuitiveness scores were 5.67, 4.00, 1.00, and 3.21, respectively). For example, the sign ‘Range of Course’ actually stands for providing information of programs/degree offered (e.g., BSc and MSc in Psychology) in the university. But participants thought that the sign would provide the list of courses (e.g., object oriented programming language, data structure, etc.) offered in the university. They were also confused with the word ‘range’, as it could be used for different purposes like range of time or range of course fee. Here, this sign points to *Website Ontology*, since it is very specific to the website for this kind of information. However, participants treated the sign as built on *Current Web Domain Ontology*, *System Ontology*, and *Common Sense Ontology* to provide information about the list of courses offered in the university.

Principle V: The word ‘Megaliths’ means large stones. This sign in a museum website stands for providing its collection and exhibition information related to large stones.

This term is understandable only to a specific group of people who have familiarity with this Greek word. The ‘Lees Meer’ sign uses the Dutch language, and its meaning is ‘Read More’. The Sign ‘L²P’ is a very specific sign to navigate users to the university’s learning and teaching portal. Thus, the sign ‘Megaliths’ and ‘Lees Meer’ in a museum website belong to *Website Ontology* and *Cultural Ontology* respectively; and the sign ‘L²P’ in a university website belong to *Website Ontology*. Our study showed that the participants were not able to interpret the meaning of these signs properly and gave very low intuitiveness scores (mean intuitiveness scores of ‘Megaliths’, ‘Lees Meer’ and ‘L²P’ signs were 1.67, 2.67 and 1.50, respectively), since they were not familiar with these ontologies. One participant responded the following when interpreting the ‘Megaliths’ sign:

“...I do not know the meaning, without meaning how I judge it...”

5 Implications and Conclusion

The paper discussed the interface sign ontologies and the principles of ontology mapping, and demonstrated these principles with a light weighted experiment. The findings of the study suggest practitioners follow the following ontological guidelines to design and evaluate the interface sign [7]:

- (a) Design interface signs based on users’ familiarity level with ontologies.
- (b) Design interface signs that belong to multiple ontologies.
- (c) Avoid ontology conflict when creating interface signs.
- (d) (Re)design interface signs that belong to ontologies, with which user experienced lower level of perceived difficulty
- (e) Avoid creating interface signs that belong only to the *Website Ontology*.

For example, the sign ‘Megaliths’ (points to *Website Ontology*) can be re-designed as ‘Large Stones’, ‘Mega Stones’, or ‘Big Stones’. In this case, the sign will point to *Common Sense Ontology*, *Real World Ontology*, and *System Ontology*. This in turn may improve the interpretation accuracy and its perceived intuitiveness.

Additionally, the results of this study advance practitioners’ knowledge on design and evaluate web interface signs. The results may assist practitioners: (i) to model the profiles of target users based on their level of familiarity with ontologies, (ii) to investigate the problems and intuitiveness of interface signs based on users’ profiles, principles of ontology mapping, and ontological guidelines, and (iii) to apply the concept of ontologies as an integrated tool with other usability evaluation process (e.g., heuristic inspection, user tests, etc.) in order to improve the usability evaluation.

This paper has a number of limitations that may also serve as the avenue for future research. First, the current set of ontology and principles are derived for the desktop-based web interfaces. The ontologies and principles may not be directly applicable for mobile context. Thus, future work may focus on mobile interface, where signs have even more importance. Second, future research may integrate the concept of ontologies with other usability testing methods in order to assess its impact on improving the system usability.

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