Systematic Review of Visually-Impaired and Blind User Experience of Web Trends

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Abstract. *For visually impaired people, interaction with the Web can be a challenging task; this is due to poor accessibility, usability, and User eXperience (UX) of websites. Therefore, it is necessary to conduct a thorough investigation on the UX of websites, especially considering new trends on the Web. In this study, we identified, classified, and analyzed 34 906 scientific papers published in the last eight years to show the originality and relevance of investigating the UX of visually impaired and blind users. We considered new Web trends, focusing on Flat Design and Responsive Web Design. We performed a systematic review and selected 1 015 scientific papers that addressed the importance of UX or other issues relevant to UX. In this literature, we found only five articles addressing issues faced by blind or visually impaired users. None of the studies compared the experiences of users who are blind or visually impaired with those of sighted users. Considering the lack of scientific studies that address the impact of new web trends on UX and studies that examine the importance of UX, we concluded that it is original and relevant to investigate the UX of visually impaired, blind, and sighted users on the Web. From our research, it was possible to identify recurrent subjects of research relevant to UX; among them were UX methods applied to mobile, Approach to Agile UX, Usability techniques UX, and Centered Design to User.*

1. Introduction

Websites are fundamental tools for communication, dissemination of information, and services, especially for people with visual impairments. For people with disabilities, the Web is essential for social and professional integration. However, for millions of people around the world, interacting with websites and Web applications is a challenging task. This is due to the poor accessibility, usability, and UX of many websites. Web accessibility can be defined as the users' ability to perceive, understand, navigate, and interact with the information on the Web [Goodhue 1988] [Petrie et al. 2015].

Regarding accessibility, the ISO provides guidance 9241-171 on ergonomics and specifications for accessible software development. This covers issues associated with the design of software accessible to people with a range of physical, sensory, and cognitive abilities; including both those with disabilities and the elderly [ISO 2008].

Another crucial aspect of the Web is usability. The usability can be considered as the degree of conformity between the interface and User perceptions when performing a task [Goodwin 1987]. Therefore, it can be taken as a measure of how well a product can be used by specific users while achieving its objectives with efficiency, effectiveness, and satisfaction [ISO 1998].

The UX is a concept that goes beyond traditional usability, considering users' reactions and feelings. It is a new way of understanding the user response in human–computer interactions. According to the Nielsen Norman group, UX encompasses all aspects of human–computer interaction [Nielsen and Loranger 2007]. It highlights the experiential and affective responses, showing significant and valuable facets of user interaction. It also includes the users' perception of the practical aspects, such as use-fulness, ease of use, and interface efficiency [Nogueira et al. 2017]. The construction and synchronization of attributes that affect the user experience in a particular product, directly influencing behavior and perception, is known as User Experience Design [Unger and Chandler 2012].

A negative UX for visually impaired and blind persons places them at a disad-vantage in the information society, where online tasks are becoming more frequent. The inability to access the Web can have serious socioeconomic consequences, including ris-ing unemployment and the growing dependence on governments who provide little funding for this section of the population [Brophy and Craven 2007]. Unfortunately, the Web is far from fulfilling its potential for serving all users. Many websites are inaccessible and unusable. Even websites that are theoretically accessible generally have poor usability and negative UX for blind users [Aizpurua et al. 2013] [Aizpurua et al. 2015]. The lack of usability and negative user experience can make completing tasks much more expensive. According to [Nielsen and Loranger 2007], when it is possible for the blind to complete a task on a Web interface, people with normal vision perform the same tasks three times faster. A more recent study presented by [Bigham et al. 2007] showed that blind users took 4.5 times longer than sighted users to complete selected tasks.

However, website design has undergone radical change in development and con-struction in recent years [Pastore 2012]. The initial focus of these tools was to provide content like documents from a Web server through a visual interface. Today, there are several aspects that need to be embraced when considering Web design [Pastore 2012]; responsive design for mobile, interactivity, minimalist design, and flat design for ex-ample. These changes can be seen as new trends in webpage design and construction. With the advancement of technology and increased Web access by different device types [Subic et al. 2014], there is a need to conduct thorough research on the UX of visually impaired, blind, and sighted users. For all users, there is an urgent need for investigation into the social and professional aspects of these new forms of transmission of information, services, leisure, learning, work, and social interaction.

The fact that UX is becoming an established research field [Pucillo and Cascini 2014], going beyond usability and accessibility while encompassing various applications, demonstrates the relevance of studies into UX relating to universal access; for example in the design phase of software development for mobile systems (Lean UX). The UX involves users' emotions and is subjective in nature as it is a matter of individual perception and thought.

Additionally, UX is dynamic; it fluctuates due to changing circumstances and new innovations. This makes it suitable for the evaluation of new Web trends. There are two important qualities of UX: the traditional usability of human–computer interaction, balanced with a hedonic and emotional design. In this context, this study aims to identify and analyze the scientific papers published in the last eight years (from January, 2009 to December, 2016) to show the originality and relevance of investigating the experience of blind and visually impaired users relating to new trends on the Web. According to [Nogueira et al. 2017], responsive web design, proposed by Ethan Marcotte, emerged in 2010; thus justifying the temporal choice to conduct this research. This study intends to quantitatively assess UX in order to build some understanding of the most recurrent aspects. We consider the impact of

the lack of scientific studies evaluating UX on new Web trends, and aim to contribute new methods for UX related research.

To achieve this, in section 2, we conduct a literature review on the new Web trends and the user experience. In section 3, we describe the methods used for the systematic review of the literature. In sections 4 and 5, we show the results and discussions on the research data. Finally, in section 6, we come to some conclusions aiming to answer the research questions.

2. New Design Trends on the Web and the User Experience

There is a need for professionals and researchers in Web design and information technology to investigate UX to provide understanding of when and how resources and mechanisms may be best used for websites, in line with new Web trends, to fit the demands of all types of users. As evidence of the necessity of such investigation, consider interactivity on the Web.

Regarding interactivity on the Web, advances in recent years have impacted positively on universal access. Since the emergence of the mouse, we have become used interacting with the Graphical user interface (GUI) of the Web via mouse clicks and scrolling. This is an example of human–computer interaction via an input device. In the last decade, new forms of interactivity emerged, among them touch screen devices. Blind persons can use touch screens if the device provides a nonvisual mode of operation, for example, voice-over on iOS and TalkBack on Android. Hence the question arises: how will other new trends achieve universal access?

In this work, we investigate the UX focusing on two new trends on the Web, Responsive and Flat design. In Responsive design webpages are adaptive, that is the page layout adapts to the screen resolution of the user's device [Subic et al. 2014]. Flat design refers to a style of interface design that eliminates stylistic aspects that give the illusion of three-dimensionality; it focuses instead on a minimalist use of simple elements, typography and flat colors. It is contrasted with Skeuomorphism design [Pratas 2014]. A more detailed description of these techniques is provided in subsections 2.1 and 2.2.

2.1. User Experience

According to [Nagalingam and Ibrahim 2015], UX has several facets, including the us-ability of hedonic resources, measuring emotions, and the users' experience in Web in-teractions. Consequently, the UX also includes cognitive aspects of the emotional and usability design. These cognitive aspects, or the distributed cognition, occur in the in-teractions between technology and the user, and reflect the particulars of the tool in use [Lallemand et al. 2015].

The UX is a dynamic process that changes over time and influenced by usabil-ity, accessibility, and hedonic and affective design [Zaharias and Mehlenbacher 2012] [Carneiro et al. 2015] [Zaharias and Mehlenbacher 2012].Usability is a measurable unit of use of a given product by users; its purpose is to allow the searching or evaluation of the effectiveness, efficiency, and satisfaction of users [Lallemand et al. 2015].

The UX is usually employed as a synonym of usability. However, according to [ISO 2009], the UX has a wider meaning, defining the perception and responses that a given user presents towards the use of a product, system, or service. Therefore, the users' internal aspects, such as predispositions, needs, motivations, expectations, and humor [Zaharias and Mehlenbacher 2012], may be classified as pragmatic characteristics of the UX [Law et al. 2009].

According to [Law and Abrahão 2014], through the establishment of a relation-ship between the UX and usability, we may notice that the evaluation methods of us-ability are relatively more mature and consistent in comparison with methods for UX's. Therefore we consider the following premises: a) the methods for UX must be diffuse and malleable; b) must have empirical feedbacks; c) must translate the data inspection and observations in usability problems.

In this sense, through the information analysis of hedonic experience and usabil-ity, we can say that the UX becomes the main strategy for achieving significant rates of usability, encompassing the main pragmatic and subjective characteristics in the interac-tivity of applications [Nagalingam and Ibrahim 2015].

From this perspective, we need to employ new approaches to simultaneously evaluate the usability, accessibility [Brown et al. 2012], and UX in assisting technologies or web applications, especially in new Web trends.

Consequently, studies show that, although usability is directly related to the UX, websites still have a negative UX because human emotions and interaction in different environments are important for achieving a positive UX under emotional, cognitive, and usability aspects [Lallemand et al. 2015] [Nagalingam and Ibrahim 2015]. The UX is in-trinsically related to Usability under the effectiveness and efficiency aspects of the users' interaction with the applications. However, it also encompasses subjective and pragmatic characteristics, for example, the emotions felt by users during their interactions.

2.2. Responsive Design

With the advancement of technology and the rapid evolution of devices experienced in the last decade, anyone can easily browse the web using numerous devices, including: phone, tablet, mobile phone, game console, TV or personal computer [Subic et al. 2014]. Each device has its own screen dimensions and resolution. This is what motivated the professional and scientific community to research the creation of an adaptable design.

The term "*responsive web design*" first appeared in 2010, in a report published on *List Apart* by Ethan Marcotte [Marcotte 2013]. A year later the term became a fad in the construction of web interfaces.

Responsive design can be defined as a way of making the most adaptable websites; that is, websites that can be easily viewed and used on any type of device. For any device, the site will adapt to fit the screen [Peterson 2014]. Figure 1 illustrates interfaces for different Web media [Subic et al. 2014].

Figure 1. Interfaces for different Web media

The development of websites should include practices that increase the chances of the project's success [Peterson 2014]. This means that today there is a need to create designs that respond to the device, an approach that allows application content to adapt easily to any device.

It is possible to create an easy to use application, thus reducing the cost of website development. The following features are known as best practices in responsive design, having an impact on user perception [Subic et al. 2014]:

- In order to make the interface easier to use, the number of layout columns should change according to the user's screen resolution;
- The content offered by the layout should be displayed according to the context, that is, the menus and content should be prioritized based on importance from the user's perspective;
- All images and videos must be resized automatically to the screen display size;
- HTML content, images, CSS and JavaScripts must be loaded in cache to save the use of the user's Internet bandwidth;
- Data synchronization implementation should be invisible to the user, running in the background;
- Spaces among elements such as links should change in width to prevent accidental touches on small devices.

In the last decade, some technologies, such as Flash, have come close to ex-tinction, meanwhile new standards of construction layouts for the web are on the rise; for example, CSS3 and HTML5 [Mohorovicic 2013]. Thus, responsive design utilizes these resources to achieve portability between different devices. Consequently, while the HTML5 structure all content layouts, CSS3 will tell the browser how to interpret it [Peterson 2014].

One of the striking elements of responsive design are Media Queries (Figure 2). Media Queries are attributes that make websites context-aware so that they respond to devices with the appropriate resolution [Peterson 2014]; previously there was no regard of the resolution of the screens when constructing CSS webpages. The CSS Media Queries also allow us to create different styles for different screen dimensions. Thus, a Web page is displayed using the style best suited to the desired dimensions [Subic et al. 2014].

2.3. Flat Design versus Skeuomorphism

There are two widely seen styles of web design, Skeuomorphism and Flat Design. Skeuomorphism, also known as realism, is characterized by an interface designed to match its real-world counterpart [Neil 2014]. This style is characterized by the use of icons that mimic real and tangible objects [Gross et al. 2014].

```
@media only screen and (max-width: 720px){
        .site-logo, .site-nav{float: none;}
        .site-nav li {margin: 0 .5em;}
}

@media only screen and (max-width: 500px){
        html{font-size: 12px;}
}

@media only screen and (max-width: 460px){
        .grid-cell {width: 100%}
}

@media only screen and (max-width: 420px){
        html{font-size: 13px;}
        h1 {font-size: 2.5em;}
}
```

Figure 2. Example of Media Queries

This style is strongly influenced by the interfaces of the 90s, and in the past decade, Skeuomorphism was the key principle of Apple products design. This style was dominant in user interface designs until the resurgence of flat style [Pan and Blevis 2014].

On the other hand, flat design, also known as plan design, is a digital design style that was widely discussed as a trend in 2013, but first appeared in Web design in 2012 [Pratas 2014]. This style is characterized by a minimalist look, focusing on the removal of all components and the extra effects in design [Pratas 2014].

In this respect, the flat design generates more simplistic interfaces, transmitting clear information with a cleaner design, strong, vibrant colors and no depth in the images. Thus, the plan style shown in Figure 3 can also be characterized by the absence of details such as gradients, borders and shadows. The main focus of flat design is the clarity of the information. Therefore this style, with its simplistic look, can seem visually flat, thus exploiting blank space with solid lines that behave like layout elements [Pratas 2014].

It is because of this cleaner look and its impact on user interaction [Pan and Blevis 2014], that the flat design has been widely adopted as a development standard in Web design. Without a doubt, this is now the approach adopted by most designers in the construction of website layouts [Pratas 2014]. The flat design provides an opportunity to create simple webpages that look good.

Figure 3. Example of interface in flat design style. Federal University of Alagoas (UFAL)

However, it appears there is a gap in the user experience of these new Web design trends. In section 3 we present a detailed systematic review that confirms this hypothesis.

3. Systematic Literature Review

This Systematic Literature Review was based on the approach proposed by [Keele et al. 2007] in the process of planning, executing, identifying, and extracting the data. We focused on scientific articles published in the last eight years, from January, 2009 to December, 2016. Thus, a systematic review of the literature provides a method by which we can identify, evaluate and interpret the relevant searches available for a given research question [Keele et al. 2007].

To guide the research, we designed the following questions:

- Q01 - In the existing literature can we identify the differences and similarities between the experience of blind/visually-impaired, and sighted users of new Web trends?
- Q02 - In the existing literature can we understand the relevance of the study to the user experience of new Web trends to blind/visually-impaired and sighted users?

In order to perform a literature search, the results were classified as answers to Q01 and Q02, each reference included in this review was grouped into one of the categories shown in Figure 4. These categories can reveal objective results that are extracted directly from the studies as well as subjective results, which are obtained from these categories through the analysis and conclusions of the reviewer.

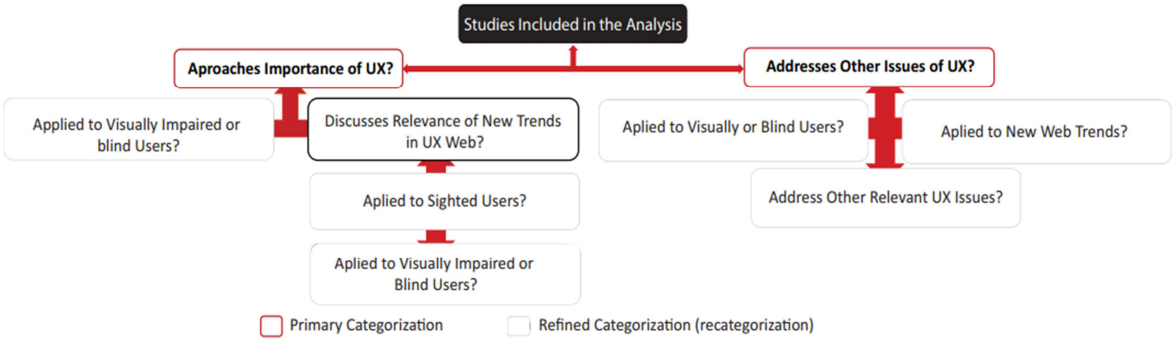


Figure 4. Hierarchical classification of UX categories

The studies included in the analysis of the articles were grouped as follows:

- G01 - The work addresses the relevance of UX to new trends on the Web;
- G02 - The work addresses the relevance of UX applied to visually impaired or blind users;
- G03 - The work addresses the relevance of UX to new trends on the Web applied to sighted users;
- G04 - The work addresses the relevance of UX on new trends on the Web applied to visually impaired or blind users;
- G05 – The work addresses other UX issues applied to visually impaired or blind users;
- G06 – The work addresses other UX issues applied to new trends on the Web;
- G07 – The work addresses other issues relevant to UX.

This classification was performed when the keywords and abstracts of articles were visible during the execution protocol, or made available through a careful reading to find such a classification. For example, items returned without abstract but which had key words relating to UX, required a more careful reading of the article to find new approaches to examine the importance of UX, new trends on the Web, or issues that address the UX applied to the blind or visually impaired.

In the following subsections, we approach the methodology used for the planning, identification, selection, and extraction of results found in the systematic literature review in detail.

3.1. Planning of the Systematic Review

In this section, we discuss the construction of the research protocol, the selection of sources, and selection criteria used to identify studies in the literature.

3.1.1 Search String

In order to guide the search for existing evidence in the literature, we considered the research questions and extracted some keywords for the elaboration of a set of three pro-tocols:

P1 - (*User Experience* AND *UX*);

P2 - ("*User Experience*" OR "*UX*");

P3 - ("*Web*" AND ("*Blind*" OR "*Visually Impaired*" OR "*Sighted Users*") AND ("*User*

Experience" OR "*UX*"));

P4 – ("*Web*" AND ("*Blind*" OR "*Visually Impaired*" OR "*Sighted Users*") AND ("*User Experience*" OR "*UX*") AND ("*Skeuomorphism Design*" OR "*Flat Design*" OR "*Responsive Web Design*" OR "*Responsive Design*")).

These protocols can be adapted according to the search engine of each source.

3.1.2 Sources Search

The research was conducted between November 2014 and January 2015, focusing on the following basis: IEEE Xplore Digital Library; Scopus; Science Direct; Springer; Google Scholar.

The search was set to find results in the English language because it is the standard language for international publications.

The ACM Digital Library base was not included in the search bases, however, it was noted that the articles that were indexed in the google scholar base, were also indexed in the ACM Digital Library base. Thus, there were no losses in the analyzes of this systematic review.

3.1.3 Selection Criteria

After the construction of the search protocol and the choice of sources for the research to focus on, the results are analyzed in order to decide their relevance. For this primary categorization of the studies, we adopted the following inclusion criteria:

(i) Scientific studies that address the importance of UX;

(ii) Scientific studies addressing other UX issues;

(iii) Scientific studies published in Journals, Magazines, and Conferences.

It was also necessary to set up criteria for the exclusion of articles so the following criteria were adopted:

(i) Scientific studies which address only usability and accessibility issues outside the UX context;

(ii) Scientific studies that address issues on UX on unrelated products HCI or Computer;

(iii) scientific studies that do not address issues about UX;

(iv) Scientific studies containing keywords like "UX" and "User Experience", but is out of this research context not addressing new trends on the Web.

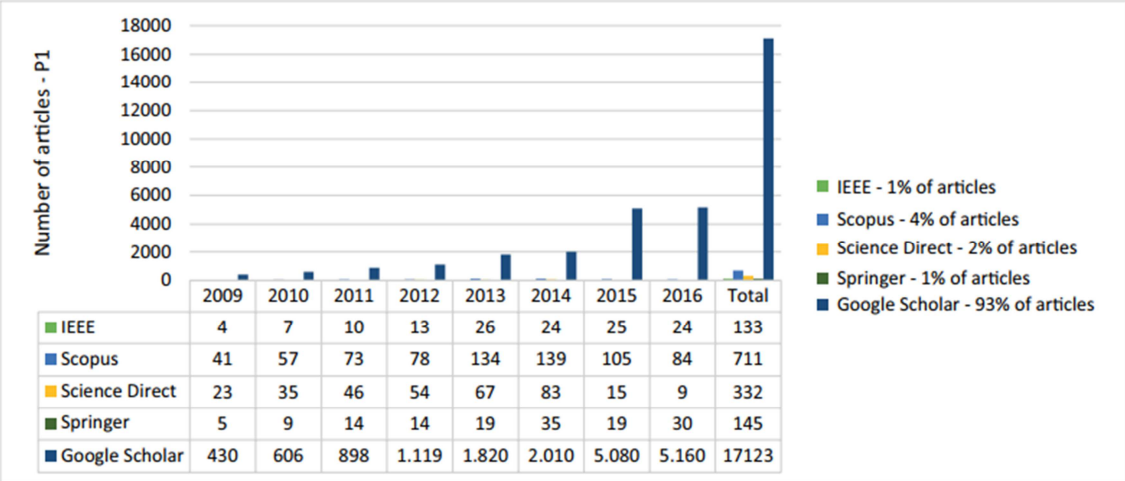
3.2. Identification of Study

The search was divided into four parts (E1, E2, E3, and E4) in order to find studies re-quired to answer the research questions (Q01 and Q02). Searches were divided according to the protocols P1, P2, P3 and P4. The executions and resulting graphs are explained in the following subsections.

3.2.1 First Execution (E1)

After defining the search strings discussed in subsection 3.1.1, we carried out the execu-tion of the P1 protocol, separating it by research source (subsection 3.1.2). The search was executed temporally, that is to say, the results of studies were separated by year of publication (2009 to 2016) as shown in Figure 5.

Running the P1 protocol for the first round returned 18 444 references; of these 133 articles were from IEEE Xplore Digital Library, 711 from Scopus, 332 from Science Direct, 145 from Springer, and 17 123 from Google Scholar (Figure 5).



	2009	2010	2011	2012	2013	2014	2015	2016	Total
IEEE	4	7	10	13	26	24	25	24	133
Scopus	41	57	73	78	134	139	105	84	711
Science Direct	23	35	46	54	67	83	15	9	332
Springer	5	9	14	14	19	35	19	30	145
Google Scholar	430	606	898	1.119	1.820	2.010	5.080	5.160	17123

Figure 5. P1 protocol output for the year of publication of articles

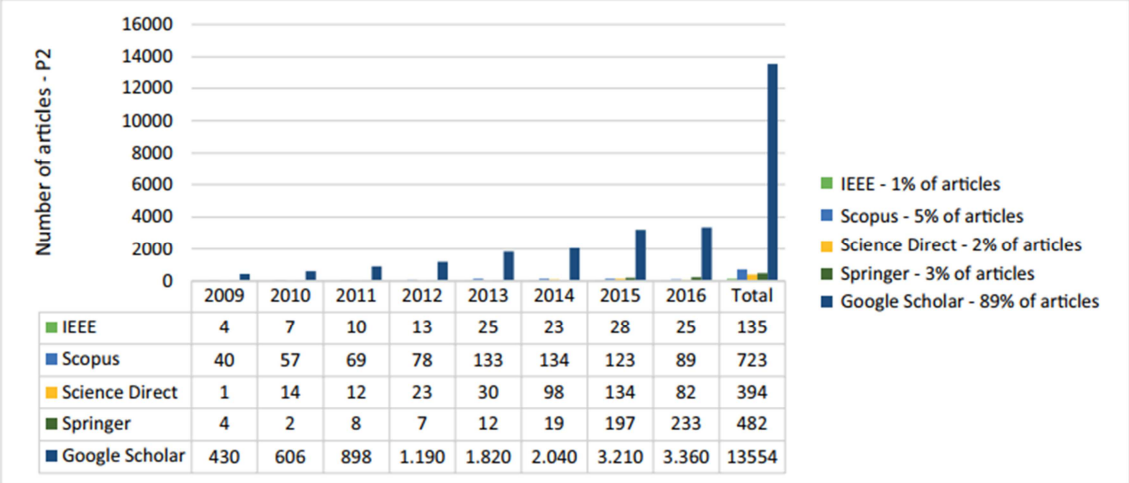
We noticed the high percentage of publications found on Google Scholar, approximately 93% of the total number of publications. Following this, we found that in the selection stage this index would decrease, since the vast majority of other research sources (IEEE, Scopus, Springer and Science Direct) are also indexed by Google Scholar, implying the presence of duplicate works, or works rejected by the criteria set out in subsection 3.1.3.

3.2.2 Second Execution (E2)

When running E2, we wished to carry out the search refinement of execution (E1). Even so, we use the P2 protocol respecting the same criteria as the first execution (E1). Figure 6 shows the results of this implementation with studies separated by the year of publication.

Running the P2 protocol for the second round returned 15 288 references; of which 135 articles were from IEEE Xplore Digital Library basis, 723 from Scopus, 394 from Science Direct, 482 from Springer, and 13 554 from Google Scholar (Figure 6). We noticed a decrease of approximately 17.2% on the findings in relation to the results of E1 execution, but this percentage did not affect the final results of the P2 protocol.

We conclude that E2 was very effective in implementation P1 protocol limiting, since most studies found in E2 execution may be contained in the results of execution E1, thus having duplicate studies. Figure 6 shows the results of the search execution by E2 source with its respective percentage.

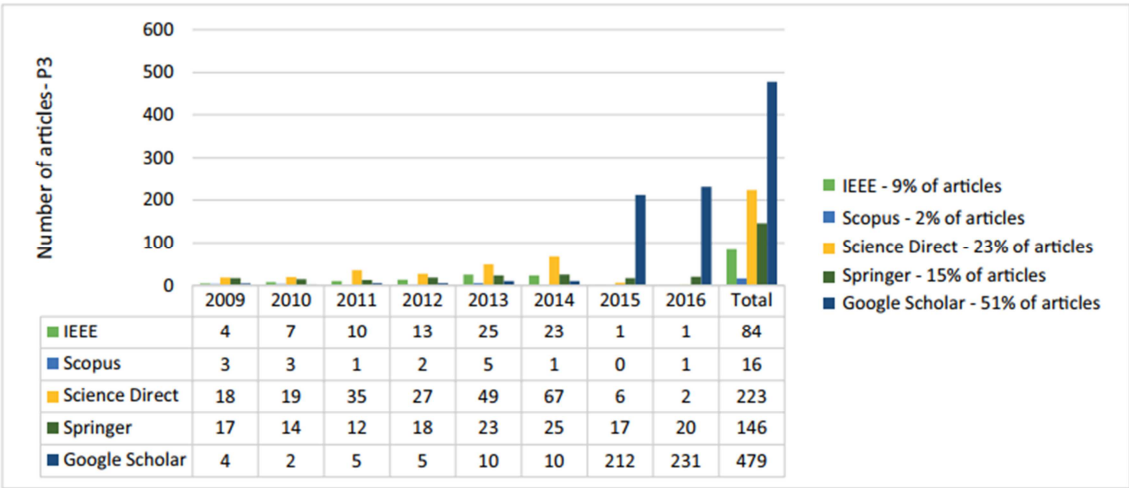


	2009	2010	2011	2012	2013	2014	2015	2016	Total
IEEE	4	7	10	13	25	23	28	25	135
Scopus	40	57	69	78	133	134	123	89	723
Science Direct	1	14	12	23	30	98	134	82	394
Springer	4	2	8	7	12	19	197	233	482
Google Scholar	430	606	898	1.190	1.820	2.040	3.210	3.360	13554

Figure 6. P2 protocol execution for the year of publication of the articles

3.2.3 Third Execution (E3)

At execution E3, we aimed conduct a thorough search of the results, aligning the studies UX and Web Accessibility. Even so, we used P3 protocol respecting the same criteria as the first execution (E1). Figure 7 shows the results of this execution.



	2009	2010	2011	2012	2013	2014	2015	2016	Total
IEEE	4	7	10	13	25	23	1	1	84
Scopus	3	3	1	2	5	1	0	1	16
Science Direct	18	19	35	27	49	67	6	2	223
Springer	17	14	12	18	23	25	17	20	146
Google Scholar	4	2	5	5	10	10	212	231	479

Figure 7. Results of the implementation of P3 protocol by year of publication of the articles

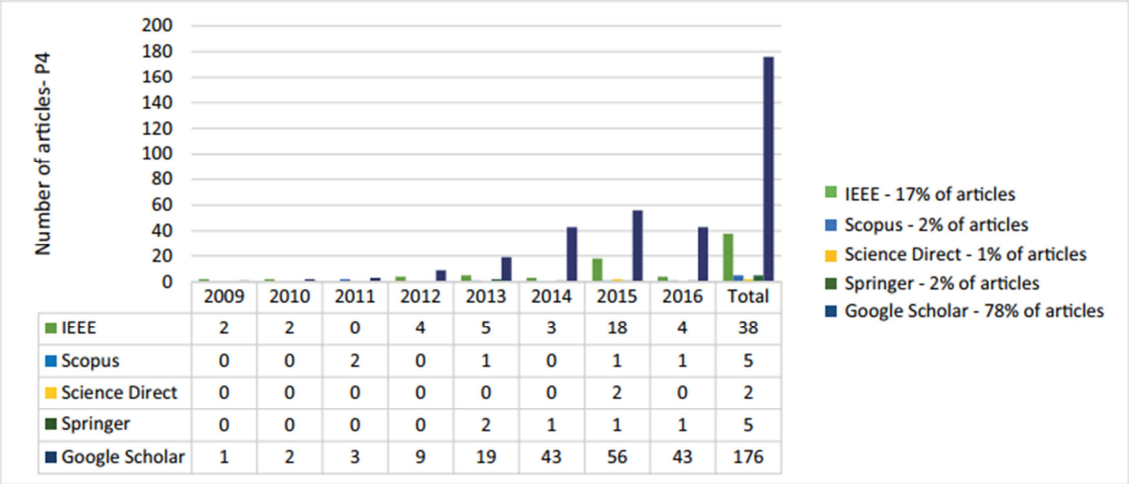
Running the P3 protocol in the third round returned 948 references were; of which 84 articles were from IEEE Xplore Digital Library, 16 from Scopus, 223 from Science Direct, 146 from Springer, and 479 from Google Scholar.

In this round, we noticed that there was a decrease of approximately 89% in the findings in relation to the results of E2 execution. Thus, we conclude that the E3 implementation achieved greater efficiency in relation to the definition of the P2 protocol, bringing results that approximate the Q01 and Q02 issues. Figure 7 shows the results of running E3 by search source with their respective percentage.

3.2.4 Fourth Execution (E4)

At execution E4, we had the objective of conducting a thorough search of the results, aligning the studies relating to UX, Web Accessibility, Flat Design, Skeuomorphic De-sign, and

Responsive Web Design. Even so, we use P4 protocol respecting the same criteria as the first execution (E1). Figure 8 shows the results of this execution.



	2009	2010	2011	2012	2013	2014	2015	2016	Total
IEEE	2	2	0	4	5	3	18	4	38
Scopus	0	0	2	0	1	0	1	1	5
Science Direct	0	0	0	0	0	0	2	0	2
Springer	0	0	0	0	2	1	1	1	5
Google Scholar	1	2	3	9	19	43	56	43	176

Figure 8. Results of the implementation of P4 protocol by year of publication of the articles

Running the P4 protocol in the Fourth round returned 226 references; of which 38 articles were from IEEE Xplore Digital Library, 05 from Scopus, 02 from Science Direct, 05 from Springer, and 176 from Google Scholar.

In this round, it is noticed that there was a decrease of approximately 76% on the findings in relation to the results of E3 execution. Thus, we conclude that the E4 implementation achieved greater efficiency in relation to the definition of the P3 protocol, returning results that approximate the Q01 and Q02 issues. Figure 8 shows the results of running E4 by search source with their respective percentage.

3.3. Selection of Studies

The purpose of the selection of studies was to conduct a primary categorization of the results of the identification of studies by applying the inclusion and exclusion criteria listed in subsection 3.1.3. This primary categorization focused on the final results of executions E1, E2, E3, and E4. Table 1 shows the results of the identification of quantitative studies (subsection 3.2) performed by the protocols P1, P2, P3, and P4.

Table 1. Total articles identified in the search

	2009	2010	2011	2012	2013	2014	2015	2016	Total
P1	503	714	1.041	1.278	2.066	2.291	5.244	5.307	18.444
P2	479	686	997	1.311	2.020	2.314	3.692	3.789	15.288
P3	46	45	63	65	112	126	236	255	948
P4	3	4	5	13	27	47	78	49	226

From the results of implementing the protocols P1, P2, P3, and P4, we have a total of 34 906 items, the results were analyzed by applying the criteria of inclusion and exclusion described in Subsection 3.1.3. Three more categories were also created to carry out the classification of the results:

(i) Duplicate articles;

(ii) Discarded items (using exclusion criteria);

(iii) Accepted papers (using the inclusion criteria).

Analysis of the papers was carried out considering the period and source of re-search; for each execution we selected a set of articles by year of publication (2009-2016), thereby accounting for the analysis period. The selection was made through a careful reading of the content of the abstracts, titles, and keywords of the articles. Some articles demanded a deeper reading in order to find the aspects listed in the classification criteria. For better explanation, the following subsections present the form and results of selecting the identification of the studies found with the implementation of the protocols.

3.3.1 Exclusion of Duplicate Studies

The exclusion of duplicate articles was performed in an automated manner with the sup-port of software designed for assistance in conducting systematic reviews (Start Tool). The Start Tool software was created by the Research Laboratory in Software Engineer-ing (LaPES) of the Department of Computing at the Federal University of São Carlos (DC/UFSCar) [UFSCar 2015]. Table 2 shows the number of articles that have been found with status “duplicate” in the search.

Table 2. Total duplicates articles in the research

Period								Total
2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
561	913	1.307	1.776	2.570	2.797	4.387	4.252	18.563

As shown in Table 2, 18 563 duplicate articles were found in rounds E1, E2, E3, and, E4 of the identification phase of the study. This represents approximately 53% of the total number of articles investigated in this study. The high duplication of articles content is explained by the large number of articles found in executions E1, E2, E3, and E4 on Google Scholar that indexed the articles found in other the research sources: IEEE, Scopus, Science Direct, and Springer.

3.3.2 Exclusion of Studies

For this analysis and classification, in addition to using the Start Tool software discussed in subsection 3.3.1, the papers were carefully read to find the elements necessary for classification. These elements, such as abstract, title, keywords, and content, were classified using the criteria of selection and exclusion discussed in subsection 3.1.3.

Table 3. Total discarded items in the search

Period								Total
2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
408	464	710	805	1.375	1.590	4.828	5.148	15.328

Table 3 shows that 34 906 articles were analyzed in rounds E1, E2, E3, and E4 resulting from the identification phase of the studies where 15 328 articles were rejected for not satisfying the inclusion criteria listed in this research. We understand that this percentage of articles, approximately 44% rejected, was due to the fact that UX is multi-disciplinary and

can therefore be included in several studies that have no relationship with HCI [Subic et al. 2014].

3.3.3 Studies Accepted

We adopt the same method of analysis applied in subsection 3.3.2 for the inclusion of the accepted studies in the research. We used the inclusion criteria (subsection 3.1.3) to perform this analysis and classification.

This classification supports the method of primary categorization of articles ac-cepted in the research and represented in Figure 4 (rank classification of UX categories). Table 4 shows the number of articles that were analyzed and classified with status “ac-cepted”.

Table 4. Total articles accepted in the research

Period								Total
2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
62	72	89	86	280	391	35	0	1.015

As shown in Table 4, in of the identification phase 1 015 articles were accepted through the application of the selection criteria in rounds E1, E2, E3, and E4. These articles were classified as “accepted” for achieving the inclusion criteria listed in this research.

4. Results

In this section, we will realize the extraction of the data collected and classified for the accepted studies in subsection 3.3.3. We seek to conduct the evaluation and summarization of articles already classified using the following primary categories (Figure 4):

I. The work addresses the importance of UX;

II. The work addresses other UX issues. For the realization of this extraction, the articles are read in full.

After extraction and primary categorization new sub-categorizations are intro-duced, aiming to identify and analyze scientific studies to show the originality and rel-evance of investigating the UX of blind users with new trends in Flat and Responsive Design in accessible websites. To this end the following subsection presents the results of extraction and summarization of this research.

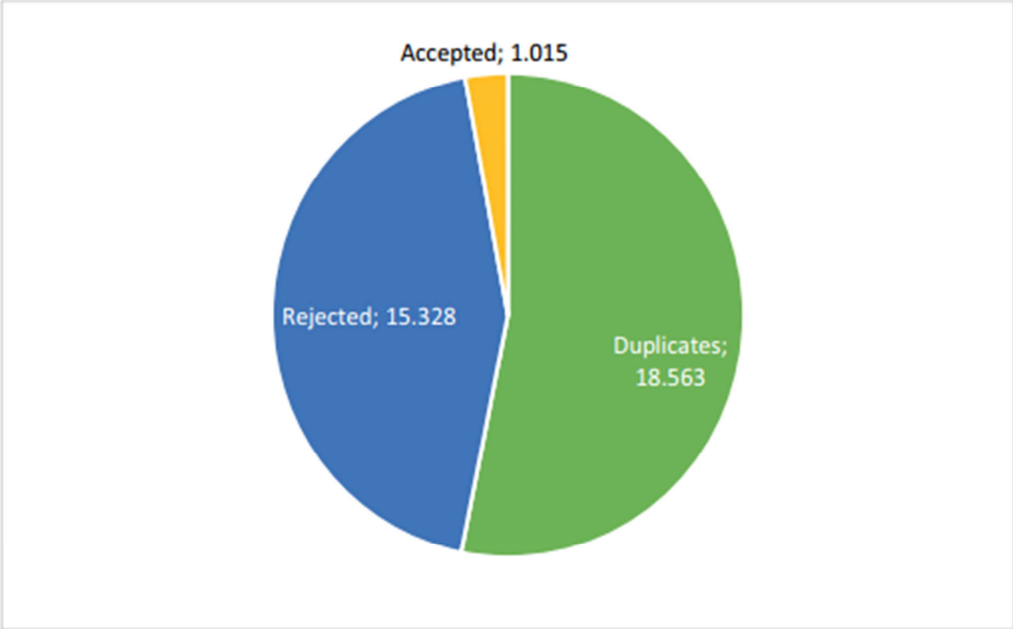


Figure 9. Rating of research articles

Figure 9 shows the number of articles that were analyzed and classified with status "rejected", "duplicate", and "accepted" as presented in Tables 2, 3, and 4.

4.1. Results from Categories I and II

The purpose of the selection of studies was to conduct a primary categorization of the results of the identification of studies by applying the inclusion and exclusion criteria listed in subsection 3.1.3. This primary categorization focused on the final results of executions E1, E2, E3, and E4. Table 1 shows the results of the identification of quantitative studies (subsection 3.2) performed by the protocols P1, P2, P3, and P4.

By means of the classification process performed during the selection phase, we were able to select 2.9% of the total of papers that could be grouped in categories I and II.

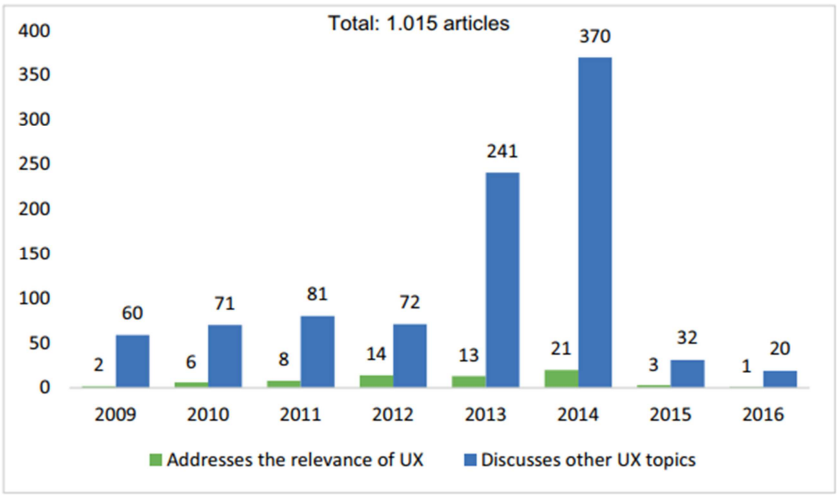


Figure 10. Summary of results from categories I and II

For the articles in category I (the work addresses the importance of UX) the arti-cles were read to verify that they address or justify the importance of UX in Web inter-actions,

specifically relating to new Web trends or applied to blind/visually impaired and Sighted users. Category II (the work addresses other UX issues) contained articles relating to methodologies or techniques applied to new trends in the Web or to blind/visually impaired and sighted users. Initially, we extracted and evaluated 1 015 works. Figure 10 shows the grouping of papers and the total in each category.

The graphic depicted in Figure 10 is a summary of 68 papers grouped in category I, and 947 grouped in category II.

4.1.1 Works that Approach other UX Issues

We found a great number of publications in category II, approximately 93.3% (of the total of papers that discuss other UX issues. Because of this, we decided to apply a refinement process for this category. The following subcategories were used to perform the reclassification:

(i) The studies approach blind or visually impaired users;

(ii) The studies approach new Web trends Flat Design and Responsive Design;

(iii) The studies approach other UX relevant issues (Table 5).

Table 5. Variables to be considered on the evaluation of interaction techniques

Discusses other UX topics	
Reclassification	**Articles**
Addresses other issues UX applied to visually impaired or blind users.	3
UX addresses other issues applied to new trends in the Web.	48
Addresses other issues relevant to UX.	896

Of the 947 articles found in category II, 896discuss other issues related to UX, and 48 relate to new Web trends. We see a lack of studies applied to visually impaired or blind users that address other UX issues. The present research found only 3 articles related to this.

4.1.2 Studies on the UX Relevance

After performing the reclassification of studies addressing other UX issues in category II, we applied the same process of reclassification to the studies in category I. In this category, we extracted 68 articles refined using the following subcategories:

(i) Discusses the importance of UX on new trends on the Web;

(ii) Studies on the relevance of UX in new Web trends applied to visually impaired or blind users;

(iii) Studies on the relevance of UX in new Web trends applied to sighted users;

(iv) Studies on the relevance of UX for the visually impaired or blind users (Table 6).

Table 6. Variables to be considered on the evaluation of interaction techniques

Addresses the relevance of UX	
Reclassification	**Articles**
Discusses the importance of UX on new trends on the Web.	62
Discusses the importance of UX applied to visually impaired or blind users.	2
Discusses the importance of UX on new trends in Web applied to the sighted users.	4
Discusses the importance of UX on new trends in Web applied to visually impaired or blind users.	0

Of the 68 articles in category I, 02 are studies that address the importance of UX for visually impaired or blind users. The other 66 items were reclassified in the subcategories (i) and (iii). We note that the vast majority, approximately 97%, of the articles contemplated the relevance of UX, but did not address the relevance of UX in new Web trends applied to visually impaired or blind users nor the relevance of UX in new Web trends applied to sighted users.

5. Discussion

The extraction and analysis permitted the subcategorization and grouping of the results, with the aim of identifying and analyzing scientific studies published in the last eight years in order to show the originality and relevance of investigating the UX of new trends on the Web by blind user/visually people. This systematic review allowed the construction of a relevant view of the relevant aspects of UX. In this sense, the results considered subcategories that were created by extracting the terms of questions Q1 and Q2 of the research.

The first question Q1 (In the existing literature can we identify the differences and similarities between the experience of blind/visually-impaired, and sighted users of new Web trends?) was addressed because we had the intention to find UX cases that addressed some of the aspects listed in section 2 (new design trends in the Web and UX). To this end, we found and analyzed articles that involve the following items:

i) Articles that addressed other aspects of UX applied the visually impaired or blind users (3 items);

ii) Articles that addressed other issues UX applied to new web trends (48 articles);

iii) Articles that addressed other UX issue (896 articles).

We found that approximately 97% of all articles classified after the analysis of relevance addressed other UX issues: UX methods applied to mobile (LeanUX); approach to Agile UX; UX measurement in Web services; usability techniques UX; UX measures applied to gamification; user centered design for UX; UX, products and software industry (organizational models).

We found three articles UX studies related to visually impaired or blind users [Yesilada et al. 2015], [Youngblood and Youngblood 2013], and [Yesilada et al. 2012], but was there were no studies comparing the UX between blind and sighted users. No studies

involving UX of blind users and new Web trends were found.

From the perspective of works that approach other UX aspects applied to blind or visually impaired users, one of the greatest difficulties for accessibility on the Web is the nonexistence of a universal agreement on the terms employed in accessibility and UX [Yesilada et al. 2012] [Yesilada et al. 2015]. Therefore, through the use of questionnaires with experts, we can promote Web accessibility as a research field, favoring a shared understanding, correlating accessibility with UX and usability [Yesilada et al. 2012].

Website Usability is another important aspect in blind and visually impaired UX [Youngblood and Youngblood 2013]. Therefore, with usability heuristics, we can mea-sure the application conformity level, changing the blind user experience in mobile de-vices into something positive, specifically, in Responsive Web Design. By studying the accessibility of websites, we can use an accessibility checker, for example WebAIM, and an HTML/CSS code validator provided by World Wide Web Consortium (W3C) [Youngblood and Youngblood 2013].

Consequently, accessibility and usability are highly related, from which accessi-bility is applicable to everyone. According to [Yesilada et al. 2015], these notions are important for usability and to UX professionals, accessibility evaluation automatized tool developers, and experts that perform such evaluations.

The second question Q2 (In the existing literature can we understand the relevance of the study to the user experience of new Web trends to blind/visually-impaired and sighted users?) began with the intention of finding UX works addressing the relevance of an investigation the UX applied to the aspects listed in section 2 (new design trends in web and UX). With this in mind, we classified and analyzed 68 articles, of which only two addressed the relevance of UX applied to blind or visually impaired users (Web Accessibility): [Haanpera and Nieminen 2013] and [Bose and Jurgensen 2014]. Most of the articles in this category addressed the relevance of investigating the UX, but not related to new trends in the Web applied to visually impaired or blind users.

According to [Haanpera and Nieminen 2013], in spite of improvements in web accessibility directives and accessibility technologies, web search interfaces still do not represent good usability for blind or visually impaired users, increasing the relevance of accessibility issue research from the usability and UX angle.

Therefore, through the extraction and analysis of the literature, it was not possible to know what differences and similarities there are in the user experience of new trends in the Web between blind and sighted users. However, it was possible to identify the relevance of a study of the UX of blind and visually impaired users, and that the investigation of this aspect, relating to new trends on the Web (Flat Design and Design Responsive) with blind and sighted users, is still an area of UX research to be investigated.

6. Conclusion

In this work, we identified 34 906 articles on UX, analyzing and sorting them according to inclusion and exclusion criteria, investigating the impact of new Web trends in the blind, visually impaired, and sighted UX. The review aimed to answer two research questions, Q1 and Q2, through a careful analysis of the identified, extracted, and categorized studies.

By means of categorization of the search results, studies on the relevance of UX, or studies on other UX issues, allowed us to partially answer question Q1 (In the exist-ing literature can we identify the differences and similarities between the experience of

blind/visually-impaired, and sighted users of new Web trends?) and Q2 (In the existing literature can we understand the relevance of the study to the user experience of new Web trends to blind/visually-impaired and sighted users?). In this sense, the hypothesis raised in the introduction was confirmed by the absence of scientific studies that assess the impact of new web trends in UX, which demonstrates the originality and relevance of investigating the blind and visually impaired UX of new trends on the Web.

Therefore, this work contributes positively to the opening up of new paths in UX research, highlighting the importance of further studies correlating the three important and current Web perspectives: Web accessibility, UX, and new Web trends.

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