

# Evaluation of Web Accessibility: an Approach Related to Functional Illiteracy

## Abstract

Functionally illiterate users, that means those lacking reading, writing, calculation and science skills, are potential Internet users, so technological solutions must ensure that content is intelligible to them. The interface design guided by accessibility norms and may improve accessibility, but considering accessibility evaluations is an essential part of this process. Evaluation can be automatic, performed by specialists or performed with the participation of users. Some barriers are only detected with user tests. Usually, usability tests are adapted and performed with the purpose of evaluating accessibility, but most of works in this area dealt with persons with visual impairment. This paper aimed to research the behavior of functionally illiterate users, identifying important characteristics that the evaluators and specialists should consider in the performance of an evaluation of accessibility with this audience. As a result was generated a list of important characteristics that contribute to the adaptation of usability evaluation methods with functionally illiterate users. Besides that, it was elaborated a list of best strategies that the specialists and researchers should consider in accessibility evaluation with the audience under examination.

Keywords: Functional Illiteracy, Evaluation, Accessibility Recommendations, Social Inclusion;

## 1. Introduction

Access to quality information, an essential requirement so that an organization can make effective use of its resources and so that people can perform various activities, is one of the factors responsible for the information technology market and the steady growth of the use of the Internet [19] [28]. Recognizing this growing market, organizations have started the development of web-based information system. Facing this, the Brazilian Government has invested in the quality of information of their portals, which offer services to help people in solving problems when dealing with public organizations [6] [7].

Since the interaction with each one of these systems is a particular process which requires a certain level of learned skills [12] [21] and so that the Brazilian population is able to exploit on-line services, there should be no barriers preventing them from interacting with the websites [18] [24] [27]. In order to make the site accessible it is necessary to remove the barriers preventing some groups of people of becoming aware of, understanding and enjoying all the computation help offered by web systems [18] [24] [27].

Some of the barriers that can mainly affect that part of the population with reading and writing deficiencies, the so-called functional illiterates, are the structure and wording of the text in front of them [5]. Therefore the development of web pages should follow some accessibility recommendations, so that functional illiterate persons are presented clear and objective information [5] considering that this group represents 21% of the Brazilian population [15]. And in order to develop interfaces accessible to the functionally illiterate it is necessary to consider accessibility norms and guidelines when designing the site interface [12].

In order to verify whether people with deficiencies or limitations are able to access the sites and perform the tasks demanded or offered by these sites, it is necessary to evaluate these sites' accessibility, which can be done in an automated fashion with the help of accessibility validating software, as well as through evaluations performed with the participations of users of different profiles. However, little research has been done dealing with the involvement of the functional illiterate in these evaluations [3] [8] [9] [21] [30].

The present study, of an exploratory character, was intended to study the behavior and the human-computer relationship of functionally illiterate people with the web pages, in order to contribute to the development of the necessary protocols to perform accessibility evaluations with the participation of the functionally illiterate. It is important to mention that the main focus of this research is the protocols for accessibility evaluations and not the results (barriers of accessibility) of the evaluations made during the study.

## 2. Functional Illiteracy

In the context of web pages, it is important to consider the functional illiterates as potential users and offer affordable solutions to them [22], to ensure that the web page contents can be easily understood [5] [26].

The United Nations Educational, Scientific and Cultural Organization (UNESCO) considers as functionally illiterate, persons lacking in reading, writing, calculation and science skills, whose level of schooling is equivalent to less than four years of school attendance. This classification, adopted by the National Institute of Education Studies and Research Anísio Teixeira (INEP) and the Brazilian Institute of Geography and Statistics (IBGE) was utilized in the present study [15] [16].

## 3. Web Accessibility Evaluation with User Participation

Web accessibility is characterized by people being able to use the Internet regardless of their physical-motor, perceptual, cultural and social capabilities [18] [22] [28].

One way to provide web accessibility is by evaluation based on observations made by persons, which includes the participation of experts and/or users with disabilities or limitations [7]. However, researchers and experts face some difficulties in these evaluations, especially with regard to evaluation methods that deal with the context of skills related to reading and writing [8] [9] [10] [17], since the literature discusses in more depth evaluation with users with visual impairments [1] [2] [11] [13].

The researched literature shows that scholars propose the use of evaluation methods for usability with a focus on accessibility, based on adapted protocols. However, they do not specify how such adjustments should be made [13] [12] [30]. Among the usability methods surveyed, "usability testing" is found, whose process involves a portion of the public to whom the system is intended [4] [23] [25].

The activities of this method were condensed in this research, in order to present most comprehensive reference:

**1. Test Planning:** this activity is essential to conduct test so that it is adequately conducted and that it may yield useful and trustworthy results [4], besides allowing the identification of the necessary costs for test execution [23]. The following tasks are performed in this activity: describing the test's purpose and objective; defining the participants' characteristics; describing the method to be followed; listing the necessary tasks for the test; describing the environment and equipments; making the evaluator's role clear; listing which data will be collected; describing how the results will be reported [4] [23] [25].

**2. Test Preparation:** preparation is the activity that ensures that all elements necessary for the performance of the tests are organized [23]. The following tasks will be performed in this activity: defining the environment where the test will be done; finding and recruiting users; preparing a schedule for orientation; preparing the data collection instruments; drafting the questionnaires and the interviews; defining the task scenarios; executing the pilot test [4] [23] [25].

**3. Test Performance:** it is when the test is actually executed that the participant interacts with interfaces and is observed by the evaluator [23]. The following tasks take place in this activity: a presentation about how the test will be conducted; observation and recording of the proceedings; interviewing the participant after test ends [4] [23] [25].

**4. Information Analysis and Recording:** in this phase the checking and verification of the information collected in the executed evaluation takes place [23]. It also includes the tasks of gathering and consolidating this information [4] [23] [25].

### a. Related Works

This article has identified a number of proposals based on methods used in usability evaluation with the participation of users, in order to evaluate the accessibility of web pages. They are:

- A technique of qualitative and subjective evaluation of accessibility and usability [1]. This technique is based on the statements of participants and on the audio of screen readers used by visually impaired users to characterize the problems.
- Recommendations for accessibility evaluations with the methods utilized by persons involved in web projects [2]. This studied assessed the pros and cons of some accessibility evaluations methods. Afterwards, a list of

recommendation for the evaluation of web accessibility for the visually impaired was developed.

- A guide of best practices of evaluation of web accessibility with the participation of visually impaired persons [11]. This guide recommends that before performing the evaluation with the users, other evaluations such as heuristic evaluation be performed. The guide also makes recommendations on how to evaluate accessibility with visually impaired persons.
- A formal evaluation of usability with focus on accessibility [13]. This proposal describes the necessary steps during a usability test with the participation of visually impaired persons in the development process of a system.

#### **4. Research Method**

This present study, of exploratory research, was based on the qualitative method of data collection consisting of four steps, described below:

**1. Selection of the profile of the users taking part in the research:** it was decided to choose adults who were enrolled up to the fourth grade, according to the UNESCO classification. All participants should have basic knowledge in web browsing.

**2. Performance of an ethnographic study:** an ethnographic study with seven students of a private organization of Education of Youth and Adults (EJA, in the Portuguese acronym) lasting 45 days, was performed to find out about the behavior of the selected public and analyze their interaction with the computer.

**3. Performance of a case study which consisted in analyzing functionally illiterate persons:** this phase is described in detail in section 6.

**4. Validation of the protocols:** based on the results obtained in the previous steps, protocols were developed. These protocols were assessed, through evaluations with functionally illiterates done by specialists in web accessibility.

##### **a. Limitations**

The first limitation was due to the fact that it was necessary to categorize the users making up the object of the study. In reality, web accessibility is a theme that has to look at different situations, whereby characteristics of use have to be considered during web page development. However the focus of the present study was aimed at persons with limitations in their reading and writing skills.

#### **5. Ethnographic Study Results**

In addition to literacy classes, computer classes were also part of the syllabus of the institution. At the end of this study, the observations were grouped and analyzed according to four approaches described in the following subsections.

##### **a. Observations of the Students Characteristics**

The seven students who were tracked were not enrolled in a particular grade, because the classes they attended were for people of any school level, including the illiterate. Socially these were students with low purchasing power, all of them living in poor communities near the institution. Some worked in strenuous jobs which restricted the time they would have available for study, besides getting no incentive from their employers.

##### **b. Observations Made During Literacy Classes**

Besides the difficulties related to scoring, to compounds and to values with digits above hundred, unfamiliar words and those in languages other than Portuguese were also limiting factors.

The students copied everything the teacher wrote on the board and were embarrassed when making spelling errors. In the case of writing, their visual understanding was higher than their auditive understanding, which can result from the fact that they were paying more attention to what was written on the board. The teacher would read together with the students (shared reading), explaining those words which would be too complex for the students, using everyday

words.

It was noticed that some students had trouble interpreting what was explained through examples. The use of images and photos helped to explain some subjects and helped in the draft of texts. Some students enjoyed talking about significant dates and their personal life, which allowed the teaching of history and geography, utilizing their own life story as an introduction to these disciplines.

### **c. Observations Made During Information Technology Courses**

The IT classes covered spreadsheets, text editors and the Internet. All students had e-mail accounts and were used in exchanging messages which helped the improvement of reading and writing texts. Students also conducted research on sites looking for information and videos.

It was noticeable that they felt well when they finished their activities. They did not give up on the teacher's help in executing their tasks. They did not hesitate in asking questions to the teacher to help completing their activities, especially questions related to reading and writing. This group of users is slow in browsing the screen because they read everything that appears on it.

### **d. Observations Made During Informal Conversations with the Teachers**

According to the literacy teacher, reading and writing can be a great difficulty to adults who spent their whole life dealing only with the spoken word. But talking to them about this difficulty is part of the literacy process. In addition, in these students' understanding, an illiterate person is responsible for Brazil's underdevelopment. Therefore, it was not advisable to call them "functionally illiterate".

The teacher also explained that even texts written on a basic level, are not understood by students. There may be terms which confuse them, leading to helplessness. She recommended explaining the written text through shared reading.

According to the IT teacher one should not use words infantilizing adult students such as "the little arrow of the mouse". It is important to treat them so they don't feel inferior to more literate persons.

## **6. Case Study Results**

The case study was divided into two stages:

**1. Evaluation with users who were not functionally illiterate:** this evaluation was made in order to adjust the stages related to the evaluations with the functionally illiterate;

**2. Evaluation with functionally illiterate users:** this evaluation was made to determine how this group participates in the evaluation accessibility process.

The results of these two stages are described in sections 6.1 and 6.2.

### **a. Evaluations with Users Who Are Not Functionally Illiterate (Stage 1)**

Considering the information gathered in the ethnographic study and in order to obtain new data that could be generated in a user evaluation with functionally illiterate users, evaluations with users who were not functionally illiterate were performed, as shown in Figure 1. As representative users, two participants in the teaching area connected to the functional illiteracy context were chosen, since their experience could provide relevant information to the research.

ENVIRONMENT	PARTICIPANTS CHARACTERISTICS
<b>Controlled context (laboratory)</b>	Participant 1 - male with a college degree in finance, over 5 years experience with the Internet. Occupation: Member of the Armed Forces Participant 2 - female with a Master's degree in education, more than 5 years of experience with the Internet. The user has experience in the education of youth and adults. Occupation: Administrative Assistant

ENVIRONMENT	PARTICIPANTS CHARACTERISTICS
<b>Context of Use (user's work environment)</b>	Participant 1 - male, degree in data processing, over 5 years experience with the Internet. Occupation: Systems Analyst Participant 2 - female with degree in education, more than 5 years of experience with the Internet. The user has experience in the education of youth and adults. Occupation: Secretary and Professor and Information Technology in an Adult Literacy Process

Fig. 1. Characteristics of the Evaluation Participants

The evaluation were based on usability evaluation method called usability test, as it is one of the most available in the literature [4] [23] [25]. In order to undertake the evaluations it became necessary to select sites where the tasks would be executed. The choice was made to use public service portals which offered basic services (social security, labor laws among others) to citizens and which has an accessibility certificate from some automatic validator. The selected sites were the Ministry of Social Security ([www.previdencia.gov.br](http://www.previdencia.gov.br)) and the Ministry of Labor and Employment ([www.mte.gov.br](http://www.mte.gov.br)). Both had grade AAA accessibility certification from DaSilva and XHTML 1.0 and CSS, of the W3C. After the sites were selected, several task scenarios were drafted, The time necessary to complete each task was not limited.

Some documents, like the profile survey questionnaire and the term of consent had their textual content verified and adapted by the Simplifica tool, an application that helps in drafting simplified texts that can be understood by a greater number of readers [29]. Besides this adjustment, the questionnaire was developed based on images and pictures, since research shows that the functionally illiterate are able to better understand the content when graphic resources are used [14].

After the evaluations and the pre-test interviews, some important information could be considered for Stage 2 as shown by Figure 2.

ENVIRONMENT	CONSIDERATIONS
<b>Controlled context (laboratory)</b>	Average completion time: 30 minutes Users voiced their opinions during the tasks (concurrent verbalization technique) There were no interruptions during the evaluation The time for completion of the tasks was not limited
<b>Context of Use (user's work environment)</b>	Average completion time: 50 minutes Scarce voicing of opinions during the tasks (concurrent verbalization technique), which led the evaluator to use the consecutive verbalization technique (information extraction after the completion of tasks, where users were asked to comment about their navigation experience) There were interruptions during the evaluation Time for completion of the tasks was limited so as not to make the evaluation tiresome

Fig. 2. Considerations of the Evaluations with Users Who Are Not Functionally Illiterate

## b. Evaluations with Functionally Illiterate Users (Stage 2)

In this stage the participants were recruited through informal contacts with other researchers, friends and family members. When the evaluation in the user's context or work environment revealed that it can be influenced by other factors, and after two tries of performing the evaluations in a university laboratory, performing the evaluation using a portable laboratory set up in locations near the participants' home or work site appeared as a workable solution. Five individual evaluations were performed according to Figure 3.

PARTICIPANTS CHARACTERISTICS	EVALUATION LOCATION
Participant 1 - female, 32 years, incomplete elementary education, 2-5 years experience with the Internet. Occupation: housewife.	Belford Roxo (residence of a family member of the evaluator)

PARTICIPANTS CHARACTERISTICS	EVALUATION LOCATION
Participant 2 - female, 47 years, incomplete elementary education, 2-5 years experience with the Internet. Occupation: general services assistant.	Belford Roxo (residence of a family member of the evaluator)
Participant 3 - female, 42 years, incomplete elementary education, less than 2 years experience with the Internet. Occupation: general services assistant.	Belford Roxo (residence of a family member of the evaluator)
Participant 4 - male, 27 years, incomplete elementary education, more than 5 years experience with the Internet. Occupation: welder	Belford Roxo (residence of a family member of the evaluator)
Participant 5 - female, 32 years, incomplete elementary education, 2-5 years experience with the Internet. Occupation: housewife	Downtown (evaluator's residence)

Fig. 3. Characteristics of the Evaluation Participants

A Brazilian law 9608 [20] provides that voluntary work cannot be paid. However the same law states that a person can be compensated for expenses related to voluntary activities. Thus an allowance was paid for transportation and food, since these participants were people with low purchasing power.

Before the tests were started, the participants were asked to keep their cell phones and fixed phones turned off, and that only one participant would be present in the evaluation. The evaluator also informally chatted with each participant. The participants talked about their personal lives and why they did not finish the studies. This chat revealed that the users were motivated to participate in the study. The same tasks developed for Stage 1 were used, as they had been adapted and tested. Before each test the participants were asked to browse the pages to become familiar with the sites. Each evaluation took one hour and forty minutes on average.

The survey questionnaire and the term of consent were read in shared reading. During the reading unknown terms were explained and after the reading, the participants were asked to sign the document. The entire reading, including the term of consent was recorded on audio.

The users were also asked to issue their opinions about the navigation during the tasks (concurrent verbalization). Even when asked to comment about the navigation, some participants did not utter opinions. Therefore, only after the tasks had been completed, that, using consecutive verbalization, it became possible to extract important information about browsing. Since the tasks in both portals were executed serially, the comments of participants 1 and 2 were comparisons of one site with the other, which was not the evaluation's objective. In addition, some important points about the navigation, observed by the researchers, were not commented. The consecutive verbalization technique was utilized immediately after the completion of the tasks of each site in the evaluations performed with participants 3, 4 and 5.

The time spent on to execute the tasks (correctly or incorrectly) of participants 1 and 2 took fifteen minutes on average. So that the evaluations did not become tiresome, the researchers set the time of ten minutes for the completion of each task by the other participants, without warning them. After the ten minutes were over, the researcher would ask them whether they would like help, and on a positive answer, would help them complete the tasks. The participants were happy when they completed the tasks.

## 7. Protocols Validation Results

The protocols were defined based on the observations made during the ethnographic study and in the case study. After this definition two specialists in web accessibility, with Master's Degree in Information Technology were invited to perform the evaluations with the functionally illiterate in order to validate the defined protocols. Each guest performed one evaluation.

The evaluations followed the stages of the usability tests and were performed in the absence of the researchers involved in this study, so that they would not influence the evaluations and to check if the tests could be performed by any professional in the area of accessibility. These evaluations lasted eight days, from the presentation of the study objectives until the end of the interviews with the specialists. The evaluations were based on the same public portals and on the same tasks of the case study.

With the support of the validation results, the protocols for evaluations with functionally illiterate users were

developed, as seen in Figure 4.

<b>CONTEXT</b>	<b>PROTOCOLS DESCRIPTION</b>
<b>Call for volunteers</b>	In order to have enough time for the evaluations, participants should be recruited early in the process. If the evaluator chooses schooling as a premise, participants taking part in literacy programs are prime candidates. The Municipal School Boards may be able to help.
<b>Mention to Users</b>	The evaluator should not refer the candidates “functionally illiterate” or even “persons with limitations”. The recommendation is to treat them as “adults in the process of literacy”.
<b>Interpersonal relationships</b>	Before beginning the evaluation, there should be an informal chat about the participants’ personal life and about the use of the Internet, so that they feel more at ease.
<b>Development and implementation of surveys of profiles</b>	So that users do not feel embarrassed about their difficulties, help should be provided in filling out the questionnaire, through shared reading. In addition, the text should be drafted in simple language, which can be done with special software. Images and picture should be used to help in the understanding of some questions.
<b>Drafting and signature of the term of consent</b>	The term of consent should be composed in simple and clear language and should be read in shared fashion, so that unknown terms and the context of the document can be explained and the participants understand what they are signing.
<b>Preparation of the list of tasks</b>	So that the tasks are easily understood, it is important that they represent things connected to the users’ day-to-day experience, with regard to text as well as with Internet browsing. The tasks should be described in a simple and clear language.
<b>Use of recording equipment</b>	In view of the reading difficulty of the functionally illiterate, and to help them in remembering the information related to the tasks, the whole evaluation should be recorded. A good practice to be adopted is to record the navigation done by the user on video, as a way to help the analysis of acquired information.
<b>Time to perform the tests</b>	Each task should have a preset time in order to avoid a tiresome evaluation. This time may be managed by the evaluator so that the entire test, from beginning to end is not a grueling experience.
<b>Allowance</b>	Labor laws related to volunteer work should be kept in mind. In the Brazilian case, since the users are usually humble persons of low purchasing power, and to avoid burdening them with extra expenses in transportation and feeding, an allowance is recommended. If the allowance is not possible, the evaluator should provide means of transportation and a snack after the evaluation. In other countries, legislation related to volunteer work should be consulted.
<b>Location and environment for evaluation</b>	A portable laboratory should be set up to perform the evaluation so that all the necessary equipments can be installed at a location that all participants can easily reach.
<b>Equipments to be used by the participants</b>	One should try to choose similar equipments and software (such as browsers and assistive technologies) which the participants are used to, so that problems in accessibility related to the use of equipments are kept to a minimum.
<b>Assistance in completing tasks</b>	It is recommended that after a while in which the user is trying to complete the task, the research help the user in completing the task. Thus, the participant will be encouraged to continue in the evaluation. In case this assistance is necessary, the researcher will have the option of including this time in the overall task time, or not.
<b>Information about browsing recorded on notes</b>	So that important information is collected for analysis, concurrent verbalization is recommended. However, the user may not verbalize certain points during his/her navigation. The evaluator should pay attention to what the user is doing and write down pertinent observations that may help in consecutive verbalization.

CONTEXT	PROTOCOLS DESCRIPTION
<b>Insight into the problems of accessibility and usability</b>	During the execution of the tests, the evaluator may realize that there are problems of usability in addition to accessibility. It is recommended to list and categorize these detected problems in the analysis of results.

Fig. 4. Protocols for Web Accessibility Evaluation with the Participation of the Functionally Illiterate

## 8. Final Considerations

This present study, of exploratory research, aimed at studying how functionally illiterate persons behave and interact with web pages, in order to contribute to the development of protocols for conducting evaluations of web accessibility with functional illiterates.

The research consisted of several stages, among them: an ethnographic study in a learning institution for youth and adults, in order to categorize the selected audience and see how they utilize the computer; a case study based on accessibility evaluations with users who were not functionally illiterate and those who were functionally illiterate; a validation of the developed protocols with the help of specialists in web accessibility, through evaluations with the participation of functionally illiterate persons.

Although the case study and the validation were based on usability tests to evaluate accessibility, the proposed protocols were categorized in different contexts, so that the evaluator is able to use them in those stages of the method where they are most appropriate to the evaluation.

It is hoped that these protocols can help to provide relevant information to other projects, not only in the academic but also in a technical context, so that the evaluation of web sites with the participation of the functionally illiterate becomes part of the development process of web-based Information Systems.

As future work, it is suggested conducting a study about main barriers faced in accessing this web site to the functionally illiterate people, especially those belonging to public institutions, since there are laws that guide government portals that are accessible to anyone.

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