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# Interacting with the Web Navigation Helper: First Lessons about Mediated Metacommunication for Increased Accessibility

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**Abstract.** Semiotic Engineering is a semiotic theory of HCI in which human-computer interaction is viewed as a particular kind of computer-mediated human communication. In it, designers of interactive software are communicating their design vision to users. The designers' message tells the users about how, when, where and why to communicate with software in order to achieve various kinds of goals and effects, thus a case of *metacommunication*. In this document, we report and discuss findings of research on mediated metacommunication, as a strategy to address accessibility problems. We carried out a qualitative study with the Web Navigation Helper (WNH), a user agent designed to help users perform scripted activities on the Web. WNH assistance is given through mediation dialogs created by savvy end-users who act as helpers of users in need. We investigated how a small group of elderly users received different instances of mediated metacommunication created by helpers. The results of the study point at the promises and challenges of mediated metacommunication as a strategy for increasing accessibility on the Web.

**Keywords**: Semiotic engineering, metacommunication, accessibility

**Resumo**. Engenharia Semiótica é uma teoria semiótica de IHC, em que a interação humano-computador é vista como um tipo particular de comunicação humana mediada por computador. Nela, os designers de sistemas interativos comunicam sua visão de design aos usuários. A mensagem dos designers fala aos usuários sobre como, quando, onde e porque se comunicar com o sistema, a fim de se atingir diversos objetivos e efeitos, sendo então um caso de *metacomunicação*. Nesta monografia, nós relatamos e discutimos achados de uma pesquisa sobre metacomunicação mediada, como uma estratégia de se endereçar problemas de acessibilidade. Nós realizamos um estudo qualitativo usando o Web Navigation Helper (WNH), um agente de usuário desenvolvido para auxiliar usuários a realizarem atividades na Web. Este auxílio é dado por diálogos de mediação criados por usuários experientes que ajudam usuários que precisam de auxílio. Nós investigamos como um pequeno grupo de usuários idosos recebeu diferentes instâncias de metacomunicação mediada criada pelos assistentes. Os resultados dos estudo apontam para promessas e desafios de metacomunicação mediada como uma estratégia para melhorar a acessibilidade na Web.

**Palavras-chave**: Engenharia semiótica, metacomunicação, acessibilidade

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## 1. Introduction

Research about Web accessibility is in high demand because of the ever-growing number of people that want to use the Internet, but face special challenges associated to permanent or transient limitations. Researchers have been choosing various kinds of solutions, from assistive technologies to user agents and accessibility standards [20], including explorations in social computing and crowd sourcing [19].

Our research in this area is guided by Semiotic Engineering [7], a semiotic theory of HCI in which human-computer interaction is viewed as a particular kind of computer-mediated human communication. In it, designers of interactive software are communicating, in whichever style they choose to do it, their design vision to users. For example, designers of smartphone applications tend to adopt a completely different style of communication than the designers of 3D computer-aided design applications. Moreover, for communication to be in place, the designers do not have to (although they may) represent themselves explicitly in the user interface. For example, communication can be achieved with control manipulations (in which case the designers communicate through interface *objects*) or with humanoid agents (a strategy often used when communicating affect and emotions is important).

The designers' message tells the users about how, when, where and why to *communicate* with software in order to achieve various kinds of desired goals and effects. It is thus communication about communication or, more technically, metacommunication. Occasionally, users may not be able to receive or understand the designers' message, which leads to metacommunication breakdowns. Some of these breakdowns may be due to accessibility issues.

In this paper we report an in-depth study to investigate the promises and challenges of *mediated metacommunication* as a means to achieve accessibility. We examined how a group of older Brazilian users (ages 63 to 82) reacted to their first encounter with the Web Navigation Helper (WNH), a user agent that mediates scripted task-oriented interaction with Web pages [11] [12] [15]. WNH is built on top of CoScripter, a macro-recorder for the Web [5] [14]. It allows experienced users to create mediation dialogs to capture input and clarify output produced while a scripted task is executed. The main purpose of the mediation dialogs is to guide users needing help to complete scripted tasks. In other words, WNH achieves accessibility by allowing savvier users to script and mediate interactions with websites, helping one or more people on a person-to-person basis. Mediation dialogs are not meant to be generic or fit for wide audiences. On the contrary, they are meant to meet the needs of one person or a very small group. For instance, WNH can support family members in helping a visually-impaired relative, care-givers in helping a small group of disabled patients, and so on. In this context, mediated metacommunication can rely very heavily on fine contingent knowledge. The result may be high-quality communication, very well fit for the targeted users, although *probably* at the expense of breadth – only scripted activities can be supported by WNH.

Our motivation for this sort of research is the enormous variety of needs that Internet users have and that cannot always be attended to by Web application developers. Generic accessibility solutions (or means to achieve them) typically concentrate on coarser-grain resources (*e.g.* design guidelines) and enabling devices (*e.g.* assistive technologies). However, the barriers faced by a large number of users are totally contingent to their special case, and are known only by themselves, their families, friends, co-workers, care givers, and others with whom they have close personal contact. We thus frame the problem as one of *rephrasing* barrier-laden interaction into barrier-free interaction, which can be achieved by *experienced end-users* that want to help someone they know well.

A distinctive feature of this research project compared to the vast majority of accessibility research done to-date is that it is tightly coupled with a specific HCI theory. Although Semiotic Engineering has not been developed to address accessibility issues, it can – as we will show – produce a theoretical account of certain aspects of those, using the same concepts and methods developed to address HCI issues in general. By the same token, research in accessibility through mediated end-user metacommunication can shed light onto human-computer interaction in general. The context of this research gives us unprecedented insights into how designer-user metacommunication can be rephrased and how rephrased communication can be received. Therefore, this kind of research strikes a good balance between social value and scientific interest.

In this paper, we present and discuss our first steps along this research avenue. Specifically, we focus on how the *rephrasing of metacommunication was received* by participants in the study mentioned above. We saw that mediation dialogs were effective in helping older users overcome certain accessibility barriers. We also had relevant insights about some of the promises and challenges of metacommunication mediating technology for increased accessibility.

The next section provides the necessary background in Semiotic Engineering for readers to follow the discussion about metacommunication issues. Then, we briefly explain some of the details about how the Web Navigation Helper works. Next, we describe the methodology adopted and the case study procedures. After that, we discuss the case study findings. Finally, in view of existing related work, we present our conclusions and future work.

## 2. Semiotic Engineering Background

Semiotic Engineering (SemEng) is an HCI theory dedicated to the study of how designers (one person or a team) and users communicate through systems interfaces. A system's interface acts as the designer's deputy, telling the user what the designer knows about the user, what the designed system does, how and why (the designer's vision of how his product benefits the users, how it attends to their needs and meets their expectations) [7]. The communication of the designers' vision is received by the user as he or she interacts with the system and discovers the meanings designed into it. This is called metacommunication, communication about communication, and constitutes the prime object of investigation for SemEng. **Figure 1** represents the idea of metacommunication from the designer's point of view. He "speaks" through interface, he communi-

cates with user using interface signs and thus the designer's message is *mediated* by the interface.
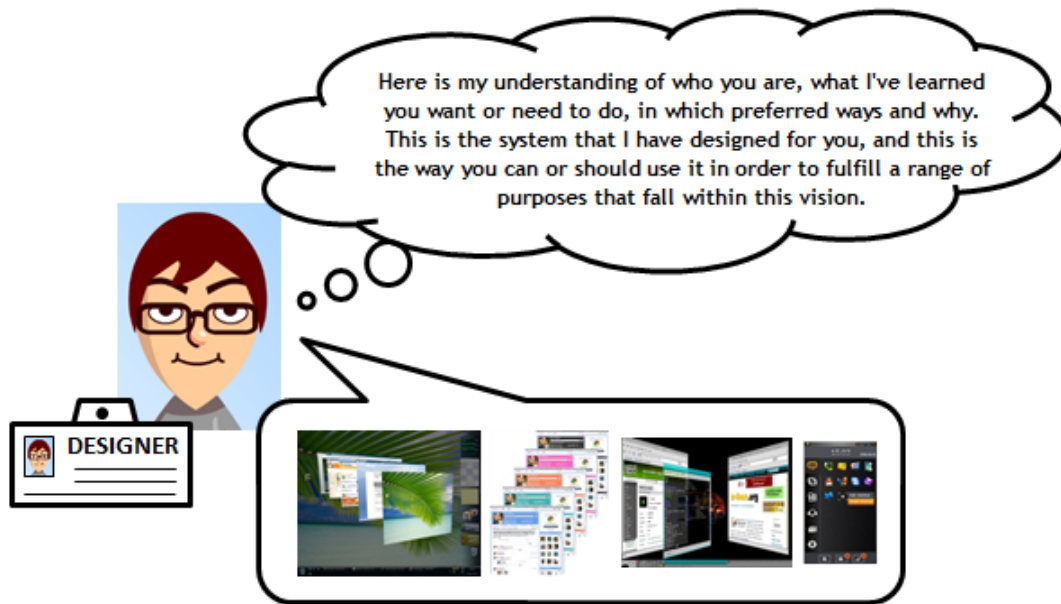


**Figure 1- Designer's message emission**

At the other end, users receive the designer's message through the interface, which functions as the *designer's deputy* at interaction time. The user interacts with the interface (which ultimately constitutes the designer's *message* as well as the *medium* that supports interaction). When interface signs are well designed, chances of smooth and productive communication are maximized. If not, the users are likely to experience communication breakdowns due to misinterpretations, lack of sufficient information and related problems. In this case, according to SemEng, the interface has *communicability* problems [7] [8]. **Figure 2** represents the reception process of the designer's message in an ideal world, where the designer is able to communicate with the user in a fully satisfactory way.



**Figure 2 - Designer's message reception**

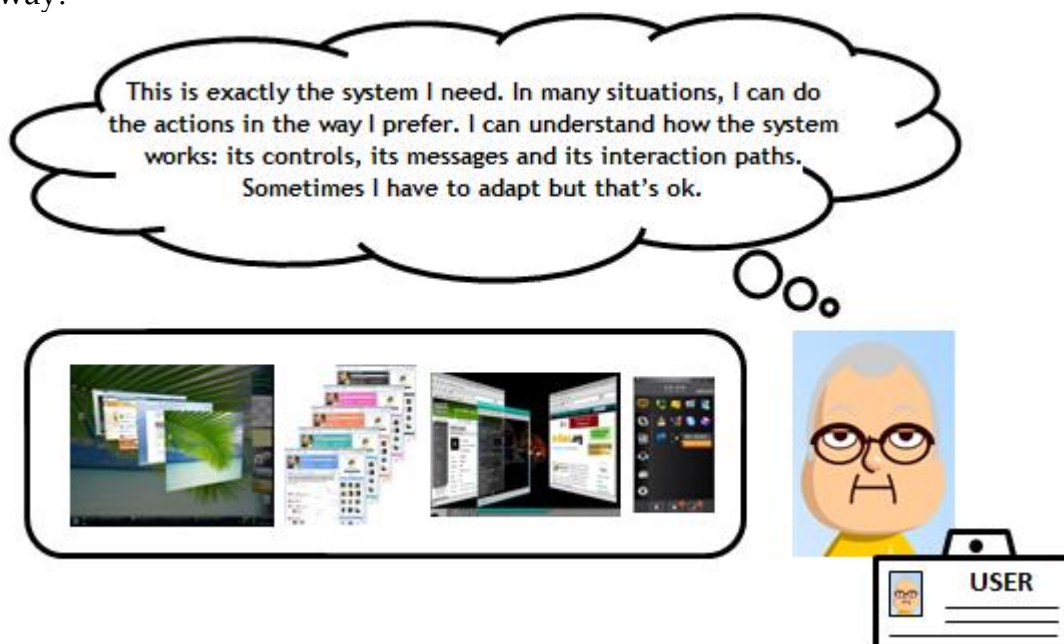SemEng postulates that interactive computational artifacts establish communication between two (groups of) participants at interaction time: designers and users. **Figure 3** shows a diagrammatic representation of the metacommunication process at top level (communicative role and function names at the top of the image and red arrows for communication flow) and lower level (additional role and function names at the bottom of the image and gray arrows for communication flows). Users, as indicated in the figure, interact with the interface, which is at once the designers' deputy – the sender of his computationally encoded message and the receiver of users reactions – as well as the *medium* for the designer-user and user-system communication. Through this complex but not necessarily difficult metacommunication process, users gradually unfold the full length of the designer's top-level *message*.
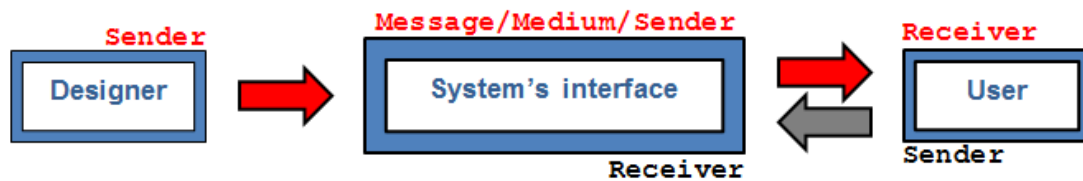


**Figure 3 - Communication between designer and user**

For a very brief illustration of what this sort of metacommunication amounts to, let us take the main elements of Google's search engine interface (**Figure 4**). The black circle has been added by us to spot a special item in this example. The most salient element communicated by the designers is the company's logo. Users should thus be able to identify whom they are talking to. The designers take advantage of the users' computer literacy; the text box contains no indication that users should type search terms in it, or instructions for how they can or should formulate the search. 'Just enter what you need and then fire a *Google search* or tell us if you are *feeling lucky*', the designers communicate. They also communicate that they think the users want to go straight to the search. There are no distractions. should we wonder about what the circled icon means (a microphone, perhaps), 'Guess or ask.' would seem to be the designer's answer. If the user hovers the mouse over the icon (a way to ask what it is), the designers give the answer with a tool tip: "Search". At this point the communication is teasing: 'No clue yet? Ask for more.' the designers seem to say. If the user clicks on the icon, they finally communicate: 'Speak now or cancel.' Therefore, the top level metacommunication message in this very brief example is that Google wants to put users directly in contact with the search. They want to support fast, flexible search. Voice input can serve more than one purpose: comfort, speed, mobility and accessibility. All of these meanings are communicated by the designers through communication with the interface and their style, as we suggest, has a touch of playfulness. Unless the users understand how to communicate with Google, they don't get the message. The *conversation* about the meaning of the encircled item illustrates further steps in metacommunication: by communicating with and about the icon, users learn how to use this search feature.

**Figure 4: Main elements of Google's international interface
(circle around icon added to spot a special item)**

In the next section we begin to address *mediated metacommunication* by describing in detail how WNH works.

## 3. The Web Navigation Helper

WNH is a tool whose first targeted application has been to support users with (temporary or permanent) accessibility needs for navigating the Web [11] [12] [15] [1]. It helps them to accomplish tasks with mediation dialogs created by someone interested in helping them throughout navigation. The tasks are scripted by CoScripter [5] [14], a macro recorder for the Web that provides the base technology for WNH. WNH requires that there be a "helper" user, typically a savvier user who knows well the accessibility-challenged user's needs and who then creates customized mediation dialogs for this person (the "helpee"). A specialized dialog editor provided by WNH allows helper users to design dialogs with which to obtain task-related input from helpee users and give them additional explanations about the task process, its output and results, or whatever else is considered necessary by the helpers.

These dialogs may achieve increased accessibility [15] [16] with the following characteristics:

1) Focus: mediation dialogs limit interaction to script steps that require input from helpees (data submission and navigation steps in the script are performed automatically) and they prompt such users for only the required data;

2) Decomposition: mediation dialogs break interaction into smaller steps, reducing the complexity of interaction required to perform typical unassisted tasks on the Web;

3) Explanation: mediation dialogs give challenged users as much explanation as helpers think is necessary, ranging from task to technology, from domain to interface elements, and so on (WNH supports the creation of contextualized help in each dialog).

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1 Broadly speaking, WNH has been designed to achieve two kinds of purposes. In practice, it is aimed at supporting mediated interaction with Web applications (accessibility is only one of the possible reasons why we would use this sort of mediation; coaching and guiding users as they visit websites is another). In research, WNH is aimed at revealing how users *interpret, rephrase or repurpose* interactive Web applications and how they create conversations about this with other users through simple systems interfaces. Thus, WNH is also a powerful tool to investigate end-user semiotic engineering.

4) Customization: mediation dialogs can be created following certain characteristics or preferences of the targeted user. The dialog creators can combine the three items above according to what they think is necessary to alleviate the user challenges. For example, they can replace certain kinds of interaction controls that are challenging for the helpees (e.g. list boxes to radio button groups), as we will see below.

To make things clearer, suppose that a novice Internet user needs to look at the weather forecast under slightly different circumstances (which means that a bookmark in the browser would not be a solution). A friend, who is an experienced Internet user, then helps him by using WNH. First she creates a script for weather forecast searching (with room for using different parameters each time the script runs) and then she creates the mediation dialogs to support her friend as he uses WNH later, by himself. In **Figure 5**, we see a screen shot of WNH, showing mediation created for "The Weather Channel" website[2]. The underlying script is designed to collect search parameters for the task, like the location of interest, the dates, the choice of temperature unit, etc. Mediation dialogs show up in the browser on top of the original website page. The user is prompted to provide the requested information, in this case by typing the city name into the only text box that appears next to the helper's communication. To continue, the user must click on the "Continue" button. The city name is then filled into the corresponding text box in the Weather Channel website (indicated by the dashed line in **Figure 5**). Note that the user does not need to type the website URL; neither does he need to look for the right place to type the desired city name, the right button to click, etc. All these actions are automatically carried out by CoScripter, the script interpreter[3].
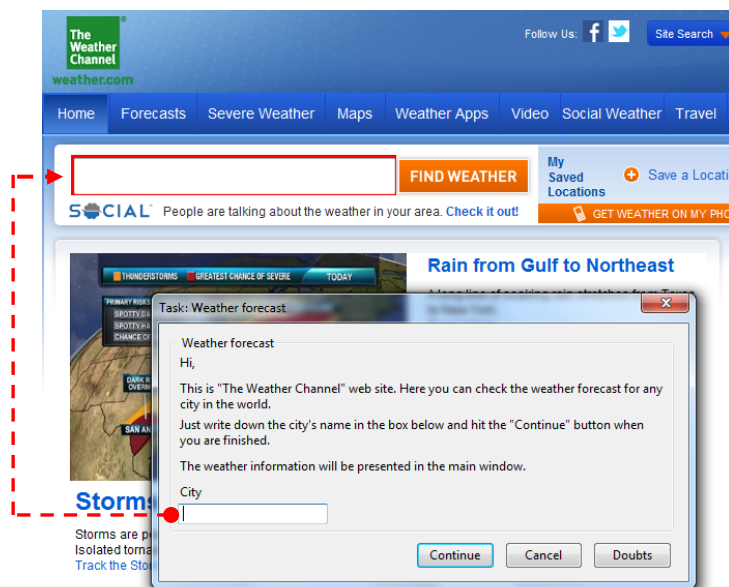


**Figure 5 - How WNH mediates Web navigation**

2 http://www.weather.com/

3 The mediation dialogs by default show up in the top left corner of browser and can be moved around the screen area. In **Figure 5** we positioned the dialog in a way that the relevant areas and information in the website could be easily identified by the reader. In alternative versions of WNH, dialogs appear on the browser's sidebar.

**Figure 6** shows the dialog content in a readable size. There is a button called "Doubts" at the bottom. When the targeted users press that button during interaction, they get explanations about what they must do, the meaning of specific terms, the effects of the task, the overall goal of the website, and so on. The users' doubts must be anticipated by dialog authors during the dialog creation process. This is a very important feature in the rephrasing of metacommunication for accessibility purposes.
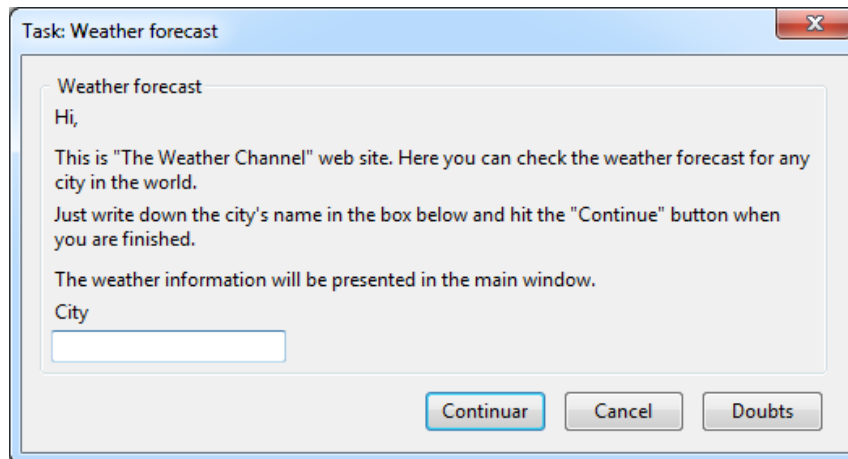


**Figure 6 - Mediation dialog for weather forecast (magnified)**

WNH has two different modules: 1) the agent itself (the helper's *deputy*, or 'helper', for short), which supports some end user(s) with special needs in performing web scripted tasks, like the illustrated weather forecast consultation; 2) the dialog editor, which is a specialized composition tool created to support dialog authors during the dialog creation process. The WNH editor offers a set of HCI components and operations that can be used in the dialogs. The dialog creator can, for example, decide to *group* tightly related fields into a single dialog window, regardless of the order in which they appear on the original Web page design. If deemed helpful for the challenged user, he can also decide to use formatted input capture for numbers, dates, and currency, for instance. Dialog creators can also include opening and closure dialog messages, before the first and after the last script commands, respectively. These can be used to welcome the helpee users at the beginning of the task and to guide them about how to examine or interpret results on the original Web page as they finish the scripted task. **Figure 7** shows one of the dialog editor screens.
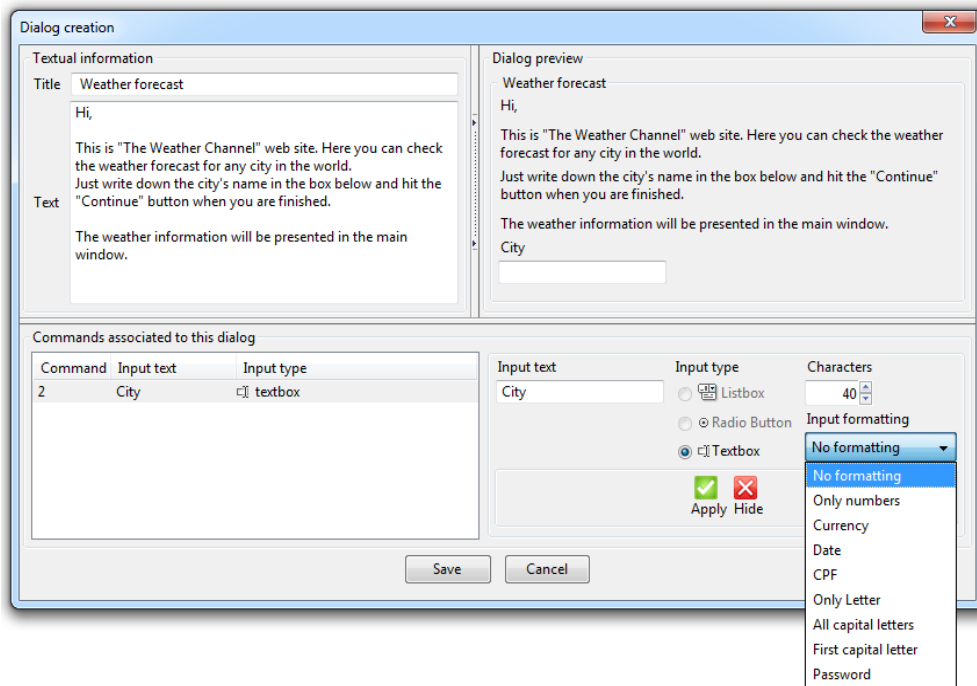
**Figure 7 - WNH dialog editor**

Regarding how mediated metacommunication occurs with WNH, as previously mentioned, a system's designer has a message that he intends to communicate through the interface, with more or less explicit references to the metacommunication process that allows him to *talk* to the users. **Figure 8** represents this process in a simplified way.
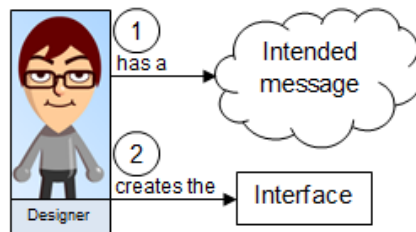


**Figure 8 - How designer communicates**

The helper user's first step in trying to increase accessibility of some particular Web task is to interact with the originally designed interface which enables the task at hand. According to SemEng, in this step the helper receives and interprets the original web application designer's message. Then, depending on the needs of the helpee user that he is about to help, he builds a new message, in which accessibility challenges are removed, circumvented or alleviated. For this, the helper uses the WNH editor and creates his specifically designed mediation dialogs. He can add explanations about the interface, talk about signs in the original interface, rearrange or change interactive controls to facilitate access, and so on. In short, the helper *rebuilds* the original designer's message, rephrasing it in a way that he thinks is more appropriate for the specific individual (or small group of individuals) that he is working for. **Figure 9** shows the complete communication circuit from the helper's point of view. The circled numbers denote the sequence of steps that he must achieve in his own semiotic engineering process.
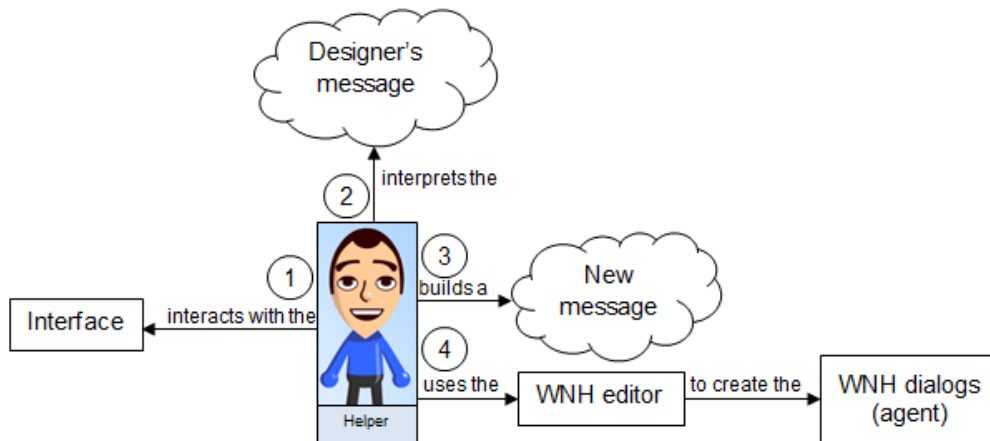
**Figure 9 - How helper communicates**

Finally, when all mediation dialogs are ready to be used, the helpee user accesses them through WNH. He interprets the helper's message, which refers to and in most cases should contain the gist of the original designer's message, and then begins to accomplish the task he needs or wishes to do. **Figure 10** represents this process from the helpee user's perspective. Again, circled numbers mark the sequence of steps.
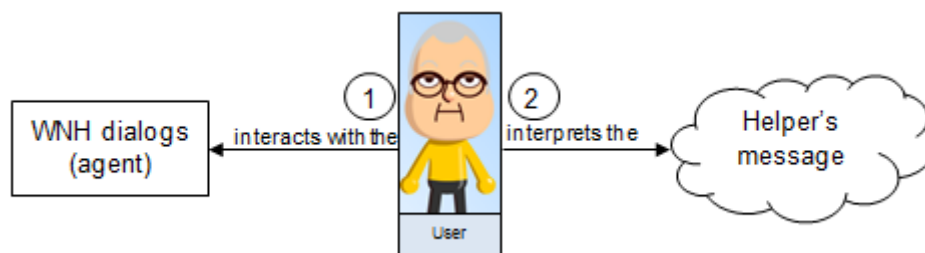


**Figure 10 - How user receives the message**

Regarding the explanation of how mediated metacommunication proceeds, we refer back to the communication schema shown in **Figure 3**. We now know that WNH is positioned between the original designer's deputy (*i.e.* the original interface) and the targeted helpee user, as a mediator of the original metacommunication. **Figure 11** illustrates the communication path from the designer to the final user passing through the mediation done by WNH. However, an important detail is not represented in the illustration. The user interaction is *focused* on WNH dialogs, but the user can still access the original interface. It is open behind the WNH window and can get in focus if the user explicitly commands a switch from the WNH to the original interface (*e. g.* by clicking on the original window). Consequently, the user has access to the original design's deputy, which the helper can – if he so desires – explore extensively in his conversations with the user. For example, he can include passages in the mediation dialogs saying things like: "Now, click on the original interface window and read carefully what it says. When you are done, come back to me, by clicking on the WNH window."
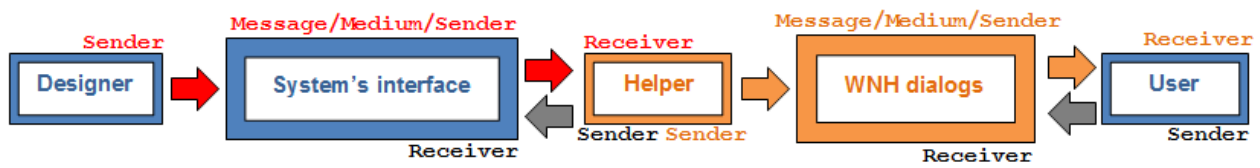
**Figure 11 - Mediated metacommunication with WNH**

Using SemEng as a theoretical basis for research with WNH is particularly illuminating because dialog creators are *reconstructing* the original metacommunication and because they are actually engaged in the same metacommunication design process as the original designers were. The difference is that helpers are aiming at improving accessibility for a specific individual (or group of individuals) that could not get the original designer's message. This reconstruction can not only reveal their own perception of the original metacommunication, but also show what adjustments they think are needed if the metacommunication is (re)directed to that specific (group of) user(s), in some contingent situation. When helpers break the original interaction into arbitrary steps, or change the way input data is requested, the original designer's message is reinterpreted, transformed, and implicitly critiqued for a specific well-known context of use. Hence WNH is also a promising research instrument for SemEng, in addition to being a potential accessibility tool.

A challenging aspect of metacommunication brought about by WNH is that end users are actually "listening" to three different designers' voices: the original interface designer, the dialog creator's (who actually instantiate mediation dialogs with the WNH editor) and – we should not forget – the designers of the user agent, WNH, itself (who decided on what technological features are offered to helpers, setting the contour of metacommunication rephrasing). A study of metacommunication in this context can give us, among other things, a deeper understanding of "varieties" of metacommunication, and their effectiveness in different contexts.

The WNH study reported in this paper is only part of a larger qualitative study [6] [13], which among other things investigated how helpers themselves perceive interaction and rephrase it for different audiences. Our focus here is, however, placed on mediated metacommunication from the end user's perspective, that is, we are interested only in the final end *reception* of the mediated message.

## 4. WNH Case Study

This section aims at describing our case study in detail. We explain how and why we chose the qualitative methodology to guide us through the research. We also describe the profile of participants selected for experiments, the methods and procedures we adopted, as well as how we collected and analyzed the data. The last sub-section presents the main results we obtained.

## 4.1. Research Question and Methodology

Our general research goal is to gain better understanding of mediated metacommunication, using WNH as a rich context for empirical studies. This research involves two units of analysis: a) the process of rebuilding the metacommunication (carried out by the helper using the WNH editor, as seen in **Figure 9**); and b) the process of receiving rebuilt metacommunication (carried out by the targeted user through the WNH agent, as seen in **Figure 10**).

Up to now, all research involving WNH has been done with qualitative methods. We have chosen this approach because it is especially appropriate for exploring and understanding new, unknown or unpredictable research questions and phenomena [6] [13]. With a qualitative approach, we can make an in-depth exploration of multiple forms of data typically collected in the participant's settings before we begin to scale up data collection and to submit them to statistical analysis aiming at generalizing conclusions to larger contexts. Our aim with a qualitative study is to unveil and identify various meanings that individuals or groups ascribe to a complex set of factors surrounding the central research question. Unlike the case with quantitative methods, qualitative research methods usually work extensively with the participants' discourse (written or spoken) and/or non-verbal signs (gestural language, interaction paths, etc.) related to the phenomenon under study. These elements carry meanings that are thus analyzed, categorized, described and interpreted by researchers. The end result of qualitative research is an integrated set of signs with which researchers articulate an interpretative framework, useful to reach a deeper and more explicit understanding of the research question.

In our research, among different qualitative approaches, we used the case study strategy [13] because it is a good strategy when a "how" or "why" question is being asked about a contemporary set of events, over which the investigator has little or no control [21]. In our case, we are trying to answer *how* the mediated metacommunication affects web accessibility and we have little control about the behavior of participants during experiments. The only control we have is set by the protocols encoded in the WNH agent itself. Yin [21] underlines the fact that case study inquiry can also cope with situations where there may be many more variables of interest than data points and the researcher must then rely on multiple sources of evidence. The validity of results depends, of course, on the convergence of all data throughout a careful triangulation process.

The case study we present is part of a larger research to evaluate the WNH [15]. Three exploratory studies have been previously carried out. The first and the second were done at design time, with paper prototypes of WNH. Our aim was to gather knowledge and information about what the dialog creators needed and what we should thus include in the design. The third exploratory study was performed with a working prototype. It was conducted in two steps: an evaluation of the editor with dialog creators; and an evaluation of the agent with users confronted with accessibility barriers. Only the latter is the object of discussion in this paper. The study involved older users challenged by low digital literacy, which they were trying to overcome taking an introductory course

about the Internet and its uses. Further information about the other phases can be found at [15] [16].

## 4.2. Participants

To recruit the participants we followed three criteria:

1) they had to be officially declared elderly citizens (which in Brazil, as in most other countries, means that they are entitled to receive special assistance in performing various kinds of social activities; we picked accessing the Internet as one of them);

2) they had to have some interest in using and learning more about computers and Internet (then, they would be motivated in participating);

3) they had to have minimum previous knowledge about how to operate computers and how to navigate the Web with a browser (to understand the scenario proposed and to be able to perform the task).

According to the Brazilian legislation, people with 60 or more years or age are officially declared elderly citizens. This is the same age limit considered by the World Health Organization (WHO) for developing countries and the age range we used in our study.

We recruited six participants, ages ranging from 63 to 82. In this group there were four women and two men. All were enrolled in a digital literacy course for elderly citizens promoted by the Rio de Janeiro State government. This situation ensured that they matched the second recruitment criterion above. Two of the participants were in their first week of classes, three were in their second week, and one was in the fourth week. For digital literacy, three of them had never used a computer (Internet included) before starting to take classes in this digital inclusion program. From the remaining three, only one (a retired English teacher) had used the Internet before retiring in 2000, to search for news and other texts to use in her classes. Moreover, none of them had their own computer at home. All were accessing the Internet only with computers in their digital inclusion classes.

## 4.3. Methods and procedures

We designed an experiment to collect empirical data. It had four phases: 1) participants watched a demonstration of a sample Web task mediated by WNH dialogs; 2) they read the proposed task scenario that they should carry out themselves; 3) they performed the task using WNH; and 4) we carried out a semi-structured interview with each one.

The demo task, created by us, was one of searching for dessert recipes in a popular TV show website. The main activity, mediated by WNH dialogs, was to inform a keyword or expression associated to the desired recipe. In the first dialog (a protocol welcome dialog), WNH informed that only dessert recipes could be searched in the context of that particular task. In the "Doubts" section, there was a question to demonstrate this functionality. It said: "I don't want to search for desserts… What should I do?" The answer was: "This script can only help you search dessert recipes. If you are looking for another type of recipe (meals,

fish, salads…), you must do the search directly in the website (main screen)". The second dialog asked for search terms, and the third and last one reported the end of the task, congratulating the user for having achieved it successfully. This demonstration took about 10 minutes.

**Table 1 - Task scenario**

Suppose that the other morning you were talking to the nice doorman in your condominium and that you learned that he shared the dream of so many Brazilians: to be the owner of a house. You have seen it on TV that this governmental property acquisition program, called "My house, my life"[1], aims at facilitating the process of buying a house, helping mainly to people with low income. They get subsidized property values and low interest rates.

As you are finishing this introductory course in Computers and the Internet, you talk to your instructor about your interest in the "My house, my life" program and he tells you that there is an online mortgage simulator available in the Caixa Econômica Federal (CEF)[2] website. There it is possible to know details about bank financing conditions, for example, the value of installments, interest rates and subsidies placed by the government.

Your instructor then uses a system called WNH to create mediation dialogs that can support you as you fill in the form for the online CEF simulator. With a lot of enthusiasm, you tell the news to the doorman and he provides you with all information you needed to run the simulation for his case. You now have then the mission of completing the mediated task created by your instructor and filling in the doorman's data for the simulator in order to obtain information about a house mortgage.

The required simulation data in your doorman's case is the following:
- Location of the property: Rio de Janeiro-RJ
- Date of birth: July 7th, 1974.
- Family income: R$ 1,500.00
- Value of the property: R$ 100,000.00
- Down payment value: R$ 20,000.00
- Period of financing: 300 months

_____

After reading this scenario, we ask you please click on the WNH screen that will be presented to you and then do the following:
- Choose the task corresponding to the online simulator of CEF;
- Run the task;
- Fill in all the data until you finish the whole task.

_____
[1] http://www1.caixa.gov.br/popup/home/popup_home_9.asp
[2] Caixa Econômica Federal (CEF) is an important public Brazilian bank, in charge of financing house acquisition in the "My house, my life" program.

After this brief demonstration, the six participants read the task scenario. According to it, the participant's job was to interact with an online mortgage calculator made available by a Brazilian public bank in order to find out how much money they would have to pay monthly if they got a loan to buy a house. The scenario text is shown in **Table 1**, above.

We should add, as a cultural clarification, that mortgage prices are a big concern in Brazilian society, cross-cutting age ranges (from young adults to elderly citizens) and economic classes (from lower income to higher income). Even citizens who do not have to pay mortgage themselves (like the elderly, for example) are usually concerned with mortgage paid by family members or other people they are closely related to.

After reading the scenario, participants were invited to begin using WNH and perform the proposed task. This step was designed to take about 30 minutes. At the end of the task, we performed a semi-structured interview with

the participants individually, which took about 15 minutes. The set of topics that guided interviews are shown in

**Table** 2.

**Table 2 - Guide topics to interview**

| Personal | WNH |
|---|---|
| Age | Opinions about WNH |
| Familiarity with computers and the Internet. | Perceived advantages and difficulties |
| Computer class experience | Perspectives for adopting or declining the use WNH for other activities in the Internet |
| Frequence, location and other conditions of Internet usa (including kinds of activities carried out). | WHN role in the learning process (would users get some computational ability by using WNH? what kind? why?) |

The mediation dialogs for the participants' task scenario were created in a previous study [15] [16] by participants with different profiles: graduate students doing research on accessibility for elderly users and instructors of the digital inclusion program. The details and results about this previous study will not be discussed in this paper, but can be verified in [15] [16]. We used two sets of mediation dialogs: one created by a graduate student (PR) and another by a digital inclusion program instructor (PI). Three of the elderly participants used the PR set and three others used the PI set. **Figure 12** shows the first screen of the online mortgage calculator, in Portuguese, with brief explanations in English about the content of some of its fields. In terms of metacommunication processes discussed in earlier sections, this screen corresponds to the original designer's message, communicated through the interface.

For further illustration, **Figure 13** is a screen shot of the exact moment when the WNH asks the user to inform the federal state where the property is located. The dialog was created by PR and we indicate in the figure which field the dialogs refers to.



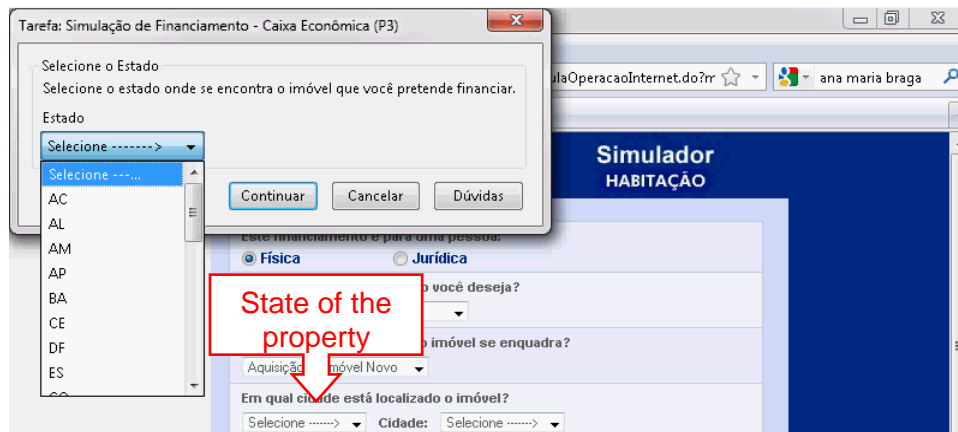**Figure 12 - Online mortgage calculator**

**Figure 13 - Dialog asking state of property (PR)**

All content created in mediation dialogs by PR and PI is reproduced in English in **Table 3** and **Table 4** respectively. It is worth noting that the dialogs are expressed in oral Brazilian Portuguese, using different linguistic styles and different social protocol forms. These are crucially important in the helpers' message. Helpers were specifically prompted to use expressive styles that reconstruct and rephrase the original designer's message in such a way that it achieves improved accessibility. Aiming at preserving the gist of the helpers expression, we opted for a free translation of helpers' dialogs. Further analysis of the impact of different communicative styles for elderly users is discussed in **Section 4.5.8**.

**Table 3 - PR dialogs content**

| | Main dialogs | Doubts |
|---|---|---|
| 1 | Welcome to the mortgage calculator. In the following, some information will be asked of you, so that we can calculate the mortgage costs for your house. It is important that the information be correct. If you have doubts, click the "Doubts" button. | |
| 2 | Select the state where the property is located. | *I can't find my state name* In this list, the federal identification of each state will be presented. Usually, states are represented by the first letter of each word in their name. For example: Rio de Janeiro = RJ |
| 3 | Select the city where the property is located. | *I can't find my city* Maybe the city doesn't belong to the selected state. Check if it does, and if necessary choose the correct state. |
| 4 | Inform the value of the property you want to buy. Please, inform the value correctly. It is very important for the calculation. | |
| 5 | Inform the total value of your household income. | *What is household income?* Household income is the value of all your family members, who lives in the same house, earn monthly added. It is not necessary considerer in this income any expense with rent, light, gas or any bill. |
| 6 | Inform the birth date of the older person contributing to the household income. | |
| 7 | Inform the down payment value that you intend to make. | *What is down payment?* The down payment is the value that will be paid up from and will be discounted from the total value of the property in the loan calculation. For example: If the property costs |

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| | | 100,000.00 and you give 20,000.00 for down payment, then your loan will be only 80,000.00. |
|---|---|---|
| 8 | Inform in how many months you intend to pay your mortgage. Depending on the number of months, the value of the installments can change. | |
| 9 | Congratulations. You have concluded the mortgage calculation successfully. If you want to print it, use the "Print" button. | |

**Table 4 - PI dialogs content**

| | Main dialog | Doubts |
|---|---|---|
| 1 | Click with the mouse on the arrow below and then choose your state. | |
| 2 | Click with the mouse on the indicator below and choose the city where you live. | |
| 3 | Write, in the white space below, the value of the property you want the loan for. | *Do I write the value straight or with punctuation?* To write the value of your income use periods and commas. |
| 4 | Inform in the white space below your monthly income. | |
| 5 | Write in the white space below your birth date. | |
| 6 | Write in the white space below the value of your down payment. | |
| 7 | Write in the white space below the number of installments to pay for the mortgage. | |

## 4.4. Data collecting and analysis procedures

As said before, case studies usually collect data from different sources. In our study the data came from:

1) Interaction recordings. All interaction with WNH agent was recorded with screen capture software. Recordings allowed us to examine which interaction paths were followed, the time each it took for interaction to be completed, the circumstances of errors, the breakdowns during the reception of the mediated metacommunication message, and so on.

2) Audio recordings. We recorded all interviews with audio recorders. This allowed us to make an in-depth analysis of the participants' discourse while talking about the task, their opinions, perceptions and experience.

3) Notes taken during observation. All participants' reactions, behavior or verbalizations that caught our attention while they performed their task or during the interview were registered in field notes. These notes were later crossed checked with the other data to support our interpretation and analysis of observed phenomena.

We did intra-participant and inter-participant analysis. In the first case, we observed all the material available for each participant individually. Items were crossed checked with each other for redundancy, consistency, clarification, elaboration, and the like. In the inter-participant analysis, we were able to detect recurring elements like behavior, opinions, difficulties, etc. We then identified a number of categories with which to organize and report our findings.

## 4.5. Results

The results of our study go beyond the technical aspects previously reported in related work [1] [18]. They point at some psychological, cognitive and social aspects evidenced by the data. However, these are only contextual cues for an interpretation of evidence related to the focus of our research: mediated metacommunication. Our aim is to investigate the role of metacommunication strategies and processes supported by WNH in helping this particular group of users to achieve the proposed task. We organized our findings in nine categories, which we present below along with our view on how they contribute to discovering the effects of mediated metacommunication.

### 4.5.1. Critical thinking

On a number of occasions we could appreciate the fine judgment and critical thinking of some of the participants. For example, one participant said that the "Doubts" question about other kinds of recipes in the introductory example was unnecessary, since there was an explanation about the task limits right in the welcome dialog (described in the beginning of **Section 4.3**). This observation showed how much attention she had been paying to all the material, and how she had been exercising her critical thinking. The message sent by the designer (in this case, the dialog creator) was considered redundant.

Another participant seemed a bit suspicious of WNH. When we asked him if, in the future, he would like to have WNH installed in his computer, to help him do various tasks on the Internet, he thought for a while and then said that he would have to ask this to his son-in-law, who was the person he most trusted for computer-related matters. He would ask him if WNH was the best option available to solve his problems. This showed how much this person (and probably other elderly) depended on some trusted relative, friend, or acquaintance to help them make decisions about computers.

The same participant had yet another concern: whether the amount of mediated tasks available was representative of people's needs in general. This was interesting because his implicit skepticism matched the reasons why we abandoned the idea of having a WNH server on the Internet, with a large volume of scripted tasks for people to download and use [11] [12]. Of course it would be ultimately impossible to target all accessibility needs, and have scripts for all users that face barriers to use the Internet. We would never be able to *predict* all relevant situations, and build a script base that would be "representative of people's needs in general".

The critical thinking observed in some participants pointed to relevant questions about the role of metacommunication strategies. One of them is the redundancy when it is considered unnecessary. The helper is supposed to do a reconstruction of the message not a verbose repetition. Another one is the reliability issue. The message should be emitted by safe sources, by someone in whom the user trusts. The WHN design perspective as a person-to-person help tool matches this requirement. As discussed in [15], WNH has been actually perceived as a *transition* tool, capable of helping users become more independent.

### 4.5.2. Hesitation and slowness

We observed that hesitation was a common pattern among all the participants. It could be noticed in various kinds of behavior:

- The participants often spent long time thinking about what to do next, studying the WNH interface and reading carefully, looking for clues. They seemed to wait for some action or feedback from the system, even when they hadn't done anything as input.

- They often tried to check what they had just done before proceeding to the next step. One participant cross-checked all the data provided in the dialog fields against the information presented in the scenario. Others seemed to ask us for permission to continue. One participant, having chosen the correct action still asked us: "Is this right?" These were indications of their need to be continually reassured throughout interaction.

- When participants made a mistake, they were totally lost. For example, two of them accidentally selected the wrong state (for property location) and suddenly they did not know how to solve the problem.

The feeling of hesitation is natural in this context and with this group. They are all beginners with computers and the Internet. Some of the actions were done slowly and attentively. They tended to look carefully for number keys on the keyboard and to use the scroll bar controls in discrete leaps (clicking repetitively on arrowheads on either extreme of the scroll bar), rather than continuous mode (clicking and dragging the control up or down the scroll bar). To be sure, this slower mode was not necessarily a problem; it is a known characteristic of this user population [18]. The participants themselves seemed aware that the learning process at their age takes longer. One participant said: "For me, as an older person, it has to be slower".

Evidence of hesitation and slowness shows us how crucial effective and efficient metacommunication is to avoid or alleviate problems. For example, communicating frequently and encouragingly with the user, in an attempt to make him or her feel reassured. Notice that the dialogs created by PR and PI did not adopt this sort of communication style. Both helpers used an *instructional* tone (although instructions referred to remarkably different aspects of the overall task). None of them included communication about what to do in case of error, for example, or a note of encouragement along the process. Only PR seemed to have some kind of intuition about this need, when he included a "Congratulations!" message at the end of the dialog.

### 4.5.3. Free answers

While entering requested information in some dialogs, participants showed a tendency to answer mediation questions with more freedom than they actually had. For example, two participants tried to enter the Brazilian currency "R$" sign, when providing information about monetary values. In these cases only the numeric values are necessary, of course, but three participants tried to type "300 months" (with the word "months") in the text box where the

number of months was requested. Another one tried to type "three hundred" instead of "300".

The effects of metacommunication style in such situations was clear. Wherever the dialog creator used data types to pre-format input fields, equivocal attempts at entering data with the wrong format did not cause problems. Participants realized that their typing was not being captured by the system, which to us was a sign that they got the (helper's) message that "only numbers are allowed". An alternative to formatting input fields, in this situation, would have been to communicate explicit instructions and explanations about which format to use (see "Doubt" content created by PI, as shown in Table 4). Both (field formatting and explicit instructions) are examples of metacommunication that tries to prevent erroneous "free answers", although one (pre-formatting) is clearly more effective for error prevention than the other (instructions and explanations). The latter, by the way, can lead to more problems if the dialog creator forgets to include a data-entry validation function in his dialog. If input with unexpected format is passed on to the main application at the end of a script execution step, the application will throw an error message, which – as shown in Table 3 and Table 4 the created dialogs were not at all prepared to handle.


### 4.5.4. Reading attention

Most of the participants read the first one or two dialogs very carefully, paying attention to each word. However, after a couple of successful steps they tended to read only the input fields' labels. In some cases, reading the label was enough to continue the task successfully, but in other cases not reading the whole instructions led to mistakes. Coping with this behavior is a challenge for dialog creators (and for HCI designers in general). On the one hand, they may give more explanation in the first dialogs and less in what follows. On the other, the lack of explanation (to match the reading behavior) may occasionally cause problems to participants. Once again, this is a clear case where decisions about metacommunication styles (with more or less explanations) make a difference in the user's performance. Neither PR, nor PI, gave us any evidence of a particularly elaborated strategy in this regard. Therefore, the participants' behavior is actually a warning that might eventually be part of an end-user semiotic engineering style guide distributed with WNH.


### 4.5.5. Interaction difficulties

All the six participants had problems using the list boxes needed to select the state and the city of the property they were talking about. The most serious problem was that participants often did not recognize a list box as an input element. For example, one participant clicked the "Continue" button even before selecting the state in the list. This is a very interesting case of interactions between communicability problems in the original Web page design and how it percolated to the communicability of the mediation dialog. Because of a bad design choice in one of the list boxes on the original page, which the dialog creator imported into his mediation dialog, the top item in the list box with city names

was "Select-->" (see Figure 13). The intended effect was, apparently, to point at the list box control handle to the right of the item. However, this has apparently been interpreted by the above-mentioned participant as "select in the following dialog". This would explain why this person clicked on the "Continue" button, without having informed the city where the property was located. If the first item of the list box had been "Click here to select the city" instead of "Select-->", maybe the communication would have come through more effectively. This is only the result of semiotic engineering analysis on the metacommunication design because we did not collect evidence that this interpretation is fully correct. It is, however, clearly plausible (and thus a valuable indication of semiotic engineering choices to be *avoided*, regardless of present evidence).

Some other participants also seemed to be unable to recognize immediately a list box as an input element, because it took them a long time to realize that the list box was clickable. One participant, for example, tried to click on the label "State", instead of on the list. Moreover, when they eventually "opened" the list, some did not know how to find the right item or, when they found it, they did not know how to select it.

Using the scroll bar inside list boxes was a challenge for most participants. They did not know when to click on the up and down arrow controls, since the direction where the list moved was the opposite than they expected. One participant suddenly asked: "Here, is this ahead or behind?" Another observed difficulty was that when some participants finally found the item they wanted, they tried to select it by pointing the mouse cursor to it. However, for lack of dexterity, when they clicked to select, the mouse would move slightly and they would accidentally select the wrong state or city and have to start all over again. Note that none of the dialog creators included any tip about how to circumvent the pointing and clicking problem, or the navigation in list boxes. Not even PI, whose communication was remarkably centered around interface widgets (see his messages about what users should do with 'white spaces', 'arrows', 'indicators', in Table 4), included further instructions about how the keyboard can be used to support navigation in long dropdown lists. His simple instructions about list boxes, however, proved to be effective in helping some of the participants to try and to use this widget.

During the whole experiment, we could verify the problems that participants had in filling out Web forms in general. These problems had already been mentioned by the digital inclusion program teachers on a different occasion. They told us that elderly users could deal with text boxes, links and buttons more easily than with other interface controls. Although WNH, with various types of metacommunication rephrasing resources, can really help the users accomplish tasks with form-filling activities (more about it in [15]), once again the helpers seemed to lack the semiotic engineering expertise to put such resources into use when they were needed.

Additionally, since participants tended to keep their eyes on the keyboard as they typed input values, some did not notice the automatic formatting behavior of the system, introducing slashes, commas and periods in appropriate positions. These participants failed to receive the helper's intended message. The *system's* (representing its *designers'*) cooperative behavior was further

communicated with other field formatting techniques that helped prevent errors. For instance, one participant typed "3oo" (with the letter "o") instead of "300" in the installments text box. Had she used PR's dialogs, with formatting techniques in place, she would have been spared the trouble caused by input in the wrong format.

### 4.5.6. Learning difficulties and needs

Talking to each one of the participants after the experiment gave us valuable insights about their thoughts and challenges. The first insight relates to their personal expectations and constraints. During the interviews we came upon major personal issues with *learning* processes in general. For example, one participant, while talking about why she liked WNH, said that navigating with the helper was easier. Then, in a lower key, and almost whispering, she added: "…because there are some things that… I don't know how to do everything, do you understand?" She looked a little ashamed to admit that she might not be able to do the task without assistance. Another participant, at the end of the interview, asked to us: "So, I wasn't that stupid, was I?" clearly wanting to check her performance in learning how to use WNH.

Most participants talked about their strong desire to learn. Some of them were clearly proud of even the few things they had learned. One participant said: "Now, after taking these classes, maybe I'll go ahead, because now I have a little notion, isn't it? Have you seen that I can already manage the mouse?" Another participant said: "… but for someone who never got to have a computer, I can do some little things."

Participants also talked explicitly about their needs and expectations when learning how to use computers and about their challenges as elderly users. Here are the main points:

- They must rely heavily on repetition. Their teacher needs to repeat explanations at least twice and often more times. They have to do the same action many times in order to memorize it. It is interesting to contrast this piece of evidence with the comment made about "unnecessary redundancy" in one of the sample dialogs. We take the comment to warn us against mistaking problems of *memorization* for problems of *attention*. In fact, as already mentioned, participants were in general very attentive readers, which unfortunately is not enough to fight memory problems.

- They struggled to do the same task on different computers. One participant talked about how disappointed she was when she tried to do something at home and failed. There, she said, "everything was different".

- One participant said he liked WNH because "it saves time. This is a lot, isn't it? We never have time, you know? Although I'm retired, I'm not just sitting and waiting, you know?"

In general WNH was welcome as a *helping* agent, an attempt to alleviate their difficulties and help them do the task. All participants explicitly said that

they enjoyed using WNH. They all found it easy to use. Some participants even showed much excitement during the test and the interview, making a lot of compliments to "the agent", mainly because, even with difficulties in some situations, all of them managed to accomplish the task successfully. As some participants put it, using WNH was "a training activity" for them, and as students, they would like to practice and learn more about Internet with the agent. This was a clear indication of WNH's further potential in the context of accessibility. By analogy with how kids learn to ride a bicycle, navigating the Web with WNH is like using training wheels.

### 4.5.7. Learning evidence

Even if struggling to resolve certain difficulties, participants learned new things about interacting with computers and had the opportunity to use it during the test activity. For example, upon meeting a second list box from which to select an item, most of them showed tangible evidence of progress in screen recordings. They learned that the list was a *clickable* item, and some of them even learned how to use the scroll controls with greater ease.

They also learned from their mistakes. For example, one participant used the wrong separator when informing the property value (a semicolon, instead of a comma), and failed the task, having to start over. The dialog creator had not used field type controls, and the error was not captured by WNH. The second time around, this participant paid close attention and used the correct separator. Participants using dialogs created by PR sooner or later realized that the system was introducing the right separators automatically as they typed in values. Having realized that, they then learned that they did not need to type slashes, commas, etc. Notice that again this behavior points to an important metacommunication message. Participants trusted the "system" for consistency. Therefore, if a dialog creator (as was the case of PI) had not used field typing consistently throughout all dialogs, he or she would have certainly caused annoying communicative breakdowns for the users.

### 4.5.8. Reception of dialog communication

The text used in dialog messages is the most powerful instrument of end-user metacommunication rephrasing some original designer's metacommunication presented in a system's interface. Dialog creators have the opportunity to use natural language and directly talk to users about whatever they consider important for achieving the scripted task in view of their knowledge and assumptions regarding their audience. Different writing styles and skills of dialog creator will lead to different interactive experiences with WNH. As seen in Table 3 and Table 4, PR and PI have very different writing styles and communication strategies, which had different effects on users.

The welcome dialog created by PR was visibly well accepted by participants who used his script. It prepared them for the task ahead. Participants manifested their understanding, showing recorded evidence that this reassured them and encouraged them to take the next step. Because PI did not adopt the

same strategy, participants using his dialogs did not have the opportunity to prepare themselves before the task was launched.

The closing dialog created by PR was also welcome because it informed the user that the task was completed (and what could be done next). PI did not create this special dialog, and one of the participants that used her dialogs even asked us at the end: "How do I know that it has ended?" Probably, with a closing dialog, she would not have been in doubt.

PI did not use formatting for entry fields where currency information was requested. This is not a serious problem considering that she could have textually explained the details about how to fill in monetary values. However, as seen in PI's dialogs (see Table 4), she did not do it in the main dialog message. She pushed this communication one level down and included it in the "Doubts" section related to dialog 3, which users only resort to if they can diagnose it *themselves* that they are in trouble. Not surprisingly, all participants who interacted with PI's dialogs had trouble with this sort of information and eventually had to start over the whole task execution.

We could also see the importance of help and feedback messages. Explanations embedded in dialog phrasings were useful, and their absence occasionally led to error. Error prevention and recovery strategies were critically important as well, since our novice elderly users were particularly prone to making mistakes. Help information in the "Doubts" section, in spite of being a powerful resource, was very rarely used by participants. Nevertheless, in the single instance when a participant visited this section (PI's dialog 3, Table 4), the help provided was useful and sufficient to solve the participant's problem.

There were cases where the original website metacommunication was substantially changed by dialog creators, in an attempt to communicate "better" what the original designers *supposedly* wanted to say. This is interesting for two reasons. First, it very clearly shows the dialog creator's interpretation of the original metacommunication (which is not necessarily how the original designers wanted it to be interpreted). And, second, it shows what sense of "improvement" the dialog creators have with respect to effective and efficient metacommunication for the specific group of users that they are addressing with their own mediating metacommunication. PR and PI (as well as other participants of the experiment wherefrom their dialogs were selected for the study reported in this paper) changed some original metacommunication expression quite substantially. For example, take information about income. In the original website it was referred to as "gross household income". However, PR rephrased it as "the total value of your household income". Likewise, information about the duration of the financial loan was originally referred to as nothing more than "desired term". PI rephrased it as "number of installments (months)". Quite strikingly, as the comparison of dialogs in Table 3 and Table 4 clearly shows, some interpretations of dialog creators seemed not to coincide. And if they did not coincide, the way these interpretations were communicated through WNH dialogs clearly pointed in completely different directions. For example, compare PR's "Inform the birth date of the older person contributing to the household income", in dialog 6, with PI's "Write in the white space below your birth date", in dialog 5. Although we haven't checked the validity of the

mortgage simulator results against the data used in the test scenario, it is clear that these dialogs have put participants on completely different interpretive tracks (thanks to the dialog creators' completely different interpretations of what the original interface was meant to communicate). This is a critical issue in studying mediated metacommunication, possibly one of the richest findings we collected in this case study, showing the value and limitations of WNH as an accessibility tool but perhaps more importantly its value as an instrument for empirical research in semiotic engineering.

### 4.5.9. Perceived value of WNH

During observation and interview, the positive reaction of participants to WNH was clear. One participant, uttered spontaneous and enthusiastic compliments at every new dialog she saw or new functionality she accessed. She said things like: "This program is cool!", "But, that's wonderful", "This program should have been already there before ...".

All the participants said that it was easy to use the WNH agent. One participant explained why she liked WNH: "Because it gives you better conditions to find things easier, faster…". Another participant explained why WNH can be considered an accessibility tool: "It was easy and it worked. With WNH it is easier because it simplifies. […] You see that small square (pointing to dialog window), you see it and do it naturally. There is nothing there to complicate [things] and you cannot make mistakes. It is extremely easy, even for someone who understands nothing. […] You just go on clicking, the numbers go in this part, the letters are visible and you just follow what is [shown] here. Then, square by square, on you go… Then you fill in the small square, the values, everything… and go forward, 'Continue'. There is no way to be complicated. […] You cannot be lost, because it is sequential".

Another participant used an interesting analogy to express her perception. When we asked how she liked WNH, she said: "I liked it very much. I am like a crawling baby. [I] can hold on to anything but I am going to choose what is easiest." Yet another participant added: "It's very good. It's much easier to solve problems; the easier, the better, isn't?"

From recorded interactions, we concluded that the key feature in the way this agent helps users is by "breaking" interaction into small steps. In ordinary web forms, the amount of textual elements and interaction possibilities is almost "scary" to novice users. With mediation dialogs (and mediated metacommunication) as provided by WNH, the sequence of unitary steps and the possibility of incorporating sharply focused explanations supports users with special needs, increasing their chances of having successful interaction.

## 5. Conclusions and Future Work

This case study presented WNH as both an accessibility agent (for practical purposes) and a metacommunication research instrument (for investigation purposes). With it we found answers to questions we had before we conducted the study as well as new questions that we now want to answer. We discussed many aspects of how mediated metacommunication was received, and how this

reception related to the way metacommunication was phrased both originally and then by WNH helpers. From evidence produced by the participants in the study, we concluded that WNH was perceived as a useful accessibility tool. An interesting direction emerging from the data was that WNH can be used as "training wheels" for continued learning of how to interact with computers. This is thus one line of research that can be pursued by researchers interested in digital literacy and related topics.

We saw that the many difficulties and barriers that participants said they have while interacting with computers – and that we could easily anticipate that they would have if they tried to interact directly with the mortgage calculator – could be overcome by the way dialog creators rephrased the system's original metacommunication. In fact, this system (in the version we used in this study) had numerous and severe communicability problems, which we detected previously in an HCI classroom exercise done by undergraduate students. This encouraged us to test the task with WNH mediation, in a kind of worst (or at least very bad) case situation. If novice users can do the task untroubled by obvious communicability problems existing in the original design, then WNH proves its worth. The upshot of this decision, however, is that dialog creators – the helpers – may, themselves, have been affected by such problems (and then silently pass the consequences on their misunderstanding to users). This is, of course, the risk of low quality mediation that WNH necessarily involves (as any other mediation situation, even in scholarly contexts like academic debate, involves as well).

So, we saw that occasional misunderstandings of the original website's communication, as well as inappropriate choices of rephrasing styles, introduced problems where there might potentially be none, if the users interacted directly with the website. We should only add to this that problems with interpreting metacommunication are not likely to be lesser with alternative technologies. For example, user agents that perform automatic transformations of Web page designs for accessibility purposes can also misinterpret the designers' message. One example is the Google Translator.

We believe that our case study has a distinctive contribution to make, in practical and in methodological terms. In practice, the use of accessibility user agents has been previously pointed out as one of the gaps in accessibility research for elderly [18]. From the observations reported in this paper, we confirmed the presence of some relevant accessibility barriers already reported [1] and realized new ones contingent to the task performed. Difficulty using list boxes and dealing with numerical information like currency values and dates haven't deserved much attention *per se* and maybe they should, in view of popular uses of e-commerce websites, where these often appear. In addition, it was possible to see that some 'best practices' strategies should be more strongly recommended than others when creating dialogs for specific user profiles, like the elderly in this case.

Still talking about practical applications of mediated metacommunication, there are other projects using macro-recorders for accessibility purpose [2] [3]. However, they focus mainly on visually impaired users; thus their technological solutions explicitly aim to benefit this specific population. In comparison,

WNH is a more general tool. It can even be used in association with screen readers [11] to provide mediated goal-oriented interaction for blind users, as well as in other ways as this study has shown.

The person-to-person WNH perspective is a way to address very specific accessibility needs that some users may have. As already mentioned by other researchers, they can be so specific that the user population may actually amount to a "universe of one" [4]. Only the users themselves and closely-related people who know their daily activities and challenges can actually grasp the meaning and priority of their needs. This is an approach also used by the Internet Buttons project [10], a system that allows any user to create a personalized page for friends or family members. The page has buttons linked to favorite sites or services in the Internet. It is like a homepage full of bookmarks. The personal flavor of using this technology is apparent in some examples shown in their gallery of pages. Here are some of the messages on customized Internet Buttons pages: "Hope you enjoy these Granny", "If you need help, give me a call on 020 8987 0982", "Now you can't complain the internet's too complicated Mum! Have fun!" [10]. However, unlike WNH, Internet Buttons, at this stage, cannot support interactive *processes*. It can only support *access to the starting point* of activity, like a bookmark.

We conclude that in practical terms WNH is a promising user agent alternative for special accessibility cases. We should, however, provide further help for dialog creators (and end users, as well).

As future work, besides making necessary improvements to WNH, we plan to use it in experiments to evaluate usability and accessibility for other user populations, like the deaf. Another item in our agenda is to use WNH as a design tool, helping designers to test different styles of metacommunication for their original products. One possibility is that WNH be fully adopted by website designers if they explicitly want to have different conversations with different kinds of users. We plan to test this possibility in the context of cultural accessibility, using WNH to explain and explore cultural differences for foreign visitors to a native Brazilian website.

The use of WNH for learning purposes is also a possibility for future research, since it was explicitly suggested during the tests. One of the interesting questions to investigate is to find out whether WNH actually leverages the users' learning and smoothly leads them from mediated interaction to direct interaction with a website.

As this study strongly suggests, WNH has a huge potential as an instrument to collect empirical evidence of metacommunication reception and also about end users' intuitions about (and even critique of) situated metacommunication processes. Actually, fine semiotic engineering dimensions, such as the perception of syntactic and semantic features associated with interactive language constructs and patterns, like dropdown lists (compared with option buttons or check boxes, for example) can be empirically probed in experiments using WNH.

In the context of theoretical research, WNH is also very promising. One of the exciting topics to explore with it, at the intersection between HCI, computer-mediated human communication and psychology is *self representation*. In fact, we have already started to do research on this topic, investigating how

teachers represent *themselves* while using WNH to communicate with students as they use scripted navigation to visit a particular website and learn a particular lesson from the teacher [17]. This line of research has been listed as one of the most promising opportunities for semiotically-inspired research in HCI [9]. Semiotically speaking, computer programs and systems ultimately communicate content meant by humans (systems designers and developers) and to humans (systems users). Thus, as an explicit mediation tool, WNH is a prime instrument with which we can probe many and diverse possibilities in terms of metacommunication purpose, style and quality, as perceived by its various senders and receivers.

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