Focusing on Older Web Users: An Experience in Patagonia Argentina

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***Abstract*—Older Web users are now facing one of the most difficult challenges of their lives. The Web changes every day and they cannot keep up with it. As older age comes, individuals experience gradual and fluctuating decline in capabilities. These physical impairments make usage of the Web even more difficult. Web accessibility is an area devoted to solve accessibility problems of disabled people. However, as older people suffer disabilities, although less severe ones, they can profit from Web accessibility solutions. In this article, we review some of the most common impairments that affect older Web users, we analyze how these impairments are considered by Web Accessibility standards, and explore different approaches that improve Web user interface, in particular Email systems. Finally, we introduce our ideas to overcome unsolved Web accessibility barriers for older users describing an experience carried out at our University in Argentinean Patagonia.**

Keywords - Web Accessibility, Older Web users, User Interface (UI).

I. INTRODUCTION

This paper is an improved and expanded version of the ICSEA 2013 conference paper "Web Accessibility for Older Users: A Southern Argentinean View" [1].

The fact that the number and proportion of older people in the world population is progressively increasing arises as a critical factor to the present and future of civilizations, which are developing a strong dependence on Information and Communication Technologies (ICT). Particularly, the Web has become an essential tool and older Web users are struggling to keep up with technological changes and their demands of use in day-to-day life.

Most older adults experience age-related changes to their functional abilities (vision, hearing, cognition and mobility). These changes may complicate Web use [2], particularly for poorly designed sites. In Table I, we show some common functional impairments affecting older Web users, which we extracted from the literature review published by the W3C [3].

The study presented by Sayago and Blat [4] revealed that the accessibility barriers that had a more negative effect on the daily interactions of older people with the Web were remembering steps, understanding computer jargon and using the mouse.

Besides, from this study, we acknowledge that older Web users desire two conditions: independency and inclusiveness. Independency is the ability to use the Web on their own and inclusiveness is the need to interact with the Web using ordinary technology, as they do not intend to be different from the rest of users.

TABLE I. FUNCTIONAL IMPAIRMENTS AFFECTING OLDER WEB USERS

Ability	Impact	Difficulties
Vision	Screen Keyboard	1. Decreasing ability to focus on near tasks 2. Changing color perception and sensitivity 3. Pupil shrinkage and decreasing contrast sensitivity
Hearing	Audio Multimedia	4. Increasing inability to hear higher-pitched sounds
Motor skill	Mouse Keyboard	5. Slowness of movement, trembling
Cognitive	Overall Web use	6. Short term memory problems, concentration difficulties, distraction, change blindness

Another problem that older people have to face is social isolation [5]. Factors like diminished personal social networks, bereavement and health problems contribute to social isolation. Using the internet has significant value for elderly people, since it helps avoiding loneliness, boredom, helplessness, and decline of mental skills and it may increase the self-confidence, ability to learn, and memory retention.

Traditional communication technologies, such as the telephone, have played an important role in mitigating social isolation and supporting group gatherings. Also, the World Wide Web offers potential benefits for older adults, but its uptake is yet extremely limited.

One of the most used online communications is email. As of August 2011, Pew Research Center's report [6] observes that 34% of online seniors use social networking sites like Facebook and LinkedIn and 86% use email. We do not have detailed statistics in Argentina about older adults and online communications, the only fact is that 34.5% of adults who are ages 60 and older use internet.

There are many reasons why older adults do not use the Web [7]. Firstly, they tend to see the Internet as a tool to achieve functional goals such as bill payment, and not as a social or entertainment source [8]. Besides, they need an incentive to get and stay online [9]. It is often younger people who encourage technology use by older adults. Staying connected with geographically remote grandchildren is a major motivation for older adults in using technology

(such as email, chat, blog, video call and social network applications). An interesting finding was reported in [10], where it is suggested that given the right trigger many older people (even those previously uninterested) will make tentative steps towards some technology. In this case, the trigger was a disaster, the "ash cloud", which caused large scale disruption for air travel across Europe in 2010, and it motivated the need for computer usage.

Once older people are online they discover the advantages, such as being able to maintain existing social relationships and perhaps renew old ones that distance had precluded. Over two thirds of "silver surfers" say that using the Internet has improved their lives [11].

Other reasons for non-use of the Web include those involved with age-related impairments, such as the ones presented before in Table I.

In this paper, we analyze senior needs at the Web and explore different proposals to improve their Web interface experience [12]. Taking into account the state-of-the-art and the experience gained by our group while teaching computing to older people, we describe our ideas and show the improvements achieved during the delivery of the courses for elderly Web users. Since many fields are concerned on improving human-technology interaction, such as information retrieval and data mining, Human-Computer Interaction (HCI) and GUI, at this point, we have to clarify how we decided to face this work. We have been working for a while on accessible UI design to conform the W3C accessibility recommendations [13] [14]. Our knowledge gathered about UI design and Web Accessibility standards, permitted us to explore practical techniques to reinforce accessibility and usability and focus on the interaction between our seniors and the Web, using a real experience on Yahoo mail.

The rest of the paper is structured as follows: in Section II, we review Web accessibility standards and their relation with age related disabilities. Then, in Section III, we overview different useful approaches to improve older users' Web interface. After that, in Section IV, we examine three of the most popular email systems and analyze the accomplishment of their interfaces with desired characteristics of an older adult's oriented design. Then, in Section V we describe an experience performed at our University and explain our ideas for improvement. In Section VI, we introduce some discussion based on our experiences. Finally, in Section VII, we conclude and present some further work.

II. Web Accessibility Initiative Guidelines and Aging

The next few decades will see an unparalleled growth in the number of people becoming elderly compared with any other period in human history. The United Nations estimates that by 2050 one out of every five people will be over 60 years of age, and in some countries the proportion will be much higher than this [15].

There are some initiatives that provide advice addressing Web accessibility and usability for all people. As regards older users, many requirements are already considered by these initiatives.

The World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI) [16] brings together people from industry, disability organizations, government, and research labs from around the world to develop guidelines and resources to help make the Web accessible to people with disabilities including auditory, cognitive, neurological, physical, speech, and visual disabilities.

Among these series of guidelines developed by WAI, widely regarded as the international standard for Web accessibility, are: Authoring Tool Accessibility Guidelines (ATAG), User Agent Accessibility Guidelines (UAAG) and Web Content Accessibility Guidelines (WCAG).

- The Authoring Tool Accessibility Guidelines (ATAG) documents define how authoring tools should help Web developers produce Web content that is accessible and complies with Web Content Accessibility Guidelines.
- The User Agent Accessibility Guidelines (UAAG) documents explain how to make user agents (Web browsers, media players, and assistive technologies) accessible to people with disabilities, particularly to increase accessibility to Web content.
- The WCAG documents explain how Web content can be made accessible for people with disabilities. The WCAG 2.0 [17] has twelve guidelines, grouped in four fundamental principles of accessibility: perceivable, operable, understandable, and robust. Each guideline is in turn decomposed in a set of success criteria, which are classified within three levels of conformance: A (lowest), AA, and AAA (highest).

As we have said previously, many requirements for older Web users are already covered by these initiatives. But recently, the WAI [16] has moved a step forward to provide valuable recommendations related to older Web users.

The WAI project, Web Accessibility Initiative: Ageing Education and Harmonization (WAI-AGE) project [18] analyzed the Web accessibility requirements of older Web users based on the research and investigation of many people.

WAI-AGE has identified that the existing WAI accessibility guidelines address the majority of requirements of older people for Web use [19]. It also identified that many Web designers and researchers are not considering the WAI guidelines when making recommendations about Website design for older people.

Although the guidelines developed by WAI were not written with older users' problems in mind, they provide solution to many of them. In Table II, we show the results of performing a matching analysis between most common older people accessibility barriers, presented before in Table I, and the corresponding guideline in WCAG 2.0.

TABLE II. OLDER WEB USERS DIFFICULTIES AND CORRESPONDING WCAG 2.0 GUIDELINES

Difficulty	WCAG 2.0 Guideline
1. Decreasing ability to focus on near tasks	1.4
2. Changing color perception and sensitivity	1.4
3. Pupil shrinkage and decreasing contrast sensitivity	1.4
4. Increasing inability to hear higher-pitched sounds	1.2 – 1.4
5. Slowness of movement, trembling	2.1 – 2.2
6. Short term memory problems, concentration difficulties, distraction, change blindness	2.2 – 2.4 – 3.2 – 3.3

We can see that the first three difficulties, which are visual impairments, are addressed by WCAG 2.0 in guideline 1.4. The fourth barrier, a hearing disability, is tackled by guidelines 1.2 and 1.4. The fifth difficulties, motor impairments, are addressed by guidelines 2.1 and 2.2. Finally, the sixth barriers, cognitive difficulties, are considered by guidelines 2.2, 2.4, 3.2, and 3.3.

The former considerations show that WCAG 2.0 guidelines meet most of older Web users' requirements. The problem is that few developers conceive Websites design with these guidelines in mind. In any case, there are already useful proposals to explore for providing better practices addressing senior needs, as we have highlighted when introducing the bases of our ideas for improvements (see key issue (2) in Section I)

However, having proposals to explore and apply for implementing/developing improvements, attends only part of the problem. Again, as we have highlighted (see key issue (1), finding best proposals to involve elders in the process of discover good improvements, is another challenge.

On this spot, (WAI-AGE) project [18] proposes a working draft, Web Accessibility for Older Users: A Literature Review [3], which is an output particularly focus on Europe but relatively speaking, this document could also apply internationally as well. In particular, Section 3.7 emphasizes older Web users' participation and provides some insights for involving the elderly in Web design and development. For example, some of these basic advises are: making the participants comfortable; keeping them on track; listen for their beliefs about computers and the Web; avoid computer jargon; give them time; thinking aloud; etc.

III. DIFFERENT WEB SOLUTIONS THAT IMPROVE SILVER SURFERS' EXPERIENCE

Many Web solutions have been developed to address cognitive, perceptual, and physical changes related to aging.

Aula et al. [20], designed a simplified search interface, called Etsin. This study showed that a simple design makes the search experience less problematic and more manageable for older adults. Dickinson et al. [7] developed a proof of concept search and navigation system focused on the usability of the interface, which demonstrated that appropriate software could provide a more positive initial experience of the web and could increase elderly persons' confidence in their ability to master the Internet.

In [21], an email system for older people with no experience of Internet use was developed. The system, named Cybrarian system, had reduced functionality and a simple interface. It was meant to attract older people, who were unconfident in the use of computers, to use the Internet and encourage them to progress to more sophisticated Internet use. Hawthorn [22] developed SeniorMail, an email system based on Microsoft's Outlook Express, which addressed the problems older novice have remembering how a system works by having a list of possible actions presented in a simplified menu system. Another solution developed to improve elders Web experience is ElderMail [23]. This system allows seniors to communicate easily with others via a Web based email system designed with a very simple interface that uses only three color coded buttons to send and receive email.

Nevertheless, older people's functional impairments are very different in type (vision, hearing, mobility, cognitive) and severity, and usually change over time. Thus, it is very difficult to specify a unique Web interface that meets the requirements for all of them [24]. So, the solution could be that each individual older user would be able to select the appropriate configuration by themselves.

There are some very interesting works related with this idea such as the IBM's Web Adaptation Technology [25], which develops a browser extension that allows manipulating Web content by combining and applying a number of page transforms and adaptations according to user preferences without requiring Web designers and developers to rewrite their Web content. A similar approach is proposed in [26], an ActiveX-based accessibility solution called Easy Web Browsing was developed to add senior-friendly features to existing Web sites. This solution does not require Web site owners to change their existing Web content. This design allows Web site owners to keep their Web content stylish for the younger people, while enabling senior citizens to access them with the assistive technologies provided by this ActiveX object.

Another tool is the Senior Citizen on the Web 2.0 (SCWeb2) Assistance tool [27], which is designed to assist older users as they use Web 2.0 content. For some users, dynamic content can be problematic due to the many updating components throughout the page, causing them hesitancy, stress, and frustration about unexpected situations. This tool provides help only when users require it, avoiding assistance and browsing the page in the usual manner when support is not needed.

There are many other solutions that provide Web accessibility not specifically oriented to older people. For example, Garrido et al. [28] propose improving Web accessibility in client browsers through interface refactorings. This approach is called Client-Side Web Refactoring (CSWR), it allows to automatically create different, personalized views of the same application. The refactorings proposed are compliant with W3C guidelines.

Besides, there are tools that allow users to change the way Web content is presented. GreaseMonkey [29] is a

Firefox extension that allows writing scripts to alter visited Web pages. It can be used to make a Website more readable or more usable, Web applications can be modified by adding content and/or controls to them. For instance, Mirri et al. [30] describe GAPforAPE (GreaseMonkey And Profiling for Accessible Pages Enhancement), an augment browsing system based on GreaseMonkey, which allows Web users to set up their preferences at client side and thus modifying content on the browser interface.

A. Summary

There are many methods that have been developed to facilitate access to the Internet to older people. Some of them are specialized solutions, such as simplified browsers or email systems. However, this approach does not consider inclusiveness, one of the two desired conditions in ageing. The second kind of solution is personalization of appropriate features in Web pages. They can be easily selected if the user needs to use them. There are repositories with many of these personalizations available, but it is necessary to find the most suitable solution.

In our work, given most elders prefer to use standard Web applications, although they have difficulties when they use them, we chose this second approach to improve the application interface. As we could not find a complete built solution in the repositories, we developed some personalizations that make older users' experience easier. These personalizations instantiate solutions to the barriers faced by older people.

IV. E-MAIL INTERFACES FOR OLDER PEOPLE

Although elders meet various barriers to computer use, there is considerable evidence that a significant number of older people do use email. Given the importance of positive experiences for allowing continuing computer use, appropriately designed interfaces would be very helpful.

In [21], a research on email for older novices was performed. As result, researchers concluded that such an email system should have a reduced set of functionality presented in a non-cluttered way without menu systems, page-specific help and instructions for the user, and a one-click paradigm where a mouse-click always led to a new screen in order to reduce user confusion. Besides, the default system appearance should have larger text and higher contrast between foreground and background.

With these constraints in mind we evaluated the interfaces of three email systems: Outlook, Gmail and Yahoo. Through this analysis we could observe the following: Outlook interface is the most simple one, good contrast, large text and big buttons, only the necessary options on each screen. One problem detected is the banner of publicity that may distract or confuse the user. On the other hand Gmail interface is the most cumbersome. In the main screen there is a lot of information, different tabs, and buttons without labels. When a message is selected to read, the layout of the screen is very confusing. To write a new mail, a new small window opens, leaving the previous screen partially behind. The button options do not have labels, unless the mouse is over them. Last, Yahoo interface is rather simple. Main screen layout is very similar to that of Outlook, although it shows more options and tabs. In screens to write a new mail or answering, there are unlabeled buttons. Besides, it also shows a publicity banner. A problem detected for all of the three email systems is about closing user session. There is not a button option for this task, it is implemented as a menu option on user menu.

Since we teach Yahoo email to older adults who take courses at University, we decided to make our own experience with our elders and evaluate the usability of this email system.

V. EVALUATION OF OLDER USERS' EXPERIENCE IN PATAGONIA

Since 2009, the National University of Patagonia Austral and the National Institute of Social Services for Pensioners (PAMI) have signed an agreement [31] for teaching computing, music, and theatre courses to older people.

These courses are taught twice a week and last three months. Computing courses are the most crowded, having about 20 pupils each.

Older people who assist to computing courses have expressed that they come to learn computing because they want to keep in touch with their families, with their grandchildren who live in other country regions.

Here, in Patagonia, distances between cities or towns are extremely long; besides, we are 1242 miles away from the capital city, Buenos Aires. Moreover, the weather is a critical factor, too. Winters are very long and cold, and strong winds blow. As a result, older people spend most of their time inside their houses, and they often feel lonely. Thus, getting online can have positive benefits for them. Tools like Email, FaceBook and Skype can empower older adults to stay connected with their friends and family.

In this study the purpose is to find out, which are the accessibility failures that the email's Web interface has got and evaluate if a more accessible interface would allow older people to utilize it more frequently and without suffering frustration for not remembering how to use the application.

A. Experiment 1

During the second half of 2012, teachers taught email classes. At the beginning of 2013, when computing classes started again, teachers noticed that most pupils did not use this communication tool. When asked for the reason of not using it, most pupils said that they did not remember how to use it, a few said that they were not interested in sending or receiving mails, and the rest, only some of them, said that they still used it. So, the purpose of this experiment is to investigate what accessibility difficulties has got the email's Web interface design.

1) Participants:

Eighteen older adults ranging in age from 64 to 73 years old (eleven women and seven men) were recruited for this activity. All of them took computing courses between April and June of 2013 and also during the second half of 2012.

2) Materials:

For this experiment, we used Yahoo mail application (Figure 1), which was also used during email classes.

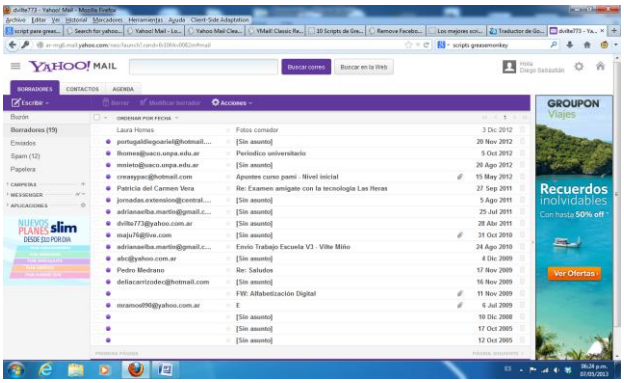

Figure 1. Yahoo mail inbox.

It is important to highlight that the courses are taught in a 25 desktops Lab equipped with 15 LCD monitors of 19-inch and 10 LCD monitors of 17-inch, whose resolutions are WXGA 1366 x 768 and XGA 1024x768, respectively. Although changing terminals settings (font sizes and colors) is posible, the Lab is used intensively every day to adopt this practice as usual.

3) Procedure:

Usability testing with the think-aloud method was conducted [32]. The evaluations were pair-based because older people feel more relaxed and confident about their work. Each evaluation was recorded, in order to analyze participants' behavior and comments.

4) Tasks:

Five tasks were proposed to explore the interface usability:

a) Read an email
b) Reply an email
c) Write a new email
d) Delete an email
e) Close user session

5) Results:

Of the 9 couples of participants, all could finish Tasks a) and c), 6 could not complete Task b), 2 could not conclude Task d) and 8 could not end Task e). These results are detailed in Table III.

From these results, we have found three problems throughout Tasks a)-e):

a) Problem 1: Advertisements

All participants complained about being distracted or even confused with the advertisements that appeared on the right side of the screen. They were afraid of clicking by error on these ads and causing an unexpected behavior of the email application, like closing, or losing the work being done.

b) Problem 2: Visual presentation difficulties

Besides, participants experienced other difficulties involving visual presentation of pages. Three couples of participants in Tasks a) and b) could not differentiate selected emails, because of light color contrast. Three couples of participants in Task a), three in Task b), and five in Task c) had difficulties in visualizing text because of font size, style, and inter-letter spacing. Also, 6 couples of participants in Task d) and 9 in Task e) made a great effort to distinguish available commands in menu bar.

TABLE III. RESULTS ACHIEVED BY OLDER USERS IN EMAIL USAGE *EXPERIMENT 1*

Task	Couples Error Ratio
a) Read an email	0/9
b) Reply an email	6/9
c) Write a new email	0/9
d) Delete an email	2/9
e) Close user session	8/9

c) Problem 3: Not understandable buttons

Participants also had trouble identifying buttons that represented email actions like "Reply" or "Forward". Eight couples of participants had difficulties identifying the button to conclude Task b), and 6 couples could not complete the task because of this problem. All participants had difficulties in Task e), remembering how to leave the application or "Sign Out", and only one couple could complete this task.

All the difficulties suffered by older users, are age-related issues like cognitive and visual impairment. Another factor involved is the lack of knowledge of technology and Web applications. Evaluating the WCAG 2.0 guidelines, we found that all these problems are considered within WCAG guidelines as we demonstrated before in Table II. Problems 1 and 3 correspond to difficulty number 6 detailed in Table II, which involves short term memory problems, concentration difficulties, distraction, and Problem 2 involves visual accessibility barriers shown as difficulties 1, 2, and 3 in Table II.

Hence, Yahoo email application is not compliant with this standard. However, this application provides solution to some of them, by setting appropriate configurations. But this is a very complex task to be performed by older users.

B. Experiment 2

The purpose of Experiment 2 is to evaluate an improvement to the email Website interface, which we developed to solve the problems found in Experiment 1.

In this improved interface, vertical banner ads have been deleted, and labels have been added for "Reply" and "Forward" buttons. Also, a button was added at the top of the form to allow users closing their sessions.

Figure 2 shows the modified interface of Yahoo mail inbox, including both adaptations: for Problem 1 vertical ads banner removement and for Problem 3 a button ("2" in Figure 2) labeled "Cerrar Sesión" to close user session, and the two labels "Responder" y "Reenviar" ("1" in Figure 2) for replying and forwarding, respectively.

1) Participants:

Fourteen older adults ranging in age from 66 to 74 years old (eight women and six men) were recruited for this activity. All of them took computing courses during the first half of 2012, and now they are taking theatre but not computing classes. However, they were willing to participate in this experiment.

Figure 2. Yahoo mail inbox after interface improvement.

2) Materials:

We modified Yahoo interface by applying two adaptations [33]. One of them is a script for deleting vertical ad banners that we downloaded from a scripts repository and the other one is a script developed for us in JavaScript to solve problems with buttons.

a) Problem 1: Advertisements

Although this vertical banner ad can be removed, this was not a permanent solution and became an annoyance to older pupils. In order to give solution to this problem, we chose GreaseMonkey. There are many add-ins that provide a number of features for visual and navigational enhancements to Web pages, which may fill usability gaps for older users.

Figure 2 shows the modified interface of Yahoo mail inbox where the vertical banner has been deleted. This modification was achieved by the installation of a GreaseMonkey script, CleanUp 1.1 that we downloaded from the scripts repository [34].

b) Problem 2: Visual presentation difficulties

Here, there are solutions provided by the browser and also by the operating system. The browser (Mozilla Firefox) allows modifying default settings for font size and style, and the operating system (Windows 7) provides an Accessibility Center that allows improving visual presentation, mouse setting and color contrast.

c) Problem 3: Not understandable buttons

At this point, we did not find any GreaseMonkey script, which solves difficulties with buttons' understanding or 'Sign Out' explicit inclusion in the application interface. So, we developed a script named "Oldie 1.0" that added labels to "Reply" and "Forward" buttons and a button to allow users closing their sessions.

3) Procedure and Tasks:

The same as for Experiment 1, detailed in Sections V.A.3) and V.A.4), respectively.

4) Results:

Of the 7 couples of participants, all could finish Tasks a), c) and e), 1 could not complete Task b), and 1 could not complete Task d). These results are detailed in Table IV. In this experiment, Problems 1, 2 and 3 detected previously have been eliminated. A couple of participants could not finish tasks b) and d) because they did not remember how to perform those tasks.

Therefore, we observe that this improved interface contributed to increasing task completion rates. But, for further analysis of the findings we performed statistical analysis of the number of participants that completed each task on each Yahoo interface.

TABLE IV. RESULTS ACHIEVED BY OLDER USERS IN EMAIL USAGE *EXPERIMENT 2*

Task Id	Task Description	Couples Error Ratio
a)	Read an email	0/7
b)	Reply an email	1/7
c)	Write a new email	0/7
d)	Delete an email	1/7
e)	Close user session	0/7

A significant Shapiro-Wilk test of normality indicated that the data were not normally distributed, in addition as the two samples are independent of each other, a Mann-Whitney U test was used. It demonstrated that there was not a significant difference in the median number of tasks completed on the original Yahoo mail application (Mdn = 7) and the modified Yahoo interface (Mdn = 7); the U-value is 11.5, the critical value of U at $p \leq 0.05$ is 4. Therefore, the result is not significant at $p \leq 0.05$.

Consequently, we decided to make a new experiment with a greater number of couples participating, in order to obtain more accurate results.

TABLE V. NUMBER OF PARTICIPANTS ACHIEVING TASKS

Task Id	Yahoo	Modified Yahoo
a)	9	7
b)	3	6
c)	9	7
d)	7	6
e)	1	7

C. Experiment 3

The purpose of Experiment 3 is to perform a new evaluation of partipants' accomplishments, as they successfully complete pre-defined tasks on both Yahoo mail application versions, the original one and the modified one. Besides, we are interested in comparing the usability provided by each interface.

1) Participants:

Fifty older adults ranging in age from 56 to 82 years old (thirty five women and fifteen men) were recruited for this activity. All of them participated in some UPAMI course previously, but they did not have the same computing level. Some of them had participated in several computing courses and others only once. Nevertheless, the idea of our experiment was to evaluate the usability in both versions of the application. If participants were not familiar with the original interface, then the new one would help them to accomplish tasks. In relation with the aging impairments, 42 participants suffered vision difficulties, 3 were affected with cognitive problems (short term memory) and 2 had a motor

disability (trembling). They were grouped in couples to perform the tasks.

2) Materials:

We used the two Yahoo interfaces that were already used in Experiment 1 and Experiment 2. Each Yahoo version run in a separate computer. Every couple of participants had two computers, one running the original Yahoo mail application and the other running the modified Yahoo mail application.

In addition, participants got a Likert questionnaire [35] asking what version they preferred completing each task on. This 5 point Likert question ranged from "Original" (original Yahoo) to "Modified" (Modified Yahoo) with a neutral point of "No Opinion". This resulted in five of these answers for each couple of participants (one for each task). The Likert questionnaire is detailed in Figure 3.

Besides, participants received two System Usability Scale (SUS) questionnaires [36], one per Yahoo interface version, which provided a 0-100 score relating to the usability of the corresponding Yahoo version (Figure 4).

3) Procedure and Tasks:

Each couple of participants was asked to attempt 5 tasks on both Yahoo versions:

a) Read an email
b) Reply an email
c) Write a new email
d) Delete an email
e) Close user session

These tasks were the same that the ones assigned in previous experiments. Participants attempted each task on one of the two Yahoo versions before moving on to the second Yahoo version.

After each task was performed, we noted whether a participant successfully completed the task, allowing completion rates to be investigated.

Then, after each task was completed on both systems, participants answered a Likert questionnaire on paper about what version they preferred completing the task on. This resulted in five of these answers for each couple of participants (one for each task). The Likert questionnaire is detailed in Figure 3.

After all tasks were attempted, participants completed two System Usability Scale (SUS) questionnaires [36], one by each Yahoo version, which provided a 0-100 score relating to the usability of the corresponding Yahoo version (Figure 4).

4) Results:

a) Task Completion Rates

In Table VI, we can observe the improvement of participants' performance when using the modified Yahoo mail application.

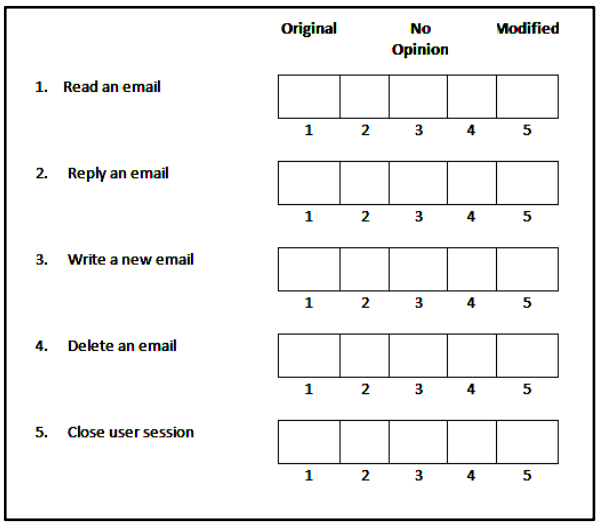

Figure 3. Likert questionnaire for expressing Yahoo version preference.

In Table VI, we can observe the improvement of participants' performance when using the modified Yahoo mail application.

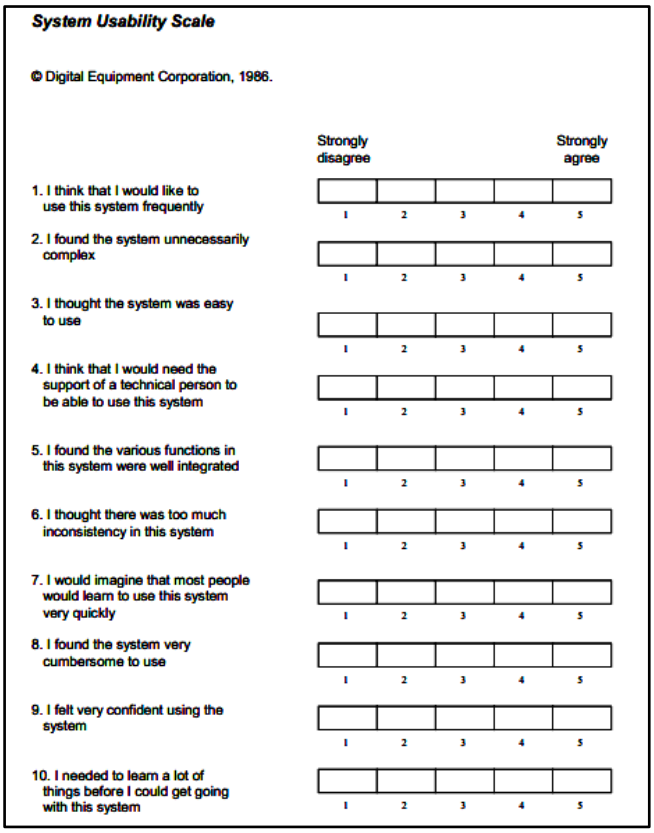

Figure 4. System Usability Scale (SUS) questionnaire.

A significant Shapiro-Wilk test of normality confirmed that the assumptions of a paired t-test were not met. Besides, as this experiment samples are paired, the Wilcoxon signed-rank test was used, which shows that a statistically significant difference exists between the median number of tasks completed on the original Yahoo application (Mdn=16) and the Modified Yahoo interface (Mdn=24). The W-value is 0. The critical value of W for N = 5 at $p \leq 0.05$ is 0. Therefore, the result is significant at $p \leq 0.05$.

TABLE VI. NUMBER OF PARTICIPANTS ACHIEVING TASKS IN EXPERIMENT 3. TOTAL NUMBER OF PARTICIPANTS: 25

Task Id	Yahoo	Modified Yahoo
a)	20	24
b)	12	18
c)	20	24
d)	16	22
e)	11	25

b) Preference Per Task

In Figure 5, we show the results of the Likert questionnaire, which illustrates participants' preference for Yahoo versions in each task.

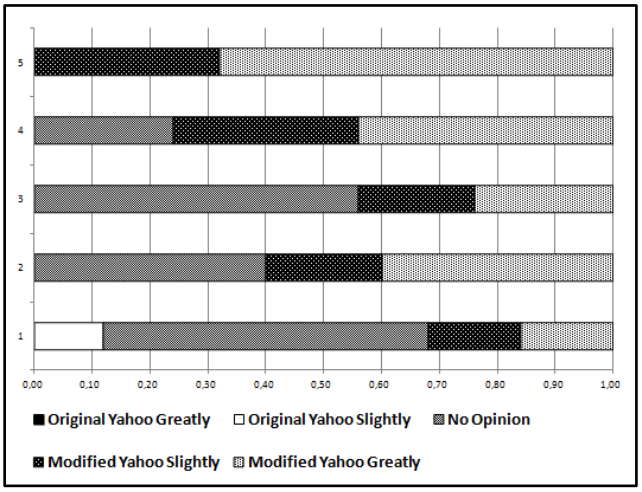

Figure 5. Bar chart showing Yahoo version preference responses for each task.

As we can see, no participant chose Yahoo in its original version for any task performed. The most preferred options were "Modified Yahoo" (Slightly or Greatly) and "No Opinion".

In Figure 6, a summary of Yahoo version preference responses is shown for all tasks performed.

The high frequency of "No Opinion" being selected may be partially explained by considering that some tasks were not directly affected by the modified Yahoo interface. This resulted in some tasks having the same steps to completion on both versions of the interface.

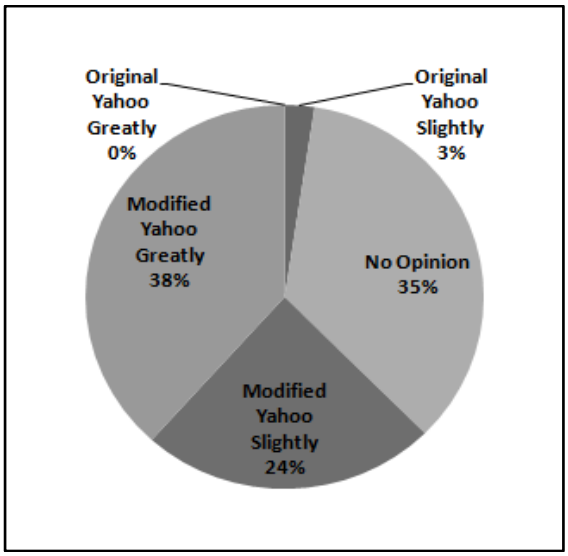

Figure 6. Pie chart summarizing Yahoo version preference responses.

For further analysis of the Likert-based preference questionnaire, we categorized answers into 3 categories: (1) Original Yahoo is preferred ("greatly"or "slightly"), (2) Modified Yahoo is preferred ("greatly"or "slightly") or (3) "No Opinion" is selected. We grouped the Likert points together to compare the three overall perspectives.

A Friedman test was used after the assumptions of a one-way repeated ANOVA were not met. The results of the Friedman test show that there was a statistically significant difference between the number of instances where participants preferred either the Original Yahoo interface (Mdn = 0), the Modified Yahoo interface (Mdn = 15) or "No Opinion" (Mdn = 10); $\chi^2(2. 5) = 6.3$, $p = 0.0429$. We can therefore conclude with considerable confidence that the observed differences among the mean rankings for the three categories of preferences reflect something more than mere random variability, they reflect a clear predilection for the Modified Yahoo interface.

c) System Usability Scale Scores

In this Experiment, we generated two SUS scores (one for each Yahoo version) per participant.

SUS yields a single number representing a composite measure of the overall usability of the system being studied. Note that scores for individual items (questions) are not meaningful on their own.

To calculate the SUS score, firstly the score contributions from each item must be added. Each item's score contribution will range from 0 to 4. For items 1,3,5,7, and 9 the score contribution is the scale position minus 1. For items 2,4,6,8 and 10, the contribution is 5 minus the scale position.

Then, the sum of the scores must be multiplied by 2.5 to obtain the overall value of system usability. SUS scores have a range of 0 to 100.

In Table VII, we show the corresponding scores obtained from each of the 25 participants in each Yahoo version. It can be appreciated that the Modified interface has got better usability scores than the original one.

TABLE VII. CALCULATED SUS SCORES PER PARTICIPANT AND YAHOO VERSION

Participant	Original Yahoo SUS Scores	Modified Yahoo SUS Scores
1	45	75
2	62.5	75
3	60	100
4	50	70
5	62.5	90
6	67.5	82.5
7	67.5	82.5
8	47.5	87.5
9	60	85
10	67.5	82.5
11	67.5	82.5
12	45	75
13	62.5	75
14	62.5	75
15	60	85
16	75	75
17	55	87.5
18	55	87.5
19	42.5	90
20	50	75
21	50	75
22	55	87.5
23	67.5	82.5
24	63	90
25	68	82.5

Using a Wilcoxon signed-rank test, we can show that there was a significant difference in the SUS scores for the Original Yahoo interface (Mdn = 60) and the Modified Yahoo interface (Mdn = 82.5); Z = -4.2857, p = 0. The result is significant at $p \leq 0.05$.

Table VIII shows the median response to each SUS question per interface version. These detailed individual questions of the two SUS scales allow for more specific comparisons into the different components of the SUS's usability model over just the score alone. For example, participants strongly agreed that they would like to use the Modified Yahoo interface frequently, but had no opinion about the same question regarding the Original Yahoo interface.

VI. DISCUSSION

Many of the difficulties suffered by older Web users are already solved. However, as older people do not recognize their disabilities, they miss the opportunity to use the Web in a more comfortable way.

There are many accessibility tools provided by the operating systems and also by the Web browsers. But as they are classified as 'Accessibility Tools', most users believe that they are targeted to help people with severe disabilities that do not include the elderly.

Besides, there are some useful accessibility tools developed and available in Web repositories.

We have worked with some email accessibility requirements detected while teaching computing courses to older adults. Experiment 1 allowed for gaining a significant experience to develop our ideas, while Experiment 2 applied for testing these ideas on the field. Afterwards, in Experiment 3 we performed a more complete execution of both Experiments 1 and 2, including additional activities to allow usability comparison and evaluate interface preference between participants.

We found that some of the detected requirements could be solved by modifying the Web browser or the operating system configuration. Other requirements were accomplished by installing some scripts that provide the desired accessibility adaptations, like the scripts (CleanUp 1.1 and Oldie 1.0) we proposed and developed to solve Problems 1 and 3, respectively.

However, all these solutions require assistance from a computing specialist, or at least, from someone with the required skills, who must configure or install the appropriate add-ins.

Thus, we are working on a pragmatic research approach and applying an iterative incremental process to develop a tool that includes all the accessibility adaptations and allows older people select the appropriate configuration by themselves. Besides, this tool must be able to provide help to older users, who are not familiar with application concepts and hence avoiding hesitation and frustration. This will contribute to increasing quality of life of our Patagonian older Web users.

VII. CONCLUSION

Older adults represent the fastest growing portion of the world's population. Most older adults have got some declines that affect computer use, as difficulties with vision, hearing, mobility or cognition.

The World Wide Web Consortium (W3C) has got some initiatives like Web Accessibility Initiative (WAI) and Web Accessibility Initiative: Ageing Education and Harmonization (WAI-AGE), which provide solutions to many of the problems of older people. However, many Web designers do not consider WAI recommendations when designing Websites.

So, there are some approaches focused on improving Websites' accessibility. Some of them consist on Web adaptations that provide solution to a varying amount of accessibility issues.

TABLE VIII. TABLE SHOWING THE MEDIAN RESPONSES TO THE INDIVIDUAL LIKERT QUESTIONS IN THE SYSTEM USABILITY SCALE FOR EACH YAHOO INTERFACE VERSION.

SUS Question	Original Yahoo Median	Modified Yahoo Median
1. I think that I would like to use this system frequently	No Opinion 3	Strongly Agree 5
2. I found the system unnecessarily complex	No Opinion 3	Strongly Disagree 1
3. I thought the system was easy to use	Strongly Agree 5	Strongly Agree 5
4. I think that I would need the support of a technical person to be able to use the system	Disagree 2	Strongly Disagree 1
5. I found the various functions in this system were well integrated	No Opinion 3	Agree 4
6. I thought there was too much inconsistency in this system	Disagree 2	Disagree 2
7. I would imagine that most people would learn to use this system very quickly	No Opinion 3	Agree 4
8. I found the system very cumbersome to use	No Opinion 3	Disagree 2
9. I felt very confident using the system	Agree 4	Strongly Agree 5
10. I needed to learn a lot of things before I could get going with this system	No Opinion 3	Disagree 2

In this article, we showed different solutions provided to solve distinct older pupils' requirements. However, from our experience, we must highlight two issues about these solutions: (i) they do not cover all needs and, (ii) they are not usable enough for elderly citizens. Due to these reasons, new solutions should be developed and these solutions must prevent older people having to get help from someone else who can configure or install suitable accessibility settings to grant our seniors one of their main wishes: "independence".

As regards social requirements of our older students, our next goal is exploring difficulties experienced by them with social networks and finding appropriate solutions. This is a high priority requirement of our older citizens since our distant geographical situation and extreme weather conditions deprive them of enjoying many current activities that older people in other geographies can perform.

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