HCI related papers of Interacción 2004

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HCI RELATED PAPERS OF INTERACCIÓN 2004

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Editors' Introduction

The present book contains a collection of the best papers presented at the *5th International Conference* on *Interacción Persona Ordenador* (IPO) (which is Human Computer Interaction in Spanish), which took place in Lleida on May 5th-7th, 2004. This conference was co-organised by the *Universitat of Lleida* and the *Universitat Oberta de Catalunya*.

Each year this conference is promoted by the *Asociación para la Interacción Persona Ordenador* (AIPO), the Spanish Human Computer Interaction Association, in collaboration with the local group of ACM-SIGCHI (CHISPA). In its fifth edition this conference has become a multidisciplinary forum for the discussion and dissemination of novelty research in Human Computer Interaction.

The main goals of Interacción 2004 were:

To expand the conference scope with internationally recognised invited speakers. The plenary talks were presented by Alan Dix, Yvonne Rogers, Geritt van der Veer, and Angel Puerta.

To open the participation to Spanish speaker worldwide in order to be a point of reference of this discipline not only in Spain but also in the wider Spanish speaking community. This goal was reached through a very diverse program which included panels and posters sessions, where many different aspect of the Human Computer Interaction (HCI) were presented. All through the program, research from outside Spain was reflected through the contributions from people of other countries.

To enrich the relationship between industry and academia through the organisation, for the first time, of a day of the Industry-Academia Collaboration. During this day's diverse activities, round tables and panels were conducted, and numerous practitioners of HCI joined our conference specifically for that event.

To increase the multidisciplinary nature of the contributions to the conference. Towards this goal a great effort was made to involve researchers from disciplines close to HCI.

To help in the development of doctoral dissertations of high quality, a doctoral consortium was held for the first time.

This book is organised according to the main areas of both basic and applied research that were presented at the conference. These areas were:

- Usability and Accessibility
- Ubiquitous computing and context aware systems
- Interaction with learning recourses
- User Centred design methodologies
- Cooperative systems
- Models of interactive systems
- Applications of User Centred design
- Information of Visualization
- HCI methodologies
- Semantic web
- Group learning and work

Regarding the reviewing process, our program committee, reviewers and meta-reviewers (integrated by recognised researchers both from Spain and from the international community), made a great effort in selecting the best papers for the conference and later on for this publication. The success rate for submitted papers to be part of this publication was 54%. We will like to acknowledge the effort of the program committee of this publication: Julio Abascal, Xavier Alamán, Josep Blat, José Cañas, Pablo Castells, Alan Dix, Miguel Gea, Jesus Lores, Roberto Moriyón, Raquel Navarro, Manuel Ortega, Mari Carmen Puerta and Yvonne Rogers. We will like to also thanks the two universities that co-organised this conference, namely, the *Universitat de Lleida* and the *Universitat Oberta de Catalunya.*

We hope that you enjoy your reading and find this book useful.

An Expert-Based Usability Evaluation of the EvalAccess Web Service

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1. Introduction

The activities developed by means of Internet have rapidly increased in the last years. Most of the Internet success is due to the proliferation and popularization of information and services provided through web sites. However, many web pages have been designed without having in mind that there may be people, devices and even browsers that can not access them. A number of initiatives have been developed to prevent web accessibility barriers, including the accessibility laws promulgated by diverse coun-tries-such as the Section 508 in the USA-. There are also independent institutions that have compiled accessible design guidelines, some of them with great influence in the design of accessible web pages. In particular, the best known ones are the guidelines compiled by the Web Accessibility Initiative (WAI), which is part of the World Wide Web Consortium (W3C) [1]. All these initiatives specify and regulate the characteristics that universal accessible web sites must have. However, these efforts are not enough if developers are not provided with tools that support universal design.

EvalAccess is a tool that automatically evaluates the accessibility of web pages. It is an evolution of the EvalIRIS tool that was developed within IRIS European project [2]. EvalAccess allows verifying whether a web page -or a web site-satisfies a particular set of guidelines in order to determine its accessibility. WAI accessibility guidelines are habitually used, but EvalAccess can evaluate the compliance with any other set of guidelines if they are specified using a specifically designed XML schema. This automatic evaluation tool has been implemented as a web

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service[1] in order to be used from any web application. In this way, accessibility evaluation can be performed from any tool and can be included in the development life cycle.

Even if EvalAccess was designed as a web service to be used not by human beings but by other applications, a user interface application was developed in order to allow people to directly make use of EvalAccess. Its main aim was to let web developers and evaluators to access the services provided by the web service. Subsequently, it was found that the interface was also useful for users interested in directly performing web accessibility evaluations. Therefore, this user interface was made publicly accessible. The original interface was simple and straight because it was oriented to the own developers needs. When the Laboratory of Human-Computer Interaction for Special Needs decided to provide a public interface, the need of a deep usability evaluation and a subsequent redesign was recognized.

2. Characteristics of the evaluation

Among the frequently obviated metrics criteria[2] that any evaluation tool should accomplish such as Validity, Reliability, Sensibility, Diagnosticity, etc. Usability is one of the most relevant. We adopted this criterion as the primary requirement of the EvalAccess user interface in order to provide a Usable and Accessible way to the application.

The main purpose of this paper is the application of this criterion in a usability testing exercise, that is, the evaluation of the usability of EvalAccess interface itself. For this purpose two Expert-based Usability Inspection Methods were used: Revision of Guidelines and Heuristic Evaluation. The second step, the Empiric Method (controlled experiment with real users), is currently under development. In the next section the main methods of Usability Evaluation are summarized and the advantages and disadvantages of Expert-based Evaluation are discussed.

[1] A web service is an application that allows communication with other applications through Remote Procedure Calls (RPCs) in a distributed environment (for example, a remote or local network) [3]. The main advantage of web services is that they are platform-independent. Normally both, inputs (parameters) and outputs (results), have an XML format [4].

[2] O'Donnell & Eggemeier provide more information on metrics criteria [5].

3. A brief revision of usability evaluation methods

There are many taxonomies for classifying Usability Evaluation Methods (UEMs) according to different dimensions or categories. In this study we used the taxonomy of Andre [6] which classifies UEMs into three categories: (1) Empirical Methods, (2) Expert-Based Usability Inspections and (3) Analytic or Model-Based methods.

In this exercise, we utilized two techniques classified into Expert-Based Usability Inspections: Guideline Reviews and Heuristic Evaluation. Expert Inspections consist of the exhaustive examination of those specific aspects of an interface which are related to the effective, efficient and satisfactory interaction of users, carried by experts in the field. According to Mack and Nielsen [7] in the Guideline Reviews method experts analyse the conformity with a comprehensive, and frequently extensive, list of usability guidelines. Its main advantage is that, due to its easiness, it allows experts to perform structured evaluations avoiding formal training [6]. There are numerous sets of guidelines proposed for different types of interfaces. The most adjusted to our objective are Nielsen & Tahir sets of Homepage Usability Guidelines [9]. Its features will be explained in the next section. Nevertheless, Guideline Reviews has also disadvantages: guidelines are frequently vague, and sometimes contradictory, and lacking empirical support. In addition, according to Abascal and Nicolle [8], when the number of design guidelines is too large their application may result tedious.

On the other hand, according to Andre [6], Heuristic Evaluation uses a reduced number of experts that examine the interfaces according to recognized usability principles or general rules which describe common properties of usable interfaces. The main advantage of these techniques is that they are easy to use and they help to find several usability problems with low cost. However, the results of the heuristic evaluation are influenced by the subjective experience of the experts and can produce "false alarms". The list of heuristics proposed by Molich, R., & Nielsen [10] and Nielsen [11] are among the most used and validated. They are based on a factorial analysis of 249 usability problems. In the next two sections, we describe our experience with these two techniques used to evaluate the usability of the Web Service EvalAccess

4. Guideline Review of three Web Services: EvalAccess, Wave and Bobby.

As previously mentioned, the Nielsen & Tahir List of Homepage Usability Guidelines

[9] was selected with the aim of evaluating and contrasting the usability of EvalAccess. We also selected two tools, similar to EvalAccess, Wave [12] and Bobby [13], which provide their services through the Internet by means of a web interface. Four usability experts, members of the Laboratory of Human Computer Interaction for Special Needs (University of the Basque Country), took part in this study. Each expert evaluated the homepage of the three Web services: EvalAccess, Wave and Bobby. The order of the evaluation was balanced between experts for preventing the sequence effect.

Before performing the guideline review, we analysed the degree of agreement between experts with regard to the applicability of the selected guidelines, since the web pages evaluated were not strictly homepages. Therefore, two evaluation objectives were agreed:

- To analyze the applicability of the Nielsen's web page usability guidelines to the selected web sites and to select the most adequate ones

and

- To assess the compliance of each web page with the selected guidelines.

4.1. Applicability and Agreement among Experts

The list of Nielsen & Tahir Homepage Usability Guidelines classifies them in 26 categories: (1) Communicating the site's purpose, (2) Communicating information about your company, (3) Content writing, (4) Revealing content through examples, (5) Archives and accessing past content, (6) Links, (7) Navigation, (8) Search, (9) Tools and task shortcuts, (10) Graphics and animation, (11) Graphic design, (12) UI widgets, (13) Window titles, (14) URLs, (15) News and press releases, (16) Popup windows and staging pages, (17) Advertising, (18) Welcomes, (19) Communicating technical problems and handling emergencies, (20) Credits, (21) Page reload and refresh,

(22) Customization, (23) Gathering customer data, (24) Fostering community, (25) Dates and times, and (26) Stock quotes and displaying numbers.

	>50%	<50%	U	Z	P level
EvalAccess	285.000	66.0000	0.00	4.28	0.00
Wave	284.500	66.5000	0.5	4.26	0.00
Bobby	285.000	66.0000	0.00	4.28	0.00

Table 1. Results of the Mann-Whitney U Test used to compare applicable and non applicable categories of guidelines for each Web Service Interface.

The task of the experts was simply to decide if a guideline was applicable to evaluate de usability of the proposed interfaces. We calculated the proportion of guidelines applicable for each category and each interface. The result was used like an index of category applicability in each interface. We performed a Kendall's Concordance Test to analyze the agreement between experts about the applicability of each category. This test provides a coefficient of concordance which ranges between 0 and 1, where 0 means lack of agreement and 1 means total agreement. The coefficient of Kendall's Concordance for the three web service interfaces was 0.8 (Aver. rank r = 0.77) which means that experts agreed on category applicability in an 80%. To know if there were differences in the applicability index for each Web service interface we applied the non parametric Kruskal-Wallis Test. We introduced the Type of Web Service Interface (EvalAccess, WAVE and Bobby) as independent variables and the global index of applicability as dependent variable. The differences between Web Service Interfaces were not significant. Finally, the indexes of applicability were used to divide the categories of guidelines between applicable (>0.5) and non applicable (<=0.5). The Mann-Whitney U Test (see Table 1), showed that the difference between applicable and non applicable categories was significant for all Web Service Interfaces. This result allowed us to remove the categories of guidelines which were not applicable enough (categories 2, 8, 9, 14, 15, 19, 22, 23, 24, 25, 26).

4.2. Results of Guidelines Review

The same experts who performed the applicability test participated in the Guideline Review. The task of the experts was to decide which of the fifteen guidelines selected in the previous phase were fulfilled by each Web Service Interfaces.

We calculated the global percentage of guidelines fulfilled by each interface and the percentage of guidelines fulfilled per categories for each interface. According to Nielsen & Tahir [9] the values above 90% mean that the web page evaluated is usable; web pages with values between 90% and 80% could be considered moderately usable; for web pages with values between 80% and 50% the redesign is recommended; and web pages with values below 50% are intractable and the redesign is absolutely recommended. In the case of EvalAccess interface, the 87% of guidelines were fulfilled. The analysis per categories showed that the categories 3, 5, 11, 12, 16, 18, 20 and 21 were fulfilled to the 90%; the categories 6, 7, 10, 13 y 17 were only fulfilled to the 80% approximately; the category 1 to the 60% and the category 4 to the 30%. Therefore, according to Nielsen & Tahir, the global redesigned of this interface would not be necessary and it could be enough to redesign the aspect related to the guidelines of the categories 1 and 4 (respectively, Communicating the site's purpose and Revealing content through examples). The global fulfilment score of Wave Interface and Bobby Interface was respectively 82% and 75%. With the aim of contrasting if the guidelines fulfilment of EvalAccess Interface was significantly higher than the fulfilment of the other two interfaces, we performed a non parametric Kruskal-Wallis Test. The results showed that EvalAccess Interface was significantly more usable than Bobby Interface ($H(1, N = 8) = 5.33$ $p = 0.020$) but not more usable than Wave Interface.

5. Heuristic Evaluation of EvalAccess

Heuristics set proposed by Nielsen [11] were chosen in order to carry on this evaluation: 1. Visibility of system status, 2. Match between system and the real world, 3. User control and freedom, 4. Consistency and standards, 5. Error prevention, 6. Recognition rather than recall, 7. Flexibility and efficiency of use, 8. Aesthetic and minimalist design, 9. Help users recognize, diagnose, and recover from errors and 10. Help and documentation.

The user profile selected was "a novice user accessing EvalAccess website for the first time". Performing the accessibility evaluation of a web page was selected as the main use case, which was divided into eleven use scenarios. The following list summarizes the objectives of these use scenarios: 1. Read the using instructions, 2. Specify the web page to evaluate, 3. Configure the evaluation options (priority levels), 4. Acces the evaluation results, 5. Analyze the evaluation results, 6. Save/Print the evaluation results, 7. Perform a new evaluation, 8. Go back to homepage

from the evaluation results web page, 9. Go back to evaluation results, 10. Contact the organization which offers the service, 11. Search for related links.

5.1. Procedure

The same four experts who carried on the guidelines review participated in this process. Each expert familiarized with the EvalAccess user interface before performing individually the Heuristic Evaluation. The experts contributed with a brief description of errors found in each scenario. Then, they decided on the heuristics applicable to each encountered error, sorting them according to their applicability order. Finally, the four evaluators produced a report, discussed the different evaluations and synthesized the results.

5.2. Results and Discussion

A table showing the number of found errors and the number of not fulfilled heuristics in each scenario was produced by each expert. This allowed us to quantitatively sort and summarize the obtained data. Firstly, the average (M) of the found errors in each scenario and each evaluated web page was calculated (see Figure 1a). As can be seen, scenarios 2 and 5, Specify the web page to evaluate (M = 2) and Analyze the evaluation results (M = 3.75), gave the highest average value of errors. The next highest average value was produced by the scenarios Configure the evaluation options (M = 1.75) and Access the evaluation results (M = 1.75). The average of errors for the remaining scenarios was 1.

According to the data analysis by heuristic (Figure 1b), the highest average values for heuristics not fulfilled were produced by heuristic 10 (M = 0.77) and 6 (M = 0.66). Therefore, considering the totality of scenarios the less fulfilled heuristics were Help and documentation and Recognition rather than recall.

The heuristics not fulfilled in the scenario where the highest errors average values were obtained (Specify the Web Page to evaluate (2) and Analyze the evaluation results (5)) were also analyzed. The heuristics that gave an average value for found errors higher than 1 were the following: 8 (Aesthetic and minimalist design), 7 (Flexibility and efficiency of use), 6 (Recognition rather than recall), 5 (Error prevention), and 10 (Help and documentation).

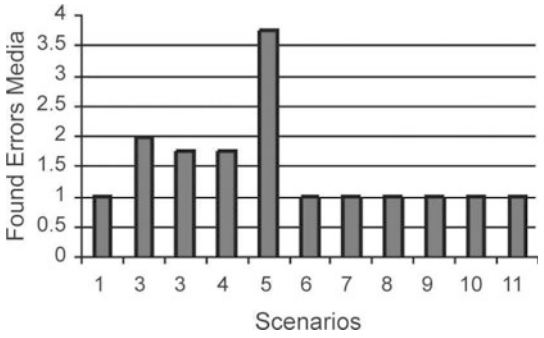

Fig. 1a. The figure shows the Average values of found errors in each EvalAccess use scenario.

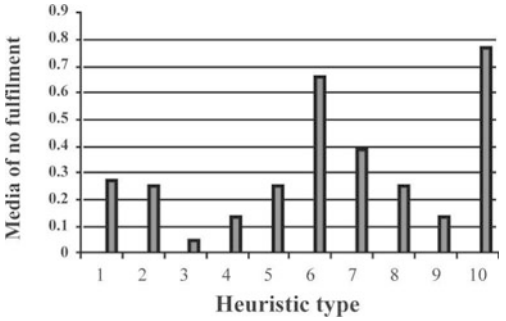

Fig. 1b. The figure shows Average values of found errors by heuristic in all EvalAccess use scenarios.

6. General Discussion of Experts' Usability Evaluation

Both the result of Guideline Review and Heuristic Evaluation reveal that EvalAccess interface provides not sufficient help and documentation of the system which allow the users to understand the propose and functioning of the EvalAccess Service. Errors which experts connect with "Help and documentation" heuristic describe situations as: poor description of the service is provided, help is not provided, the user does not know how to use the service, etc. On the other hand, Heuristic Evaluation shows some important usability problems not revealed in the Guideline Review, for example the interface produces excessive memory charge. According to the heuristic "Recognition rather than recall", the situation is described in this way: the buttons for performing the accessibility evaluation task are not explicit enough, configuration features of the priority of the evaluation are not visible and are not available in every part of the interface, the title of the results is not visible (the user has to remember which web page she/he has evaluated), etc. Therefore, descriptions of these errors have to be considered when improving the usability of the interface.

Additionally, Heuristic Evaluation allows us to evaluate diverse scenarios, which make possible to refine the diagnostic of usability problem. Regarding the scenario that obtained the highest average value of errors, Analyze the evaluation results (5), the errors that could mainly cause usability problems were related to: providing extra and redundant information, lack of visibility of the information summarizing tables, inexistence of direct accesses to parts of information (as hyperlinks), lack of errors prevention (for instance, absence of any explanation of results meaning). Therefore, this data has to be considered as a main concern when redesigning EvalAccess interface since this scenario is the one which could cause major usability problems.

7. Redesign based on the results of Evaluation by Experts

EvalAccess web service was redesigned based on the results obtained in this analysis. This redesign process was divided into two phases: homepage redesign and accessibility evaluation results page redesign.

7.1. Homepage redesign

The original homepage is shown in Figure 2. As can be seen in the figure, the homepage contained the following elements: logo and links to the entities or organizations involved in the development of the tool, several links to related information, two alternative text boxes –one of them for introducing the URL of the web page to evaluate, and the other one for introducing the HTML code to evaluate–, and a button close to each text box. Clicking any of these buttons will start the accessibility evaluation process.

Fig. 2. Original EvalAccess Homepage.

By using the elements mentioned above, different tasks can be performed:

- Accessibility evaluation of an on-line web page. This task can be performed by introducing the URL of the web page in the first text box and clicking the correspondent button.
- Accessibility evaluation of HTML code. Copying and pasting the HTML code into the second text box and clicking the associated button is enough in order to perform this task.

In addition to the previously described tasks, it is possible to configure some options of the evaluation process, for instance, it can be selected the priority of the accessibility guidelines that are going to be used to evaluate the on-line web page or HTML code.

As a result of the review of design guidelines, experts concluded that the redesign of the following categories was crucial.

- Communicating the site's purpose (Category 1)
- Revealing content through examples (Category 4) The problems and their solution related to Category 1 are the following:
- There was not any logo of the tool. A logo was designed and introduced in the left top of the web page as it is stated in [9].
- There was not any description of the purpose of the tool. A brief description was incorporated in the top of the page, under the logo of the tool.
- The most important tasks the user can perform with the tool were not clearly presented. A navigation bar was included in the web page, so the user can easily access to the different services offered, more information about the tool and help and using instructions. In addition, the navigation bar informs the user about the option or service which is currently performing (associating a different style to the active link). According to category 4, the main problem was the inexistence of any graphical examples that helped the user to have a better understanding of the existing content in the web page. The incorporation of these examples would cause conflict with the minimalist design heuristic, so the experts decided to prioritize this heuristic. Therefore, the solution adopted consisted of the help and instructions section and the brief tool description inserted on the top of the web page.

Issues detected in the evaluation of heuristic 10 and heuristic 6 were our priorities when solving the problems arisen from the heuristic evaluation, as these problems affected generally to all the described scenarios.

The detected problems and implemented solutions related to the heuristic 6 were the following (see Figure 3a y 3b):

- The action performed by each button on the web page is not clear and the text they contain is not consistent. Implementation of a navigation bar was agreed in a previous step of the redesign. This action also is a

solution for the correspondence between the service and the button that performs it. The texts of the buttons performing the same action were homogenized. Moreover, the implemented navigation bar maximizes the conformance of this heuristic, as it makes possible access to the instructions or any other option from any web page or section of the interface.

- The configuration options of the evaluation were not visible enough as they were on the down part of the web page and it was not clear which services they affect to. These options were placed below each service when dividing the services in different web pages, so the use of this feature was facilitated.

Fig. 3a. Redesigned EvalAccess Homepage. The shows the option of inserting the URL.

Fig. 3b. Redesigned EvalAccess Homepage. The figure shows the option of inserting the HTML code.

The problems detected when evaluating the heuristic 10 were solved by the implementation of the help and tool using instructions section.

7.2. Accessibility Evaluation Results Page Redesign

As it is shown in Figure 4, the original results page was formed by the evaluated web page, a summary table of all found accessibility errors and the complete report consisting of detailed information of each error, and a link to a web page where more information can be obtained.

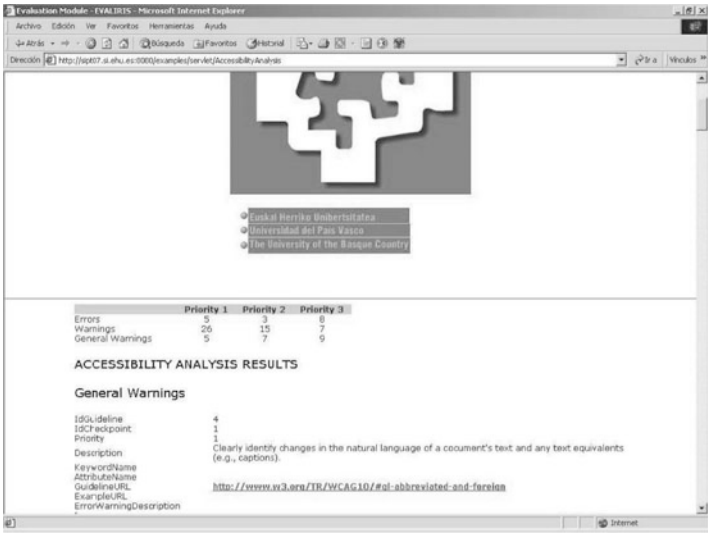

Fig. 4. The figure shows the Original EvalAccess evaluation results web page.

As a result of the heuristic evaluation, the scenario where most errors were obtained was Analysis of the Evaluation Results. This led us to completely redesign this web page. Although some detected errors affected heuristic 5, Error prevention, they were not taken into account in the redesign as their solution required changes in the implementation of the tool itself, as well as, modifications in the interface. Therefore, the redesign was focused on the following heuristics: 8, 7, 6 and 10.

The detected errors and the implemented solutions, in order to maximize the conformance of heuristic 8, were the following (see Figure 5):

- Excessive information was presented in a lineal and no-ordered way. The results web page was structured on several tables, one of them showing the global data of the evaluation and others reporting the found accessibility errors in detail. The information was shown formatted in columns in order to minimize the number of rows required for reporting one and therefore reducing the need of using the scroll.
- In the original results page, the evaluated web page was shown before the report of found accessibility errors. This was irrelevant to the user. The solution was to remove the evaluated web page from the results page showing only the important information, the errors report.
- Unusable information was shown in the report, such as empty fields. The solution taken was to remove these empty information categories.

Regarding heuristic 7, the main problem detected was the lack of efficiency when visualizing the detailed information provided in the report. This problem was solved incorporating links from the global resume table to the related detailed information in the report.

Fig. 5. The figure shows the redesigned version of the evaluation results web page.

Detected errors and their solutions in order to conform to heuristic 6 were the following:

- There was not any explanation about the meaning of the configuration options defined for performing and showing results of the accessibility evaluation. The meaning of these options was incorporated below the global resume table of results.
- In the results page shown after an on-line web page accessibility evaluation the URL of the evaluated page was not shown in an appropriate place, so the user could not easily identify the results of the evaluation of which web page she or he was viewing. The URL of the evaluated on-line web page was moved to a highlighting position in the redesigned results page. Regarding heuristic 10, previously described help and tool using instructions section has been designed and implemented. The description of the results' format and each part of the resulting report were included in this section.

8. Conclusion

The goal of this study was performing a usability evaluation of the EvalAccess web service interface. Initially, this user interface was designed with the aim of being used only by accessibility experts and by the service developers themselves. However, its use was spread out to incidental or inexpert users that do not know accessibility tools. For this reason, it has been necessary to evaluate the usability of the interface for this new user profile in order to achieve an efficient, effective and satisfactory interaction.

With this objective in mind, we made a study based on expert-based usability evaluation methods. This approach has demonstrated its validity for finding design errors that can cause problems in the use of the interface by novice users. It also showed a number of design errors that may make the interface impractical. One of the used techniques, the Revision of Design Guidelines, showed that EvalAccess interface was significantly more usable than the interface of other similar web service (Bobby). Both used techniques (Revision of Design Guidelines and Heuristic Evaluation) provided us some diagnostic data about the causes of the usability problems. Some of these causes are the following: missed communication about the purpose of the site, lack of specification of the tool functionalities that can be used via web, user memory overload due to the presentation of redundant and irrelevant information, etc.

This data set allowed us to redesign EvalAccess user interface. The comparison between the two versions of the interface (pre- and post-redesign) will serve on the secon

d phase of the study, which is currently b eing made, to contrast whether the expert-based evaluation results really express the usability problems detected by users. Furthermore, it will be used to evaluate the efficiency of the design solutions that are implemented in order to overcome the problems of the redesigned interface.

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Adaptive and Context-Aware Hypermedia Model for Users with Communication Disabilities

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1 Introduction

Technological advances improves our every-day life, and should be beneficial for all, and mobile technology gives new opportunities to user with special needs [2]. Augmentative and Alternative Communication (AAC) Systems [10] provide devices and techniques to improve the communicative ability of a person whose disability makes it difficult to speak. The causes may vary from one person to other for different reasons (sensorial, physical or psychical disabilities), it can be a temporal or permanent disorder and the population is very heterogeneous. There are several AAC systems, which are being used by different communities: sing languages (deaf people), pictorial languages, templates and communicators (e.g. Alphatalker using the Minspeak language [1]).

One of the collectives demanding such systems is children diagnosed as having autism. Autism is considered a lifelong neurological disorder characterized as follows [7]:

- These children have difficulty with social relationships and with verbal and non-verbal communication.
- The pathology and its manifestations vary from one child to another. Each child manifests different behavior, capabilities and expectations.
- The child is strongly influenced by his environment, preferring predictable situations. Changes in environment could provoke unpredictable changes in the child behavior.

Difficulty in communication causes many problems to these children, provoking fears and anxiety crisis. The crises often occur when the situation/activity is new, frustrating, uncertain or difficult. In this field, therapeutic researchers have focused on reducing the behavioural

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symptoms, anticipating future events and creating controllable situations [4] and elicitation methods [6].

One of the main objectives of an AAC system should be adapting to different kind of users and user needs. However, current AAC systems do not cover these requirements. The communicators are far too general to be used by a broad community, or they are created for a concrete context and individual, which leads to many difficulties to be modified for new situations or changes. A successful design might cover the following features: Portable, easy of use and recall, used in different context (class, house), for different purposes and as learning aid (for educators).

This paper focuses on the development of a communication architecture suitable for children with non-verbal disabilities based on user adaptation and context aware as a key goal to overcome their communication barriers. The next section shows the proposed architecture. Section three describes the user modelling technique. After that, section four shows the evolving and adaptation mechanism. Section five describes the context aware mechanism, and finally, conclusions and future works are described in section six.

2 Architecture

Sc@ut is our AAC proposal based on a extension of previous works [8] on adaptive hypermedia technology. Symbolic pictorial templates are the basis for knowledge representation. Although several pictorial standards have been proposed such as Bliss Symbols, from our experience, working and mixing these symbolic pictures with other meaningful images (e.g. the mother's image, everyday objects, etc.) improves the communication by affective motivations. Images are set on templates depending on user needs and context. The user directly selects these images by pointing. Changes for different reasons can evolve the underlying user knowledge, translating these changes to the pictorial templates. A general view of the underlying model is explained below.

The children use the hypermedia model to express their desires, navigating through the templates and selecting items.

The user profile and knowledge domain (communication context) are represented and considered in the hypermedia design.

The user interaction and navigation depends on his location.

The communicator evolves, adapting to each child and to the changes in the scenarios.

Figure 1 shows a typical template and the proposed two-tier architecture of Sc@ut. The communicator is a handheld device for the child communicative capabilities (the sound is attached to each picture), whereas the metacommunicator is a meta-tool which allows the educator adapt the communicator to the user needs and to new contexts. It also acquires knowledge from the child interaction. The meta-communicator architecture includes components responsible for specifying: the user profile, the knowledge domain, the user interaction, the hypermedia model, the learning and evolving process. This architecture is implemented in different devices. The meta-communicator is running on a PC and the communicator is implemented in a PDA device. This artefact is small enough to be portable, the speed of power-on minimises the child anxiety, and its display allows us to select an object by direct pointing with the finger. The benefit of this architecture is the separation of concerns. First of all, there are two kinds of users which use this architecture with different purposes. Secondly, the cognitive, interaction, design and learning aspects have to be differentiated to avoid the coupling. Thereby, evolution/adaptability can be done more easily and safely because the architecture components are independent [5].

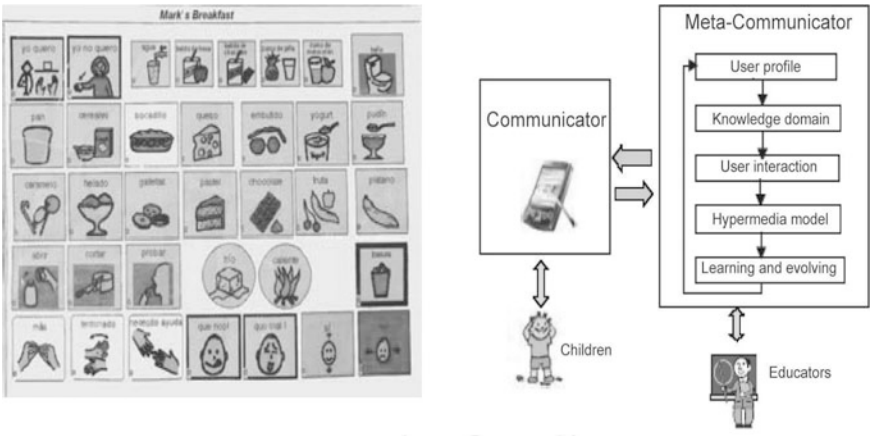

Figure 1. The Sc@ut Architecture

3 User Modelling

Up to now, educators create static templates describing different scenarios for the child as shown in figure 1. The creation of a scenario includes different interrelated concepts needed for the communication: desires (I want/I don't want, yes/no), domain objects (cheese, water, ...), qualifiers (more, finished, heat, cold), feeling (good, bad), and context (go to the bath). The user model contains three important steps: identification of user features (the user profile), an explicit representation of the context (knowledge domain) and specific goal requirements from educators to create templates of concepts on a hypermedia model.

3.1 User Profile

These templates contain information of different nature, some is specific for a particular child while other is generic to the group. The best strategy for information management is the separation of the user profile in different categories. Our approach considers the following categories.

- *Communication habits*. These aspects describe personal behaviours and general knowledge. For example, Mark is shy and has difficulties with complex scenarios (he prefers structured activities step-by-step and familiar images). However, he is capable of constructing easy sentences correctly.
- *Domain specific* (Scenario). This information is related with specific contexts (preferences). For example, Mark likes cake and ice cream a lot, and he drinks water only in his cup.
- *Educator's goals*. This information identifies educator goals for a child on a particular scenario. For example, Mark should learn that his hands have to be cleaned before eating.

3.2 Knowledge Domain

This knowledge domain is represented by means of a semantic network to capture relevant features of each user. This information is posted as a set of concepts and meaningful relationships between them (figure 3 shows a semantic network). *Feelings* denotes the child emotions whereas *Activities* are situations in which the child knows/learns how to act. Depending on the child profile, different activities will be proposed (e.g. *Nutrition*, *Hygiene*, etc.). Two kinds of concepts are showed in the network: complex