Developing and evaluating a pictogram-based Instant Messaging service for individuals with cognitive disabilities

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Abstract

Information and communication technologies pose accessibility problems to people with disabilities because its design fails to take into account their communication and usability requirements. The impossibility to access the services provided by these technologies creates a situation of exclusion that reduces the self-sufficiency of disabled individuals and causes social isolation, which in turn diminishes their overall quality of life. Considering the importance of these technologies and services in our society, we have developed a pictogram-based Instant Messaging service for individuals with cognitive disabilities who have reading and writing problems. Along the paper we introduce and discuss the User Centred Design methodology that we have used to develop and evaluate the pictogram-based Instant Messaging service and client with individuals with cognitive disabilities taking into account their communication and usability requirements. From the results obtained in the evaluation process we can state that individuals with cognitive disabilities have been able to use the pictogram-based Instant Messaging service and client to communicate with their relatives and acquaintances, thus serving as a tool to help reducing their social and digital exclusion situation.

Keywords: Augmentative and Alternative Communication, Cognitive Disabilities, Human-Computer Interaction, Instant Messaging service, User Centred Design

1. Introduction

The Internet, with services such as the web or the e-mail, enables people to access information and communicate ubiquitously and in real-time. Since these technologies become widespread in the late 90s, they have fostered the development of the so-called information and knowledge soci-

ety, where the creation and sharing of information, as well as the opportunity to communicate with relatives and acquaintances, are perceived as remarkable social, cultural, economic and political activities. But despite the huge advance in our society that the Internet technologies have brought, most of its services still remain inaccessible to people with disabilities because the design of the hardware and software than enables access to such services fails to take into account the user needs [1]. Therefore, if we consider that today almost ten percent of the world's population lives with some type of disability [2], it is easy to see how a large number of individuals are at risk of becoming excluded from the information and knowledge society [3]. This situation is usually referred as the digital divide or the gap between individuals that, for some personal or socio-economic reason, are not able to use information and communication technologies (ICTs) to access the Internet and make use of its services. This exclusion situation reduces the independence of disabled individuals and causes their social isolation, which in turn diminishes their quality of life [4].

One alternative that has been proposed to improve this situation of social and digital exclusion for disabled people, e.g. young children with complex communication needs, is to adapt the existing software that enables access to Internet services to match user needs [5, 6]. The adaptation of software to match user needs usually consists of a combination of two different approaches, namely communication [7] and accessibility [8]. On the one hand, the system used to represent concepts and communicate with the user needs to be adapted to match their requirements. For instance, written language can be replaced with pictogram-based Augmentative and Alternative Communication (AAC) systems for individuals that are not able to read or write. On the other hand the User Interface (UI) of the software needs to be adapted, including the layout and organization of elements presented in the screen and the navigation and selection techniques used to interact with the computing device. Using such approach, Tee et al. [9] developed a visual recipe book for persons with language impairments. But according to Sayago et al. [10] adapting the existing software to match user needs is not sufficient. Instead, software to access Internet services needs to be developed taking into account user needs and context from the beginning. To achieve this objective users need to become an active part in the development process, e.g. using methodologies such as User Centred Design (UCD).

Different projects that follow this approach to enable individuals with disabilities access Internet services have already been developed and evaluated. For instance, the WWAAC [11] (World Wide Augmentative and Alternative Communication) project is one of the first initiatives to consider the inclusion of disabled individuals to ICTs. The project, funded by the European Union Information Society Technologies (IST) Initiative in 2001–2004, developed a web browser and an electronic mail client that take into account the communication and usability requirements of individuals with Cognitive Disabilities (CD). Both the web browser and electronic mail client have a UI that takes into account their usability requirements and written language is replaced with a pictographic system to ease accessing information and communicating. Recently, Sundqvist et al. [12] have evaluated the e-mail client developed in the WWAAC project with children with CD obtaining positive results. Another example of this approach is the Mejla Pictogram [13] project, developed

in 2009 at the Institute of Design in Umea and the Sweedish Institute for Special Needs Education, in Sweden. The Mejla Pictogram is an e-mail client developed taking into account the communication and usability requirements of individuals with disabilities. It has a personalized UI and replaces written language with a pictographic system to enable electronic communications for individuals with CD.

But to authors' knowledge, and considering the importance of communications in our society [14, 15], up to today no Instant Messaging (IM) service and client that follows this approach to enable individuals with CD communicate with their relatives and acquaintances has been presented. To fill this gap, we have developed and evaluated an IM service and client that considers both the communication and usability requirements of individuals with CD [16, 17, 18]. In order to develop and evaluate both the pictogram-based IM service and client we have used a User Centred Design (UCD) methodology based on widely-known and well-established techniques. In this sense, we have performed an ethnographic study with users from a non-profit social institution that promotes the social integration of individuals with CD and their families, semi-structured interviews with pedagogues and social educators in charge of the users from the same institution and, finally, conducted evaluation sessions with two groups of users. From following this UCD methodology we have gained further understanding of the communication and usability requirements of the target collective and, thus, we expect that the conclusions obtained from our work will be useful for practitioners that aim to develop and evaluate software for individuals with CD.

The rest of the paper is organized as follows. In Section 2 we introduce the basic knowledge required to understand the rest of the paper. Then, in Section 3, we present the development of the pictogram-based IM service and client, including the UCD methodology that we have used to derive the user requirements taking into account their needs. Next, in Section 4 we introduce the methodology we have used to evaluate the pictogram-based IM service and client with real users. Last but not least, in Section 5 we present and discuss the results and experiences that we have obtained along the process of developing and evaluating the pictogram-based IM service and client. Finally, in Section 6 we state the conclusions outlined from the development and evaluation of the project and identify the work that remains to be done in the future.

2. Background

In order to design and evaluate a pictogram-based Instant Messaging service and client for individuals with cognitive disabilities there are different concepts that need to be well understood. This section introduces the essential concepts required to understand the rest of the paper, including a brief introduction to Cognitive Disabilities, a short explanation on Augmentative and Alternative Communications and, finally, a quick overview of Instant Messaging services.

2.1. Cognitive Disabilities

Cognitive Disabilities (CD) [19] are defined as an impairment that limits the ability of an individual to develop activities and tasks that depend on basic mental processes, such as attention, language and memory. Due to their condition, individuals with CD have problems to develop tasks that require from understanding abstract concepts or making generalizations between contexts, as well as to develop tasks that

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require from social interaction. In the end, these limitations reduce the self-confidence and autonomy level of individuals, which causes social exclusion and reduces their overall quality of life.

As with other types of disabilities, CD can be classified into hereditary, acquired or natural depending on its cause. On the one hand, hereditary are those caused by a genetic or chromosomal disorder acquired through the genetic material of the progenitors or due to a mutation. On the other hand, acquired are those developed by events that occur during the lifetime of an individual. Finally, natural causes are those that are developed as a part of the ageing process of a person. Additionally, depending on the limitations that pose onto the individual, cognitive impairments are further classified into mild, moderate, severe and profound. Today there are many diseases that cause CD to individuals, but each has its own causes and poses different limitations. The most typical causes of CD are Acquired Brain Injury (ABI), Alzheimer's Disease (AD), Autism Spectrum Disorder (ASD) and Down Syndrome (DS).

2.2. Augmentative and Alternative Communications

Augmentative and Alternative Communications (AAC) [20] is a set of methodologies aimed at complementing or replacing written or spoken communications for those individuals that have such abilities impaired, either temporarily or permanently, due to injury or illness. One form of AAC are pictogram-based communication systems, which are built upon drawings or images that represent real objects or abstract concepts to enable individuals sharing internal states, feelings, ideas and experiences. Communication using pictograms [21] usually consists of

individuals selecting elements from a set of possibilities with the aid of an Assistive Technology (AT), which can either be low or high technology (i.e. a cardboard, a personal communicator or a desktop computer).

Nowadays, there are many different pictogram-based AAC systems [22], which are usually classified according to the transparency level of its pictograms; the level of resemblance between the pictograms and the objects or concepts they represent. For instance, Rebus is a pictogram-based language developed by Woodcok to teach reading to children. PIC (Picture Ideogram Communication) was developed by Maharaj and its main characteristic is that they have a reverse contrast, i.e. white on black. Blissymbols was developed by Karl Blitz and is based on the ideographs of Chinese writing. Finally, PCS (Picture Communication Symbols), depicted in Figure 1, were developed by Mayer-Johnson in 1981 and today are one of the most widely used sets thanks to its transparency level.

Figure 1: A group of Picture Communication Symbols (PCS) pictograms. PCS were developed in 1981 by Mayer-Johnson and today are one of the most widely used sets thanks to its transparency level.

2.3. Instant Messaging services

Instant Messaging (IM) services [23] are designed to enable users to exchange near real-time presence information and text-based messages over a public network, usually the Internet, to communicate with their contacts. In general, IM services rely on a client-server architecture

to operate; IM servers provide features such as user access control and message routing, whereas IM clients provide a graphical interface for users to communicate. Nevertheless, IM services have evolved and now provide many other features besides the ones used for text-based communication, such as audio and video conferencing, file transfers and shared desktop.

Today most IM services are run by Internet-based companies, such as AOL, Yahoo and Microsoft. The protocols that support such IM services, as well as the IM client that enables users to communicate, are proprietary and their specifications are not publicly available. To provide with an open alternative the IETF (Internet Engineering Task Force) had different groups dedicated to IM services, obtaining a general model which was later adopted by two IM protocols, namely SIMPLE (SIP for Instant Messaging and Presence LEveraging) and XMPP (eXtensible Messaging and Presence Protocol). On the one hand, SIMPLE [24] provides a set of extensions to SIP [25] (Session Initiation Protocol) to support IM services. On the other hand, XMPP [26, 27, 28] derives from Jabber, an IM protocol based on XML (eXtensible Markup Language) which was initially designed by the open-source community as an alternative to existing proprietary IM protocols.

3. Development

The aim of this project is to develop a pictogram-based Instant Messaging (IM) service and client for individuals with CD. In order to develop the pictogram-based Instant Messaging service and client for individuals with Cognitive Disabilities (CD) we have used a User Centred Design (UCD) methodology [29, 30, 31, 32] that allows us to capture and understand the

needs, wants and limitations of end users early in the development process. We have selected this approach because it enables us tailor the pictogram-based IM service and client around the user requirements rather than forcing users to adapt their behaviour to match the characteristic of a common IM service and client.

3.1. User Centred Design

In order to implement the UCD methodology we have used two well-known and widely-used techniques, namely an ethnographic study and semi-structured interviews [33, 34, 35]. These techniques have been carried out with the collaboration of Fundació El Maresme [36], a non-profit social organization that promotes the education and social integration of individuals with CD and their families. On the one hand, the ethnographic study allows us to gain better understanding of the persons that will use the IM service and the context in which it will be used. On the other hand, the semi-structured interviews have been conducted with pedagogues and social educators to better understand the requirements of the IM service and client.

3.1.1. Ethnographic study

Fundació El Maresme is a non-profit social organization that promotes the education and social integration of individuals with CD and their families. Fundació El Maresme is based in Mataró but extends all over the *El Maresme* territory, a Catalan region located beside the Mediterranean coast with a total population of around half-million inhabitants. During 2009 Fundació El Maresme attended an overall of 1.540 users with CD, mainly coming from the *El Maresme* territory. Apart from the users itself, professionals also play an important role within

the organization. In 2009 a total of 267 people worked at the different sections, including both the educational and the management staff. The educational staff (including pedagogues and social educators) represents around 85% of the overall workforce, whereas the management staff (including administrative, legal, restaurant, etc.) represents the 15% left.

One important organizational aspect of Fundació El Maresme is that individuals are classified into groups depending on their age and their disability condition to provide them with a personalized education and working plan that fosters their social integration. The ICD-10 Classification of Mental and Behavioural Disorders of the World Health Organization (WHO) [37] is used to determine the disability type and degree of each individual. Considering its relevance, the two main groups of users within Fundació El Maresme are SOI (Insertion Occupational Service) and STO (Ocuppational Therapy Service). In this sense, individuals that belong to SOI have a cognitive disability level equal or higher than 33%, whereas individuals that belong to STO have a cognitive disability level equal or higher than 66%. Each group of users is assigned to a social educator that is responsible to conduct and supervise their daily activities. Finally, the different user groups are coordinated by a set of pedagogues that are responsible for their educational and working curriculum.

The pedagogues at Fundació El Maresme consider that Augmentative and Alternative Communication (AAC) systems and Information and Communication Technologies (ICTs) are key elements to foster the social and digital inclusion of individuals with CD. Therefore, both AAC systems and ICTs are integrated as part of their educational and working curriculum regardless of their age, as well as the type and degree of

their condition. To enable AAC and ICTs related activities Fundació El Maresme has different multimedia rooms equipped with personal computers and Internet connection. The computers are quite old, e.g. Pentium IV with 512 MBytes of RAM memory, and run a proprietary operating system, e.g. Microsoft Windows XP. Furthermore, for those users who present additional accessibility requirements, e.g. mobility problems, the rooms are equipped with adapted peripherals such as keyboard with large buttons or sweep-and-pick switches.

Within the multimedia rooms different AAC and ICTs related activities are held during the week depending on the type and degree of their condition. For instance, some groups who do not have read or write skills participate in preparing signs with the weekly cafeteria menu or the cultural activities schedule. To prepare these documents they use BoardMaker [38], a proprietary software created by Mayer-Johnson that enables them to create documents using the Picture Communication Symbols (PCS) pictogram set. Other groups at Fundació El Maresme who do have reading and writing skills use the computers with regular software, such as Microsoft Office, to typeset or scan documents for third-party companies. Finally, individuals also use computers during their leisure time, but always under the supervision of their social educator. For instance, some individuals like to watch popular videos from YouTube.

3.1.2. Semi-structured interviews

As part of the UCD methodology to develop the pictogram-based IM service and client, we decided to include the users early in the process to acquire first-hand information about their communication and accessibility requirements. But in the existing literature regarding the appli-

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cation of UCD research techniques with individuals with CD we found that there are contradictions about which are more suitable taking into account user capabilities. On one side, Feng et al. [39] describe the use of an online survey to understand how young individuals with Down Syndrome (DS) use computers in their daily lives. On the other side, Lepisto et al. [40] describe the need to use complementary research techniques, such as informal walkthrough or expert evaluation, in order to provide a better understanding of the user requirements.

Nevertheless, considering the oral communication limitations of individuals with CD observed during the ethnographic study, we finally decided to carry out semi-structured interviews with pedagogues from Fundació El Maresme. We have taken this approach as it enables us to easily derive the communication and accessibility requirements of both the pictogram-based IM service and client from the experience of pedagogues. We acknowledge that following this approach might introduce some bias due to personal beliefs and opinions regarding the communication and accessibility requirements of the target collective. Nevertheless, this problems can be later detected and appropriately solved thanks to the iterative process used to develop and evaluate the pictogram-based IM service and client based on the UCD methodology.

Initially, the semi-structured interviews were carried out during monthly meetings that were held between researchers and pedagogues from Fundació El Maresme to asses the evolution of the project. The meetings lasted for around one hour and during the sessions researchers asked questions regarding regarding the communication and accessibility requirements of individuals with CD. These questions were then answered by pedagogues and discussed between all the members present in the room. For instance, technical questions regarding User Interface (UI) requirements were related to the suitability of using a password to login to the pictogram-based IM service, whereas technical question regarding communication requirements were related to the pictographic system that would be used to enable individuals communicate.

The initial meetings helped to create a common ground between researchers and pedagogues. But considering its low periodicity, as well as the limited number of participants and the difficulties to achieve conclusions in the scheduled time, we decided to introduce a second mechanism to conduct the semi-structured interviews. Researchers formulated a set of questions which were sent through electronic mail to pedagogues and social educators to enable them to reflect and discuss the possible alternatives before providing an answer. This approach fostered the appearance of further discussion regarding communication and accessibility aspects of both the pictogram-based IM service and client. As an example, using this approach we decided to implement the authentication mechanism using a combination of four pictogram-based digits.

3.2. Pictogram-based Instant Messaging service

Apart from the usual IM-related requirements, the first requirement of a pictogram-based IM service is that users shall have a pictogram set available to communicate. To support such requirement there are two alternatives; having a personalized set of pictograms for each user or having a pictogram set that is shared among all users. The former approach allows pedagogues to define exactly which pictograms each user should have and to tailor it according to their learning process, whereas the latter approach gives more freedom to the user as they have the

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chance to access all the pictograms to communicate. Nevertheless, both approaches have drawbacks. On the one hand, having a personalized pictogram set may limit conversations between users as specific pictograms might not be available to some individuals. On the other hand, including a complete pictogram set may have a negative impact on interactivity, as users might need to spend more time browsing for pictograms to compose a message. But considering that actual trends in pictogram-based communication state that AAC (Augmentative and Alternative Communications) users should have a full set of pictograms available to communicate in order to promote their independence and support their learning process we decided, together with pedagogues and social educators, to have a shared pictogram set among all users.

Taking into account that pedagogues should be able to select the pictographic system that is most suitable to users according to their personal preferences and previous knowledge, the second requirement of a pictogram-based IM service is that it shall remain independent of the pictographic system used to communicate. Furthermore, considering that elements within the pictographic system include both graphical and textual representation of the pictogram itself, the IM service shall also remain independent of the textual representation of such pictograms. To satisfy this design requirement we have developed an XML-based syntax that is able to represent pictogram-based messages unequivocally. Despite the fact that both XML (eXtensible Markup Language) and JSON (JavaScript Object Notation) are platform and language neutral, we have decided to use the former instead of the latter because it has better support for internationalization, i.e. representation of Chinese characters, and parsers for different programming languages are readily available. The XML syntax, shown in Figure 2, defines that each pictogram-based message is represented by a message element, which may contain one or more pictogram elements to represent pictograms within the message.


```xml
<message from="peretuset@messengervisual.net" to="robertoromero@messengervisual.net">
    <pictogram id="34" category="beings" text="you" />
    <pictogram id="67" category="actions" text="go" />
    <pictogram id="82" category="places" text="cinema" />
    <pictogram id="54" category="time" text="tonight" />
    <pictogram id="29" category="questions" text="question" />
</message>
```

Figure 2: Pictogram-based message representation using XML. A message element has a source and a destination and is composed of one or more pictogram elements. Each pictogram element contains a unique identifier, as well as the category it belongs to and the text associated to it.

Finally, considering that the vocabulary included in the pictogram set may change over time, the third requirement of a pictogram-based IM service is that it shall provide pedagogues with means for updating it. Two alternatives have been considered regarding the architecture to enable automatic pictogram updates; a centralized and a distributed approach. In the centralized architecture the pictogram set is stored in a server and retrieved by IM clients on demand. In contrast, in the distributed architecture each IM client has a local copy of the pictogram set that is synchronized with the server. In spite of requiring an additional synchronization mechanism, as pictogram set updates need to be notified to IM clients, we have decided to use a distributed architecture because it reduces the network bandwidth requirements as pictograms are cached at the IM client. To implement the pictogram set we use a relational database instead of separate files organized into folders because it is easier to maintain and offers performance advantages [41]. Finally, the protocol to enable pictogram database synchro-

nization is based on XMPP to distribute update notifications among IM clients and HTTP (HyperText Transfer Protocol) to retrieve the pictogram database from the server, as represented in Figure 3.
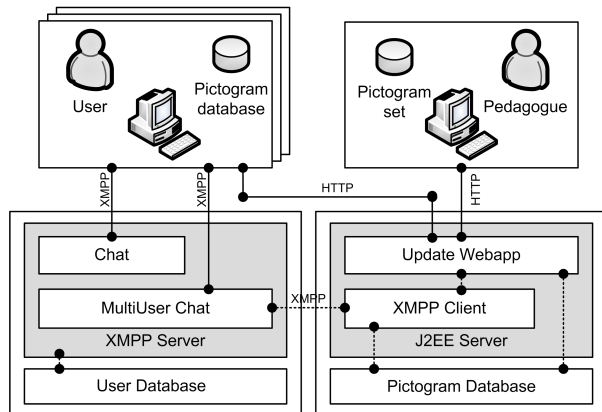

Figure 3: Messenger Visual service architecture. XMPP supports the basic IM features, as well as pictogram-based communications and pictogram database update notifications. Whenever an update is triggered, IM clients download the pictogram database from the server using HTTP.

3.3. Pictogram-based Instant Messaging Client

The next step to enable individuals with CD communicate using the pictogram-based IM service is to develop an IM client that meets their communication and usability requirements. As a previous step to the development phase the requirements of a standard IM client were analysed. In this sense, we found that most IM clients are organized to provide with a series of basic functionalities, such as access control, contacts management and chat conversations. To enable such functionalities the UI of the IM clients is organized into different windows, one for each functionality. From this analysis we decided that the pictogram-based IM client UI

would be organized following the same structure as other common IM clients.

Taking end user capabilities into account, we decided that the UI should also be limited only to the strictly necessary elements to carry out the actions that users can perform in an IM service. Moreover, the UI should be designed to be as simple as possible, avoiding the use of complex metaphors and without including hidden or implicit elements. In this sense, the UI should be an almost completely visual interface. Written language might be included, but only as a support for social educators and users with some written language communication skills. Furthermore, elements in the UI should be organized according to the requirements of the pictographic system, i.e. categories and pictograms.

Albeit the pictogram-based IM service has been designed to remain independent from the pictographic system required by users to communicate, we have initially decided to use a specific pictogram set as both the IM service and client are to be evaluated with users at Fundació El Maresme. To decide which set of pictograms to use we considered that users are already familiar with PCS pictograms, as previously described. But taking into account the fact that PCS pictograms are licensed we decided to use ARASAAC (ARAgoneSe portal of Augmentative and Alternative Communication) [42] pictograms, which are have the same transparency level but are licensed under a Creative Commons [43] BY-NC-SA license.

Next we describe the different windows that compose the pictogram-based IM client UI, namely the authentication windows, the contacts window and, finally, the chat window. In order to enforce authentication the pictogram-based IM client is based on two different windows, as shown in Figure 4. First of all, the login window

allows users to select their profile from a matrix of local user profiles stored in the computer. The window also offers a mechanism to create a new user account or to add an existing account to the local user profiles. Once users have selected their profile they must provide their passphrase in the password window to log in. Considering usability requirements the passphrase is currently based on a combination of four numeric digits represented by pictograms.
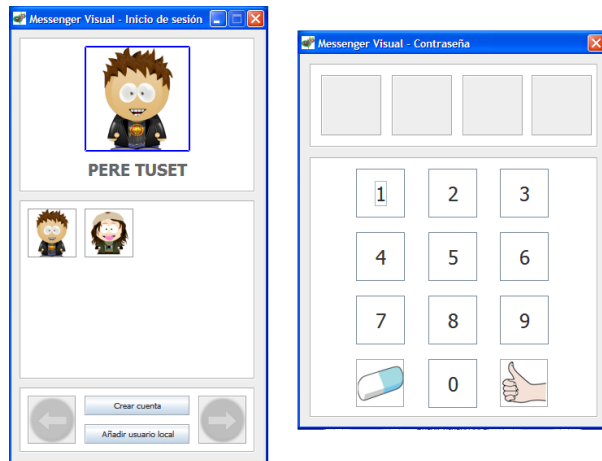

Figure 4: Pictogram-based IM client authentication windows. The first window enables users to select their profile using their picture from a users matrix, whereas the second enables users to authenticate to the IM service.

Once users have logged in to the pictogram-based IM service a window to manage their contacts appears, as depicted in Figure 5. The contacts window contains a list with all the users' contacts that are currently online and is updated whenever a contact logs in or logs out to/from the pictogram-based IM service. Taking into account usability requirements, the contacts in the list are represented by the user picture and full name. In order to start a new conversation with a user from the contact list the user has to click on the contact picture. Finally, the contact window also provides two buttons to navigate the contacts list and a button to add and remove contacts from the user contacts list.
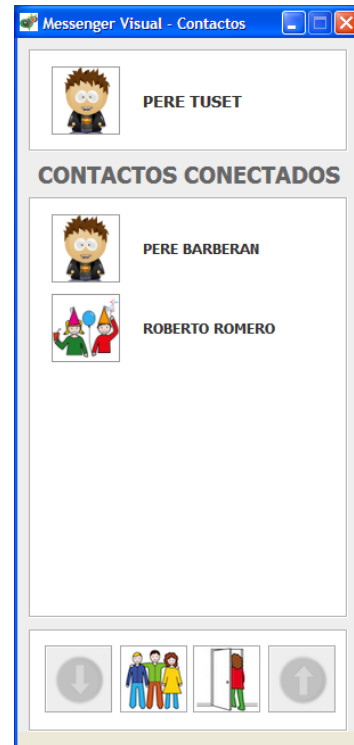

Figure 5: Pictogram-based IM client contacts window. The contacts window enables users to add and remove contacts from their list and to start pictogram-based conversations with the users that are currently online.

Last but not least, the chat window allows users to communicate by means of exchanging pictogram-based messages, as shown in Figure 6. According to the ARASAAC pictogram organization, the top of the interface contains the categories in which pictograms are classified. On the left side the most frequent pictograms appear in order to ease the composition of common messages (i.e. Hello, Goodbye, Yes, No and Thank

you). On the right side the pictograms that belong to the active category are displayed. On the bottom lies the pictogram input space to compose a message, including a button to send the message and a button to remove the last added pictogram. Finally, the central part of the window contains the actual conversation that the user is having.
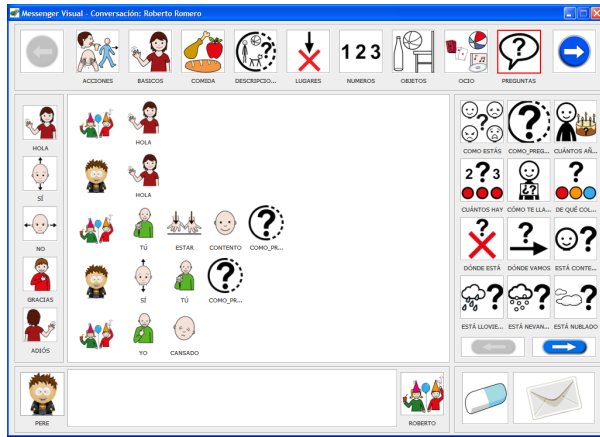

Figure 6: Pictogram-based IM client conversation window. The conversation window enables users to communicate with their peers by means of composing a pictogram-bases messages and sending it over the network.

4. Evaluation

As part of the iterative process used to develop the pictogram-based Instant Messaging (IM) service and client based on the User Centred Design (UCD) methodology, as described in the previous section, we have also carried out an evaluation process with users from Fundació El Maresme. The evaluation process is inextricably linked to the development of the pictogram-based IM service and client, as user evaluation is a key aspect in the UCD methodology. In this sense, this section, together with previous one,

must be understood as the explanation of the user centred iterative development process carried out to develop both the pictogram-based IM service and client.

The aim of the evaluation process is twofold. On the one hand, it intends to provide researchers and developers with feedback to detect software bugs and usability aspects that need to be improved for future versions. On the other hand, it aims to enable users become acquainted with the IM service to enable them communicate with their relatives and acquaintances. In order to achieve its purposes the evaluation process of the pictogram-based IM service and client has been organized into two stages, user selection and user sessions. In turn, the user sessions have been split up into three well-differentiated phases to introduce users to the pictogram-based IM service paradigm.

4.1. User selection

In order to evaluate the pictogram-based IM service and client a group of users from Fundació El Maresme have been selected. The process to select which users will participate in the evaluation process has been carried out by the pedagogues and social educators taking into account four main aspects. First of all, users need to be regular users of pictogram-based Augmentative and Alternative Communication (AAC) systems. Secondly, users need to have some previous background using personal computers. Thirdly, users need to have good communication and interpersonal skills. Last but not least, users need to have a strong motivation to participate. The first two requisites were not decisive because pictogram-based communications and computer background skills are part of their educational and working curriculum, as described

in the ethnographic study. Thus, the main factors to decide which users would participate in the evaluation sessions were communication and interpersonal skills, as well as their motivation to participate in the process.

Using these criteria twelve adults with Down Syndrome, five men and seven women and ages between twenty and forty-three years old (mean=26.83, std=6.45), from two different groups at Fundació El Maresme and their respective social educators were selected to participate in the evaluation process. The adults who have participated in the evaluation belong to two different groups within Fundació El Maresme, namely STO (Occupational Therapy Service) and SOI (Insertion Occupational Service). On the one hand, the STO subgroup is composed of five members, one man and four women, with ages between twenty and forty-three years old (mean=30.2, std=8.98) and their social educator is named after Juan. On the other hand, the SOI subgroup is composed of seven members, four men and three women, with ages between twenty-one and twenty-eight years old (mean=24.42, std=2.50) and their social educator is named after Cecilia. Last but not least, a pedagogue named after Sandra has been in charge of coordinating the educational and working activities of both groups.

4.2. User Sessions

In order to carry out the evaluation process we set up fortnightly one-hour-long sessions with two groups of users from Fundació El Maresme, STO and SOI, and their respective social educators and pedagogues, as previously described. The sessions were held on Tuesdays in the multimedia rooms at Fundació El Maresme and lasted for a period of six months. In order to help participants become acquainted with the pictogram-based IM service and client the sessions were organized into three well-differentiated phases: IM communication paradigm, pictogram-based IM client User Interface (UI) and, finally, sessions in which participants could freely chat among themselves. During the sessions researchers, pedagogues and social educators were present in order to provide support to users and take notes regarding the outstanding aspects of the process.

After selecting the users the first stage of the evaluation process, which lasted for four consecutive sessions, was intended to introduce the participants to the pictogram-based IM communication paradigm. In order to teach them the process of pictogram-based communication using an IM service we used a cognitive strategy based on the postman metaphor, as shown in Figure 7. By means of picking paper pictograms from a folder and placing them in a cardboard letter participants could compose pictogram-based messages. The pictogram-based letter was then placed in an envelope and sent using a mailbox to their addressee. With this approach participants were able to send and receive pictogram-based messages, helping them to understand the communication paradigm of IM services. It is important to remark that within the folder pictograms were classified according to their category to resemble the organization of the pictogram-based IM client UI.

Once the participants were acquainted with the communication paradigm of IM service the second stage of the evaluation process, which lasted for two consecutive sessions, was intended to introduce them to the IM client UI. The objective of this stage was to provide training to participants so that they could use the pictogram-based IM client independently to communicate. In order to achieve this purpose pictogram-based communication using the IM client be-

Figure 7: Materials used during the first stage of the evaluation process. The postman metaphor is built using cardboard to enable users compose their pictogram-based messages and send them using the post office.
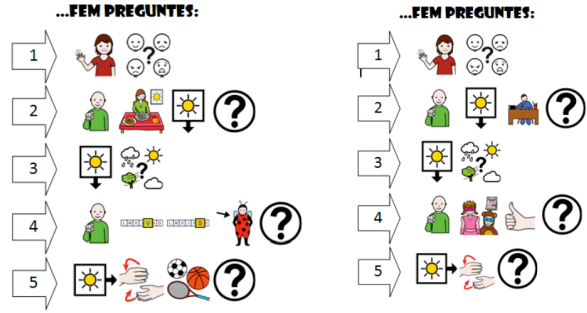

Figure 8: Materials used during the second stage of the evaluation process. The cardboard contains predefined pictogram-based questions to help users become acquainted with the UI of the pictogram-based IM client.

tween users was directed. Pedagogues created a set of cardboards with predefined pictogram-based questions and answers, as shown in Figure 8, that were distributed among participants before starting each session. Thus, during the sessions users would follow the predefined questions and answers to communicate among each other using the pictogram-based IM client. With this approach users learned to interact with the pictogram-based IM client UI to communicate.

Finally, the third stage of the evaluation process, which lasted for the four remaining sessions, was intended to enable users to communicate freely using the pictogram-based IM client, as depicted in Figure 9. Users were allowed to select the partner who they wanted to chat with, as well as the topics that they would like to talk about. It is important to remark that for these sessions we only used a reduced subset of approximately four hundred ARASAAC pictograms classified into fourteen different categories. Both pictograms and categories were chosen by pedagogues to cover the basic conver-

sational vocabulary. Finally, it is also important to remark that during these sessions users chatting to each other were located in different rooms to resemble the physical distance of IM communications. We took this decision after noticing that users would physically interact with each other instead of relying on the pictogram-based IM client to communicate.

5. Discussion

The discussion presented in this section is derived from applying the User Centred Design (UCD) methodology to develop and evaluate the pictogram-based Instant Messaging (IM) service and client described in the previous sections. In general terms, and despite some initial problems with the pictogram-based IM client related to software issues, we have observed that individuals with Cognitive Disabilities (CD) have been able to communicate using the pictogram-based IM client with the other members of their group without showing any sign of frustration, regardless of the type and degree of their condition. We believe that these positive results have been
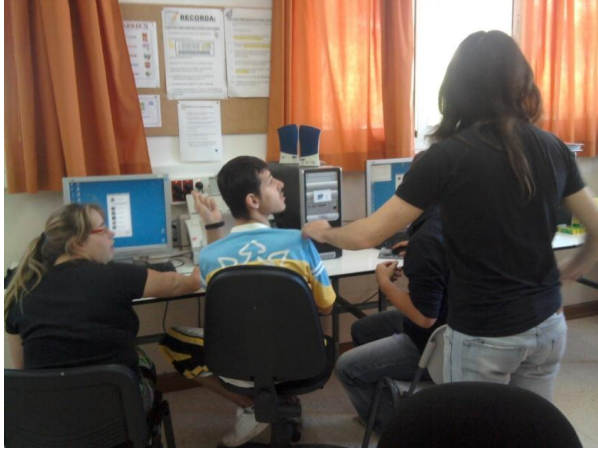
13

Figure 9: Users from Fundació El Maresme during the third stage of the evaluation process. During this stage of the evaluation users were allowed to communicate with each other using the pictogram-based IM service.

obtained thanks to applying the UCD methodology all along the project. On the one hand, by means of carrying out the ethnographic study and the semi-structured interviews with the pedagogues and social educators we have been able to understand the context and extract proper communication and usability requirements to design the pictogram-based IM service and client. On the other hand, carrying out the sessions has enabled users to gradually understand the communication paradigm of IM services and become familiar with the IM client. Nevertheless, during the sessions with users we have observed different aspects regarding pictogram-based communications and the IM client User Interface (UI) design that are worth mentioning.

First of all we have observed that, even among members of the same group of users, individuals have a wide range of communication skills. This has an impact on the pictogram-based communication interactivity, but in a different sense than we initially expected. At first we imagined that those users with higher communication skills would find it easier to communicate, as their ability would enable them to navigate across the different categories to select the appropriate pictograms faster. Nevertheless, during the evaluation we have discovered that despite being faster at selecting pictograms, those individuals with higher communication skills tend to spend more time composing a message because they create more complex messages that require from more pictograms. Instead, individuals with lower communication skills form simpler messages that are shorter and, thus, faster to be composed. In this sense, we have observed that interactivity problems appear when individuals with different communication skills chat with each other, as the conversation takes place at two different speeds.

Secondly, we have seen that there are some special situations that make pictogram-based conversations become stalled and require from the intervention of pedagogues or social educators in order for the users to take up the conversation again. For instance, if a user sends two consecutive messages without waiting for the reply the user at the other side of the conversation, which may be writing the reply to the first message, becomes confused and the conversation gets stalled. This situation can happen for two main reasons; if a user sends an incomplete message by mistake and then sends the correct message, or if a user sends a message but does not receive a reply in a relatively short period of time and sends another message. Despite this situation is not very common and is largely dependent on the communication skills of each user, we have discovered that it is a factor that has a negative impact on the users as it causes frustration due to the fact that they are not able to use the IM service in a completely autonomous fashion.

Thirdly, during the third stage of the evalu-

ation process with users we have detected that some parts of the IM client UI might need to be redesigned in order to increase its usability level for the target collective. We have observed that some elements of the IM client UI present a functionality that might be interpreted in different ways, thus becoming a source of possible confusion to users. On prime example of this situation is that buttons to navigate the contact list at the contacts window (Figure 5) operate in an up and down fashion, whereas buttons to navigate the users matrix in the login window (Figure 4) and to navigate categories and pictograms in the chat window (Figure 6) operate in a left and right fashion. Despite we have not observed important difficulties using such interface elements during the evaluation process, we believe that redesigning those elements to provide more consistency will lead to a UI that is more usable by individuals with CD.

Last but not least, we have noticed that the authentication mechanism to login to the IM service is not compliant with user requirements. Initially we designed the authentication mechanism based on a combination of four pictogram digits. Nevertheless, taking into account user capabilities, this approach has proven to be not valid because users tend to forget their passphrase and, thus, have to ask pedagogues and social educators to restore it. In order to solve this problem an authentication approach based on the possession of a personal token instead of a secret knowledge has been proposed. In this sense, we have implemented an authentication mechanism based on QR (Quick Respone) codes, as shown in Figure 10. Each user has a personal token with a printed QR code that contains all their login information. Therefore, in order to login to the IM service users only need to show their personal token to a webcam. How-

ever, this solution has not yet been evaluated as it could pose problems regarding how users manage the token, e.g. they could lose it or forget they need it to login to the IM service.

Figure 10: The new pictogram-based IM client authentication window. Users show their token to a webcam-enabled computer that decodes the QR code and triggers the authentication process to login to the IM service.

6. Conclusions and Future Work

6.1. Conclusions

This paper has presented a pictogram-based Instant Messaging (IM) service and client that enables individuals with Cognitive Disabilities (CD) to communicate with their relatives and acquaintances over the Internet. Along the text we have described and discussed the User Centred Design (UCD) methodology that we have used to develop pictogram-based IM service and client support the basic requirements of an IM service, as well as how we have enabled support for pictogram-based communications and

how we have adapted the User Interface (UI). The UCD methodology has relied on three different well-established and widely-used techniques together with the collaboration of Fundació El Maresme, a non-profit social organization that promotes the education and social integration of individuals with CD and their families.

First of all, we have used an ethnographic study to understand the context of the users, pedagogues and social educators at Fundació El Maresme in which the pictogram-based IM service and client will be used. Next, and considering the difficulties to obtain first-hand information about the communication and usability requirements of the pictogram-based IM service and client due to the oral communication limitations of users, we have used semi-structured interviews with pedagogues and social educators from Fundació El Maresme. After understanding the context and capturing the user requirements we developed a first prototype of the pictogram-based IM service and client based on the standard eXtensble Messaging and Presence Protocol (XMPP). Once we finished developing the first prototype of the pictogram-based IM service and client, we conducted the evaluation process with two groups of users from Fundació El Maresme as part of the UCD methodology, which has enabled us to detect problems with the IM client UI and better understand how individuals with CD communicate using pictograms.

All in all, from the evaluation process we can state that both the pictogram-based IM service and client are functional and usable by individuals with CD, thus enabling their social interaction and promoting digital inclusion. Nevertheless, it is important to remark that the work presented in this paper is still in progress. At this moment of time we have already contacted Fundació Vallès Oriental [44], another non-profit

social organization in our territory, in order to extend the evaluation process and validate the results obtained with other collectives of users. The evaluation process with Fundació Vallès Oriental will begin in September 2011, as we are currently selecting the users that will participate in the evaluation process together with pedagogues and social educators.

6.2. Future work

As stated earlier, the work presented in this paper focuses on the research and development process that has been carried out to develop a pictogram-based IM service and client for individuals with CD. The application of UCD techniques has enabled us to understand and capture the requirements of end users early in the development process to ensure that both the pictogram-based IM service and client are adapted to the target collective. Additionally, the evaluation process has given a first qualitative insight on how individuals with CD communicate using the pictogram-based IM service. Nevertheless, from the experience that we have obtained through the initial evaluation process with the end users, we have discovered that there are many aspects that still need to be explored in order to improve the UI of the IM client to better suit the requirements of individuals with CD, as well as to understand how individuals with CD communicate using pictograms.

On the one hand, regarding aspects that relate to how individuals with CD interact with the IM client UI, we have already implemented an authentication mechanism based on QR-Codes that enables users to log in without the need to remember their login information. But currently this mechanism has not yet been evaluated with real users and, thus, the study to compare the performance of both authentication systems is

left as future work. On the other hand, regarding aspects that relate to understand how individuals with CD communicate using pictograms, we have already developed a tool that automatically collects and processes statistical information about how users interact with the IM client UI to communicate. Unfortunately, this mechanism has not yet been uses and, thus, it is left as future work. Nevertheless, we plan to explore parameters such as the average number of pictograms per message or the percentage of pictograms that users require in a conversation. This information, collected over time for different user profiles, will provide a deeper understanding of how individuals with CD communicate using pictograms.

Last but not least, there are three additional aspects that might be interesting to explore as future work. First and foremost, it would be interesting to implement an IM gateway that supports real-time translation of pictogram-based messages to text-based messages (and the other way around) and other IM services, such as Microsoft Messenger. Such IM gateway would enable individuals with CD to communicate more naturally with their relatives and acquaintances who are not users of pictographic Augmentative and Alternative Communication (AAC) systems and use other regular IM services. Secondly, and considering the performance limitations of pictogram-based communication observed during the evaluation process, it would be interesting to implement a predictive system that dynamically adapts the UI of the IM client according to the most probable next pictogram. Finally, another aspect that would be interesting to explore are speech recognition and pictogram-to-speech features to enable individuals communicate with individuals with other disabilities.

7. Acknowledgements

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