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Increasing participation in the information society by people with disabilities and their families in lower-income countries using mainstream technologies

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Abstract: Assistive technology (AT) has been actively researched, developed and implemented throughout higher-income countries, but is relatively absent from lower-income countries. In lower-income countries, there is very little AT for reading, writing, communicating and for participation in the information society. In order for persons with disabilities in lower-income countries to participate fully in society, mainstream Information and Communication Technologies (ICTs) such as mobile phones should be used as AT. This paper explores the potential for using mainstream ICTs as AT in lower-income countries, keeping in mind current ICT trends, characteristics of the post-PC era, and ICT-based AT in higher-income countries. The paper concludes with a case study where mobile phones and SMS were used by people with disabilities and their caregivers to access information in a resourced-limited community in Bogota, Colombia. Mobile phones, a readily available mainstream ICT in this community, were a useful tool for addressing the information exclusion of people with disabilities and caregivers.
Keywords: Assistive technology; ICT4D; SMS; Information and communication technology; Lower income countries; Information society

1. Introduction

The World Health Organization (WHO) has indicated that approximately 15% of the world population experiences personal disability and 80% of those individuals live in lower-income countries [1]. The term *lower-income country* is used to refer to any country that is classified as either low or middle-income according to the World Bank [2] classification. This paper will also use the term *resourced-limited community* to refer to a community that experiences some form of resource limitation, not solely economic. Poverty and limited resources can magnify the effect of disability [1]. For example a person with a disability who is unable to purchase a wheelchair and *cannot* leave their home experiences greater disability than someone with a similar impairment, but has a wheelchair and *can* leave their home. Thus, individuals with similar impairments can have a very different experience of disability. In addition, poverty can be viewed as both a "cause and a consequence of disability" [3]. For example, poverty can be the cause of disability if a person with a disability cannot afford treatment of a medical condition, which results in an impairment. Conversely poverty can be a consequence of disability if a person with a disability cannot leave their home and is thus, unemployed.

In 2007 the United Nations Development Programme released the Convention on the Rights of Persons with Disabilities (CRPD), creating an international document focused on improving the overall health and community participation of people with disabilities by proposing policy that advocates for their rights [4]. The CRPD has been signed by over 150 countries, bringing disability issues to the forefront of international discussions [4]. The CRPD highlights the importance of improving research, development and availability of assistive technology (AT) in order to improve the participation of people with disabilities in lower-income countries [4].

AT has been actively researched, developed and implemented throughout higher-income countries, but is relatively absent from lower-income countries [5]. Within the context of high-income countries, AT that provides computer access has numerous benefits to people with disabilities [6]. Computer access provides a method of reading and writing, communication and education and with Internet access, computers can offer widespread information access and participation in the information society [7,6]. AT to access computers may include built-in universal access features or specialized technology [8]. Universal access features make computers usable by both the non-disabled population and people with disabilities. For instance, by changing a setting in the computer's operating system, repeated keystrokes can be ignored when someone who has a tremor is typing on a standard keyboard. Specialized AT may be needed, for example a camera to detect the direction of eye gaze and translate that to cursor movement on a computer screen for someone who has a spinal cord injury.

Only 5-15% of people with disabilities in lower-income countries have access to AT, and that AT is usually in the form of mobility aids such as wheelchairs [5]. Computer access devices are the least common forms of AT in lower-income communities and are not reported in the literature [8]. Barriers to implementation include: limited AT production, high costs and lack of support from healthcare systems [9]. Resource-limited communities may use low-tech AT to facilitate participation in activities like reading, writing, communication and education [10]. Low-tech AT refers to inexpensive devices that are simple to make and easy to obtain [6]. For example, a communication book or page could be made by putting symbols, letters or words on paper, or, blocks with letters could be moved on a table to form words by a child who cannot hold a pencil. However, these strategies cannot encourage greater participation in the information society.

In order for persons with disabilities in lower-income countries to participate fully in society, mainstream Information and Communication Technologies (ICTs) such as tablets, smart phones and mobile phones, along with their universal access features, should be used as AT. A summary of the literature supporting this claim is presented, followed by a case study of a project in a resourced-limited setting in Bogota, Colombia. This work was the first step towards the long-term goal of improving the health and participation in society of people with disabilities, with AT implementation as an intended component.

2. AT compared to mainstream ICT

AT is generally defined as any product or device that is used to improve function for someone who has a disability [6]. This general definition can be interpreted to include a wide variety of mainstream products "such as Velcro and microwave ovens" [11]. These everyday products serve a functional purpose and improve functional performance, but are "intended for general use" rather than primarily for people with disabilities [11]. On the other hand, AT is used for the purpose of "eliminating, ameliorating, or compensating for" functional limitations and impairments [12]. Thus, the differentiation between mainstream technologies and AT is illuminated more by the application of the technology than on the particular characteristics or design of a product. For example, a business person may use an iPad for note taking at meetings, giving presentations or keeping track of email. Though, in another context, an iPad used by a person who cannot speak may be used as their augmentative and alternative communication (AAC) device [13]. In the second instance, the iPad was introduced to overcome a physical impairment. When mainstream technology is used to compensate for loss of function or impairment, it can become an AT.

ICTs are mainstream technologies such as mobile and fixed-wire telephones, computers, tablets, radio, television, and the Internet. ICTs are electronic products that provide means for sharing information and facilitating communication. ICTs, when used for the purpose of "eliminating, ameliorating, or compensating for" functional limitations [12], function as AT.

There is an interrelated history between AT and ICT and the use of ICTs to improve the function of people with disabilities. Throughout the 20th century, ICTs were often used as AT for people with disabilities. In 1928, the American Foundation for the Blind distributed radios to the visually impaired to provide access to information that was previously only available in print format [14]. Likewise, the phonograph was initially developed to support talking books, improving education and information access for people with disabilities [14]; this was also the case with the development of the cassette tape a number of years later [15].

Advancement in ICTs has required the development of new AT in order for people with disabilities to access these ICTs [7]. The first documented example was the Adaptive Firmware Card that was developed to access the Apple computer in 1977 [16]. The card gave people with severe physical disabilities the ability to operate a computer using switch access for scanning [6]. Other, recent, examples of AT that provide alternative access to computer-based ICTs include eye gaze and head movements to enable a people with disabilities to navigate the computer's graphical user interface (GUI) [6].

Often, what started as AT became ICT. In the late 1800s, Alexander Graham Bell worked as an educator for people with hearing impairments, his inspiration coming from his wife and mother (both hearing impaired) [17]. After many years of work with the hearing impaired, Bell developed a communication device that became the basis for the modern telephone [17]. However, the benefit of the telephone was primarily to the mainstream population, actually marginalizing those who had difficulty hearing [18]. The discovery that the telephone line could be used to transmit digital data via modems initially addressed the needs of profoundly deaf people through the teletype (TTY) devices designed for sending weather and news information over telephone lines, essentially providing a "visual telephone" [18]. The technology that made this visual telephone possible led to the development of SMS (texting) on mobile phones. The vibrating alphanumeric pager also developed for people with hearing impairments in the 1970s led to mainstream pagers and vibrating alerts found in the modern mobile phone [17].

Advances in AT have contributed to some of the most advanced features in modern ICTs [17,19]. For example, in the 1980s and 1990s, innovations in voice synthesis for people with disabilities who could not use their own voice to talk led the way to speech synthesis, common in mainstream computers and mobile phones [17]. Likewise, innovations in automatic speech recognition (ASR) for entering text for people with disabilities who could not use a keyboard led the way to ASR in mainstream dictation, computers and mobile phones [17]. Apple advertises that one of the most popular features of the iPhone operating system is Siri, which uses an advanced speech recognition system and has high quality speech output [20].

3. ICT trends in lower-income countries

If people with disabilities in lower-income countries are to be able to take advantage of ICT for participation in the information society, close attention must be paid to global ICT trends. This includes an examination of the direction of ICT adoption in these countries. ICTs such as computers, the Internet and mobile phones are the primary mode of information sharing and knowledge transfer in developed countries [22]. However, rates of computer and Internet use differ drastically between developed and developing countries. In developed countries, 74% of households have a personal computer compared to 25% in developing countries; and 78% of households have fixed-wire broadband internet compared to 28% in developing countries [23]. In contrast to the lack of computer and internet access, global statistics indicate that 89% of people in lower-income countries have a mobile phone subscription [24]. Mobile phones, becoming more and more prevalent in lower-income countries, have the potential to enhance participation, with the appropriate implementation [25,26]. The largest area of ICT growth internationally is mobile broadband internet access [27]. “Wireless-broadband access, including prepaid mobile broadband, is mushrooming in developing countries and internet users are shifting more and more from fixed to wireless connections and devices” [28]. Mobile phones have numerous advantages to fixed-wire communication methods; mobile phones are more affordable, readily available, have quite reliable networks, have reasonable power requirements and batteries that can last multiple days on a single charge [26]. The proliferation and advantages of mobile, connected devices have the potential to support the global application of AT based on smart phones and tablets.

ICT trends suggest that lower-income countries will not develop widespread computer and fixed-wire internet adoption in the same way high-income countries have [29,27]. In high-income countries, it has been typical to see step-wise upgrading with respect to ICT adoption [30]. For example, Internet use began with dial-up and has transitioned to broadband Internet, while phone use began with fixed-wire telephony and has transitioned to wireless mobile phones [30,29,17]. Lower-income countries have the potential to skip this step-wise technology upgrade path, through a process termed *technology leapfrogging* [30,31]. Technology leapfrogging most often refers to the potential for lower-income countries to bypass fixed-wire communication technologies, such as the personal computer and fixed-wire internet, in favor of tablets, smartphones and other mobile devices that are connected to wireless networks [29]. These devices are often referred to as post-PC devices, mobile devices or connected devices [29]. Technology leapfrogging is already believed to have occurred with the widespread adoption of the mobile phone in lower-income markets, bypassing the adoption of fixed-wire telephones [30,29,31].

Other factors also contribute to the likelihood of technology leapfrogging in lower income countries. Lower-income countries are less entrenched in intermediate technologies (e.g., personal computers and fixed-wire Internet) making it easier to transition to newer technologies (e.g., mobile phones) than it would be for higher-income countries [30]. It is believed that the high rates of mobile phone adoption will lead to the adoption of other more advanced mobile devices [29]. Post-PC devices are also more affordable than computers and fixed-wire Internet, making advanced communications possible at a much lower price [29].

4. The post-PC era and AT

Given that lower-income countries will leapfrog the computer and fixed-wire Internet, AT professionals need to consider the implementation of AT using mainstream, post-PC devices. There is much debate over the terminology of this new era of ICTs (e.g. post-PC era, post-desktop computer era, Age of Mobilism), but there is a distinct shift in the current global ICT landscape away from personal computers [32]. The AT field is also shifting away from PC-based and dedicated AT devices [33]. The following are characteristics of the post-PC era and examples showing how these characteristics are playing out in the AT field in higher-income countries.

4.1 Proliferation of the mobile connected device

The proliferation of the connected mobile device (mainly smartphones & tablets) is the primary characteristic of the post-PC era [32]. In 2011, the smartphone officially surpassed the personal computer in global sales [32]. Rapid growth has occurred in the two dominant mobile operating systems, iOS (Apple) and Android (Google); together they account for 85% of all smartphones globally [34]. Android has seen the largest growth since its initial release in 2008, capturing over 68% of the global smartphone market share [34].

Mainstream mobile devices are being used as high tech AT since it is more affordable than computer-based or dedicated communication devices [35]. There is growing selection of software applications for use by people with disabilities (including augmentative and alternative communication) for both iOS and Android, and many of these applications are available in multiple languages [36].

Given the relatively new emergence of post-PC devices, there has been limited research into the accessibility of these devices [35]. Dolic, Pibernik & Bota compared the technical characteristics and capabilities of purpose-built AAC devices to mainstream tablets [37]. Tablets and other mainstream technologies provide a range of built-in functions that are useful to people with disabilities including Internet access, phone (voice and texting) and other applications such as navigation based on built-in capability (e.g., accelerometers, GPS tracking, cameras). Mainstream mobile technologies, being equipped with a variety of sensors, along with downloadable applications, have functionality equivalent to special purpose AT such as fall detection, wayfinding and sound amplification [38]. Mainstream mobile technologies are also frequently smaller than purpose-built AT. Other critical factors in a mobile device for someone with mobility impairments are: continuous power on, since many on/off buttons are small and hard to activate; synchronizing with one or more email accounts; a protective case since the unit may be dropped due to limited fine motor control; and a lanyard for retrieving the phone if it does drop [39].

4.2 Invisibility of the Internet

The post-PC era is a time when the Internet is no longer a visible destination, it is something that you are always invisibly connected to [40]. Walt Mossberg of the Wall Street Journal compares the Internet to the electrical grid; you do not use the electrical grid, you use the toaster/hairdryer/lamp/etc [41]. The same is happening with the Internet; we use computers, TVs, smartphones, home security systems, and other objects that are all connected to the Internet [40]. Our data is being stored remotely in the cloud and our need for fixed-wire connectivity is diminishing [42]. Physical storage (e.g. hard drives or DVDs) is no longer necessary, as information is stored in the cloud and transmitted using the Internet. The cloud can be utilized as a resource for people with disabilities. User profiles and software for functions such as text-to-speech or vocabulary storage can be stored on cloud servers and accessed using simple technology such as Bluetooth-enabled keyboards or mainstream AT devices such as speech generating devices [42]. These services and data can have features matched to the individual's skills and abilities as with current AT. Another approach is for individuals to use an older computer or tablet as an interface to access the cloud resources as their main computer/AT device, for example, AT for AAC [42] or cognitive assistive technologies [43].

4.3 Death of the graphical user interface (GUI)

The computer interface is changing from mouse-based interaction, using a mouse and cursor/arrow to select symbols, to more direct methods such as multi-touch and gesture interfaces [41]. The GUI uses symbols on a screen (e.g. folders or icons) that can be selected using a mouse, whereas an interface that relies on direct interaction such as touch, motion or speech is considered to be the Natural User Interface (NUI) [44]. Windows, the most widespread personal computer operating system, is currently transitioning away from the GUI to predominantly touch-based interface [45]. This shift to the NUI poses a unique challenge to the field of AT since the majority of computer access AT was developed for the GUI [6]. Each time Microsoft or Apple make changes to their operating system (OS), AT companies are forced to adapt their technology to ensure it will work with the new OS. One way in which the AT community has sought to mitigate this cycle is through the development of accessibility standards [46]. International standards help to ensure that people with disabilities have access to ICTs even when new technology emerges [46]. An example of standards are the ICT accessibility guidelines outlined by the International Organization for Standardization (ISO), intended to improve accessibility of mainstream ICTs for people with a wide range of ability [46]. Even with these standards, AT companies are again working at making their AT compatible with the drastically revamped Windows 8 OS and its touch-based user interface.

The two primary mobile operating systems, iOS and Android have some built-in accessibility features that assist people with visual and auditory impairments [20,47]. With the most recent update of the Android operating system, developers have a formal guide for the incorporation of accessibility features and standards into applications [47]. Accessibility standards have not been universally accepted across all mobile operating systems and devices, however the US Federal Communications Commission recently issued a public notice on the accessibility of mobile devices [48]. This will hopefully lead to the development of widespread accessibility standards for mobile devices. Alternative access methods are being developed for both iOS (iPhone and iPad) and Android devices such as Tecla [49], though these methods are very new and have had limited research [37].

Even without special accessibility options, the NUI can be accessible to some people with disabilities. Newer post-pc devices require less skill and have more user-friendly touchscreen interfaces [29]. Cook and Polgar indicate that touch screen interfaces typically require less cognitive processing as they are more direct and intuitive [6]. Touch screen access that requires a flick of the finger rather than continuous pressing of multiple keys can be easier for some people to use [39].

4.4 The consumerization of the enterprise

Consumers are beginning to dictate the technology being used in the corporate space. One of the most critical indicators for the new era in mobile computing is the adoption of the “bring your own device” program of many corporations [50]. Many business professionals are choosing to use post-PC products such as Apple’s iPad rather than the typical company laptop [51]. Consumer electronics are now driving technology change in the corporate sector [51].

Similarly, the proliferation of mainstream mobile devices is beginning to dictate the delivery of AT in the clinic [33]. The most common 'bring your own device' in AT is the iPad, which has become a preferred AAC solution for many people with complex communication needs due to the widespread availability, ease of purchasing applications and relatively low cost [33]. McNaughton and Light suggest that the iPad has led to a new, consumer-driven model of AT service delivery [33].

5. Information and Communication Technology for Development (ICT4D)

The field of international development has a history of using technologies within the context of lower-income countries [26]. While no universally accepted view of development exists, development generally refers to the act of progress and growth in an impoverished community, region or country [26]. The field of Information and Communication Technology for Development (ICT4D) has a wide array of experience using mainstream ICTs as tools to address community development goals [25,26]. ICT4D projects have ranged in focus, including social action, commerce & marketplace communication, agriculture, emergency response systems, and health service delivery [52]. One of the most widely discussed ICT4D projects is the one laptop per child (OLPC) initiative that began in 2006 [26]. The initiative intended to develop a $100 laptop that could be distributed to children in lower-income countries [26]. Unfortunately, costs became higher than expected (over $175/device), likely too high to implement on a widespread basis [26]. The OLPC initiative continues to work towards developing a low-cost device for use in lower-income countries, most recently releasing an Android tablet for children to use for education [53].

Mobile phones have become the preferred technology for ICT4D projects because of their widespread use, particularly in lower-income countries [54]. Mobile phones have been useful for improving access to information, promoting local knowledge sharing and improving social interaction for marginalized populations [55-57]. However, there is limited research on the use of mobile phones to address the needs of people with disabilities in lower-income countries [58].

6. Case Study: Using ICTs in a resource-limited community

The authors, along with Colombian research partners, began a development project in Bogota, Colombia. Prior to arriving in Colombia and learning about the context from the local partners, the initial project idea was to provide people with disabilities with a method to access mobile phones so they could communicate with each other and access information about obtaining other AT. Due to the collaborative research method and contextual factors the project evolved into accomplishing an important prerequisite step, with caregivers of people with disabilities using mobile phones to access relevant information.

Many Colombians who were displaced from their homes by violence or socio-economic factors have settled in the mountainside on the perimeter of the capital city, Bogota [68]. These communities are characterized by low socio-economic status, limited access to municipal services such as electricity and sewage, and high crime rates. Citizens in these communities, including a high proportion of people with disabilities , also experience a lack of access to fundamental health services such as rehabilitation services (including access to AT). Some knowledge, services, and resources exist for people with disabilities, however, one of the most critical issues they face is the lack of access to this information. For example, a group of Colombian researchers developed an extensive database of AT available in Bogota, Colombia [59]. However this 5000 item database could not be shared with the general public because there was no viable information distribution system. The majority of the population does not own a computer and print media would have been too costly.

A collaborative discussion was initiated with the community of El Codito, located in the northernmost region of Bogota. In preliminary discussions, community members indicated that mobile phones could be a feasible method to improve information access in El Codito as most households in the community had a basic mobile phone that was capable of voice calls and SMS messaging. The Colombian collaborators felt that using SMS on mobile phones could be affordable since all incoming SMS messages are free and the cost of outgoing SMS messages is minimal.

6.1 Methods and Materials

This was a community-based research (CBR) project based on a collaborative partnership between Canadian and Colombian researchers, and the community of El Codito. CBR is a collaborative research method which acknowledges the expertise that community member and community organizations can contribute to projects and involves them in the research process from the beginning [60]. A coordination team was formed to administer the project. The coordination team included a Canadian researcher (occupational therapist), a Colombian researcher (sociologist), a community clinician (occupational therapist) and an El Codito community leader. The community clinician and the community leader were responsible for information distribution in the project.

6.1.1 Participants

The coordination team determined that it would be best for the participants of the first study to be the caregivers of people with disabilities, rather than the people with disabilities themselves. This simplified the implementation by not needing to find a way for each person with a disability to hold and use the phone, particularly given the diverse range of impairments. Information exclusion not only impacts people with disabilities, but also their family members. Many family members become isolated since they must remain in the home to take care of the person with a disability.

Physical and social isolation limits ‘word of mouth’ advice from others in the community and contributes to decreased access to information. A purposeful sample of 8 caregivers (7 mothers, 1 father) was selected by the El Codito community leader. Each participant was a caregiver of a person with disability, had a mobile phone subscription, and was able to successfully demonstrate sending an SMS message (in some cases with minimal assistance from a family member). Caregivers ranged in age from 27-54 years old and their children ranged from 7-32 years old. One person with a disability, a 32-year-old woman with cerebral palsy, also participated in the project and accessed her mother’s phone without any need for adaptation.

6.1.2 Information Selection/Identification

In preliminary discussions it was proposed to share information about AT. However, it was determined that the database of AT available in Bogota was out of date and no other AT materials relevant to people with disabilities in El Codito were readily available. The use of existing information promotes local, contextually relevant knowledge sharing [25], so project partners decided that the community clinician and community leader would research current, relevant general information throughout the project and generate content on a weekly basis. Initial information included information on accessing health services for people with disabilities and their families (e.g. child vaccinations, a local disability registration event and information for parents on accessing mental health support). During the study, the participants indicated that information about community events was also very important to them. The community clinician and community leader, having an understanding of the context, were able to identify information about events that were most relevant to the participants and shared that information with them. The project also evolved to include information about community events for people with disabilities (e.g. a local resource fair for people with disabilities) because the community clinician felt it was important to try to reduce the isolation of the people with disabilities and their caregivers.

6.1.3 Materials

The software used for this project was FrontlineSMS, an open-source text message delivery program created for international development (FrontlineSMS, 2011). At the administration side, the system requires one computer running FrontlineSMS connected to one mobile phone via the phone's USB cable, no Internet connection is required. The computer and mobile phone act as a two-way SMS-messaging hub for sending to, and receiving messages from the participant's personal mobile phone. In FrontlineSMS, keywords that correspond with various actions in the software, can be used to facilitate two-way messaging. For this project, two keywords were used: INFO and PREGUNTA. The keyword INFO was used to send information messages to caregivers. Messages sent to the SMS-messaging hub with the keyword INFO were automatically forwarded to the caregivers participating in the project. The keyword PREGUNTA (Spanish for question) was used by caregivers in order to ask health-related questions. Messages sent to the SMS-messaging hub with the keyword PREGUNTA were automatically forwarded to the community clinician.

6.1.4 Data Collection

For three months, caregivers received information and had the opportunity to ask health questions using SMS. The number of messages sent/received was recorded in FrontlineSMS. Qualitative data were collected via a focus group. Conducting a focus group is consistent with CBR principles and the co-creation of knowledge [61], but most importantly, the Colombian researchers indicated that focus groups have been an effective data collection method with this particular community in the past.

6.1.5 Data Analysis

The project was evaluated with descriptive measures of the message data and by a content analysis of the focus group. A co-analysis of the focus group transcript occurred in English and in Spanish. This co-analysis was completed according to the thematic analysis proposed by Braun & Clarke [62] in conjunction with the content analysis outlined by Mayan [63]. The Canadian researcher conducted a content analysis with an English translation while the community clinician (in Bogota) conducted a content analysis with the Spanish transcript. Canadian and Colombian researchers discussed the data after each stage of the content analysis and validated the resultant themes with participants after the analysis was completed.

6.2 Results

6.2.1 Quantitative Results

A total of 56 information messages were sent to participants by the community clinician and community leader. An example of an information message was:

> *"Info: Vaccinations for children under 10 will be available tomorrow from 8-12 in the Codito sector"*

Participants used the PREGUNTA keyword 20 times during the three-month implementation. Of these 20 occasions, 7 were health-related questions (e.g., one of the participants asked a question about a specific bacterial infection), 6 were expressions of gratitude (e.g. "Thank you very much for the useful information"), 4 were general clarification questions (e.g. "what is the address for the event mentioned in the last message") and 3 messages had no meaningful content (e.g. a blank message). The community clinician responded individually to each caregiver question. For example, when a participant asked about a bacterial infection, the community clinician sent a response and also directed her to speak with a physician for further information.

6.2.2 Qualitative Results

The primary theme in relation to information sharing was that the project showed the participants the possibility of community participation. Having access to information in this way opened a window to a new possibility of being a participatory member of their community.

More than half of the participants identified that they attended a community event after receiving one of the project text messages. One participant stated that these events were the only events that she attended in the community during the past year.

Participants acknowledged that they had not been aware of things that were happening in their community. One participant stated:

"...sometimes one is blind to the projects that are being made for people with disabilities"

It is worth noting that participants who sent fewer questions did not necessarily find the project any less useful or meaningful. One participant noted that although she did not send many messages, simply receiving the messages was important and valuable.

6.2.3 Technical Considerations, Usability & Training

Throughout the project, participants made a total of three errors when using the keyword PREGUNTA. These errors were either a misspelled keyword or not leaving a space after the keyword. Each time an error occurred, the participant received an automatic reply to remind them of the correct way to use the keyword and the spelling. Despite making formatting errors, the three participants that made these errors all re-sent a correctly formatted message. During the focus group, participants stated that they would have liked to receive more training on the use of keywords prior to the intervention. Participants did not identify difficulty sending SMS, rather only difficulty knowing how to use keywords. Participants noted that if they had received more training they would have taken more advantage of the project, for example with more training they would have used the “PREGUNTA” keyword more.

6.3 Case Study Summary

This case study was a first step towards introducing AT to people with disabilities in less resourced settings. Using ICTs was a feasible method to provide information sharing for the caregivers of people with disabilities. Being a CBR project, iterative changes occurred throughout the project based on input from the community or coordination team. For example, the type of information changed over the course of the project from information about health resources to information about community events. The community clinician knew that these community events were important and relevant to the participants, but the participants were at first unaware of the possibilities. By participating in this project, participants became aware of their options. Simply attending events is not really "participating", rather community participation is the involvement of people in activities that serve the needs of the community [64] or contributes to change in the community [65]. Furthermore, community participation requires citizens’ active involvement in seeking solutions [66]. According to Zakus and Lysack (1998), involvement in community events can be an initial step that leads toward community participation [66]. Participants, having increased exposure to new possibilities, expressed a desire for raising awareness in their community for disability issues.

For this project, it was important to use existing mainstream technology with only small, incremental changes to the technology with which the participants were already familiar in order to facilitate technology use. ICT4D literature suggests the use of existing technology that requires basic skills rather than advanced technical knowledge [52]. In a similar fashion, the ICT4D literature also recommends that technology based projects avoid introducing new technologies

[67]. The introduction of keywords made the technology more difficult to use, however participants were able to learn this skill despite not having in-depth training. Participants, having an understanding of how the keywords worked, utilized the keywords creatively, for instance, to use PREGUNTA to communicate with researchers about their gratitude, rather than simply to ask a question.

The case focused on the caregivers of people with disabilities using ICTs, not the people with disabilities themselves. Future studies should focus on the use of ICTs by people with disabilities in communities such as El Coditio. Until post-PC devices (such as smartphones or tablets) and alternative methods of access are made more readily available, people with disabilities can use simple, low-tech devices to access existing mobile phones. For example, the phone can be held in place with a jig, and the buttons could be pressed using a mechanical head pointer made from a stick on a baseball cap, or a mouth stick can be made from readily available materials [10].

7. Conclusion

The fields of ICT and AT have a rich interrelated history that is likely to continue in the future [14]. Over the past 10 years, the field of ICT4D has made strides towards the successful implementation of technology to improve the lives of people in lower-income countries [26]. ICT4D strives to provide an opportunity for people in lower-income countries to participate in the information society [26]. The AT field has an opportunity to learn from ICT4D and help improve the participation of people with disabilities in lower-income countries.

Achieving wide-spread global availability of AT applications at an affordable local price will have to be based on mainstream devices [18]. The widespread adoption of mobile devices and technology leapfrogging in lower-income countries, along with the emergence of the post-PC era, present a strong case for the use of mainstream ICTs as AT in lower-income countries. However, devices such as smartphones and tablets are still not as common as basic mobile phones in lower-income countries [28].

Accessible ICTs can eliminate or reduce some of the socioeconomic barriers faced by people with disabilities in lower-income countries [58]. However, accessible technologies can be enhanced or hindered by government policy and legislation, the service delivery systems and available funding. As the case study above demonstrated, mobile phones, an available technology in El Codito and other resource-limited communities, can be a useful tool for addressing the information exclusion of people with disabilities and caregivers.

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