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EDUCATIONAL E-INCLUSION FOR STUDENTS WITH SEVERE MOTOR DIFFICULTIES

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Abstract: The purposes of educational e-inclusion are fairness, equality and quality in the educational processes and offering the benefits of ICTs to all students. The impossibility of using computers or accessing the Internet increases educational exclusion and segregation. In this paper, we present an experience carried out at a special education center. This experience involved users with severe motor disabilities, and its purpose was to design and develop a computer-access system that was usable and adapted to the user. This system has allowed adding activities to the educational curriculum based on new technologies.

Keywords: accessibility; assistive product, students with special educational needs (SEN).

Introduction

The integration of disabled people to the information society is one of the most relevant challenges for the programs that, since the Lisbon strategy of 2000, are developed under the term e-Inclusion. These people have difficulties using computers and, as a consequence, accessing the Internet; therefore, from an interdisciplinary perspective, we must find alternatives that facilitate and allow these groups accessing and using information and communication technologies.

On the one hand, being able to access computers and the Internet is a necessary condition to have an active presence in this new society and, as well as for non-disabled students, it enriches and offers new educational possibilities (Zubilaga, 2002). However, accessing the Web is not always feasible for all groups, thus becoming a new form of social exclusion.

On the other hand, the teaching and learning process should nowadays be as fair as possible for all students, allowing and favoring the presence, participation and progress of all students in their educational experiences and activities, regardless of their conditions, abilities or characteristics. This fairness should also be applied to virtual education programs, which should also operate within the framework of the Inclusive Education model or Education For All (EFA) that, as proposed and defended by the UNESCO since the International Conference held in Jomtien in 1990, should also manifest as an inclusive information society.

It is estimated that a large number of assistive products are released each year, but most of them do not get to the users due to unawareness of their existence or the cost of purchasing them (Scherer & Gavin, 1996). If the product does get to the user, many systems are not accepted for lack of usability (Dawe, 2006). Therefore, for a system to be accepted by users, it is essential that its design and development follows User-Centered Design guidelines, such as design based on user understanding, tasks and context, involving users throughout the design and development processes, performing user-centered assessments, process iteration, considering user experience (UX), and working in a multi-disciplinary group (ISO 9241-210, 2010).

In this paper, we present a user-centered design and development experience for an assistive product based on computer vision that offers an access system for people with motor disabilities to be able to use the computer. The adaptations implemented to improve the system's usability are particularly noteworthy. The experience was carried out at a special education center, ASPACE-Pinyol Vermell, with students with cerebral palsy, so accessibility has allowed planning and working on new activities that complement the educational curriculum of the students.

Inclusive education as reference framework

Inclusive education focuses on working on achieving two essential goals:

1. Defending educational fairness and quality for all students, without exceptions.

2. Fighting against exclusion and segregation in education.

Giné (2009) proposes that inclusion should be understood as a general principle applicable both to education and society. There is a growing international consensus around the idea that inclusion involves the following:

- Adopting certain values that should preside over the actions that could be carried out: acknowledgement of rights, respecting differences, valuing each individual student, among others. Inclusion is, first and foremost, a question of values, but there are specific issues related to practice.
- The process of increasing student participation in the curriculum, culture and community, and avoiding any form of exclusion in educational centers.
- The possibility of transforming cultures, standards and practices of educational centers to respond to a diversity of needs from all local students.
- The presence, participation and success of all students exposed to any risk of exclusion, and not only those with disabilities or special needs.

In this context, applying inclusive cultures and policies to the practice of e-Inclusion means taking into account the diversity of all people, which requires three central actions that group many others, but that can be explained through these (Muntaner, 2010):

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a) Removal of barriers for learning and participation. Removing the barriers that prevent the participation of all students in educational activities means rejecting all programs and proposals that discriminate against and segregate certain students, and which are in themselves a barrier to equal opportunity education. We must propose actions governed by a balance between the respect for the individuality of each student, with their idiosyncrasies, that is, their particular needs and abilities, different from any other, and the feeling of belonging to a group as a full member, a group in which the students can develop and feel valued, and that incorporates them and allows them to succeed in their learning process.
b) Facilitators. Assistive products are important for disabled people (Sánchez Montoya, 2002) because they offer the possibility of developing and active and independent life and allow connecting with the surrounding environment, increasing their dignity and consideration. The quality of life of disabled people is not just a question of economic safety or the availability of centers and services. It also depends on accessibility to physical media, environmental friendliness, existence and availability of resources that allow crossing communication and mobility barriers and fully participating in society under integration and normalization conditions.
c) For disabled people, achieving an independent life and social inclusion is not an easy or comfortable task, since they are limited both by physical and social barriers and by very diverse attitudes. Thus, disabled people look for acceptable and balanced life spaces that are suitable for their abilities and limitations. We must offer them opportunities that are appropriate to develop their abilities and to build their particular way towards reaching their adulthood within their social environment.
d) Assistive products are closely related to the effort done in the field of technology research. These products have to be constantly improved, and new solutions have to be proposed for the new

problems arising from this increasingly complex life we lead. In this line of action, the incorporation of ICTs to the disabilities field has largely helped overcoming some of the barriers faced by disabled people.

e) Application of universal design principles. The removal of these barriers and the appearance of assistive systems as natural facilitators to improve the functionality and participation of all students at educational centers involve adapting the classroom and curriculum. These adaptations should allow for a more flexible and open curriculum. To achieve this goal, we propose incorporating universal design principles to learning, as defined by Orkins & McLane (1998): “the design of didactic materials and activities that allow learning goals to be reachable by individuals with widely different abilities to see, hear, talk, move, read, write, understand the language, focus attention, organize, participate and remember.”

Design of a computer access system

A user that is about to interact with a computer faces three different situations: data input, output, and processing. In the case of people with severe motor limitations, they have difficulties mainly accessing the computer and, even though nowadays there is a large diversity of both commercial and free solutions that offer input systems, these are not always appropriate or usable – i.e., effective, efficient and satisfactory, for the user.

The system that was designed is called SINA (Advanced and Natural Interaction System) , and it is a pointer device that uses just a webcam and is based on computer vision techniques that detect the face and nose based on human aspect visual features. Once the nose is detected, the system follows it to ultimately inform the position of the pointer to the operating system. To carry out the actions of the mouse, there is a graphical button bar that is always visible on the screen and includes all the events. These actions are executed through the so-called “wait and click”: the user selects an action by positioning the mouse pointer on the event button and waits a certain amount of time, which can be configured, until the action is selected. From the selection, the action will be executed on any part of the screen on which the mouse position is held for a preset time. From a technical standpoint, the application has been divided in two main modules to get an easy-to-use, user-friendly and, above all, fully automated system: Detection and Processing. The Initialization module is responsible for extracting the facial features of the user. This phase locates the face of the user and extracts the best facial features around the nose for tracking purposes. The Processing phase is in charge of tracking these facial features, recovering them if they are lost, and sending event and position of the mouse to the operating system (Varona, Manresa-Yee & Perales, 2008).

Users, tasks, and context

Students at the educational center were selected based on the following criteria: need for an alternative and efficient way to access the computer, possibility of working towards curricular goals, cognitive level to understand the operating of the program, and previous experience with computers.

The center selected four students and the first source of information regarding their abilities was an initial record gathering their personal information, and physical, cognitive, and behavioral characteristics. This record was divided in data on these areas: motor, visual perception, communication, psychological, pedagogical, computer skills, and prior computer experience.

User sessions were individual and adapted to their curricular needs. The type of activities selected by therapists and/or students to work on with the computer included:

- Viewing Microsoft PowerPoint presentations where the student had to press an element to answer a question, aimed at working on spatial organization, improving the interaction with the environment, etc.
- Playing action/reaction games.

- Using JClic, Sebran ABC or Pipo applications and educational games, which are compilations of activities to learn how to read, write and compute, solve puzzles, and play association games or memory games.
- Solving educational and fun activities available on the Web or as desktop applications.
- Internet browsing and using communication tools.

Multidisciplinary group

The development team included computer science professionals, educators, physical therapists and occupational therapists. The first fully functional prototype was developed with the advice of a user with motor disability that had a technical background. After assessing it under laboratory conditions with non-disabled users, it was implemented at the special education school. The students at this center could have, in addition to their physical difficulties, some degree of cognitive limitations, so our goal was to present a robust and operating system that would not frustrate them due to technical problems. In the following section, the implementation process is described, as well as the continuous improvement process based on prototypes.

Also, it was very important to work with a centre that was involved in the SINA project at every level of the organization. The support of the management team, the users and their families, and the occupational therapists that led the sessions greatly facilitated the design of a usable system that was adapted to the needs of the users.

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Iterative usability improvement process with users

The improvement process was based on using high fidelity prototypes to favor iteration, improve functional specification completeness, and involving users in the design process and assessing at early stages (Lazar, Feng & Hochheiser, 2010). As problems were detected, they were analyzed, redesigned, and assessed with the users.

The following activities were carried out to gather information:

- The development team observed users using the system and therapists working with the students.
- Sessions were recorded daily by following a template that included data on the system, users, tasks carried out and context of use.
- Semi-structured interviews were conducted with therapists at the end of the school course.
- Reports were prepared on each of the participating students at the end of the school course.
- The sessions were videotaped.
- Ergonomics experts prepared reports on each user.
- Usability assessment: based on the definition of usability included in ISO 9241-11 standard (1998), usability tests were carried out to measure efficiency, effectiveness, and satisfaction factors. Students were presented with a set of tasks and the metrics used were: task completeness and task duration. Finally, there was a questionnaire that gathered information through Likert scales on fatigue, comfort, motivation and satisfaction.
- Comparison with other systems: some students were already using computers with other devices such as joysticks (hand and chin), head pointers or switches, so comparative tests were carried out by measuring the completeness and time required to perform tasks (Manresa-Yee, Ponsa, Varona & Perales, 2010).

The development team considered a set of factors that help involve usability in the development process. Boivie et al. (2003), divide these factors on three different levels: individual, project, and organization:

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- On the individual level, both the attitude and skills and experience of those developing the system are key factors to introduce usability. The development team was very aware of the importance of designing a usable device that was adapted to the end user, since they knew that there were other systems whose ultimate goal was accessibility and which the users had already tried and found inefficient.
- On the project level, the main challenges are planning an iterative work model that integrates usability, the complexity of system's development projects, the decision-making process, and involving the users. As mentioned above, fully functional prototypes were used to enable early user participation. With an initial functional prototype, end users were brought into the process to work on their school activities. A summative and formative assessment was carried out (Lazar, Feng and Hochheiser, 2010). Additionally, there was no coordination issues within the work team because it was small and the developers were entirely free to make any usability-related decisions. The students participated throughout the improvement process, and both the development team and the therapists observed in detail how the system was used and analyzed information documents to suggest improvements.
- On the organizational level: as regards possible organizational obstacles, there were no remarkable issues. Project responsibilities were divided based on their nature, with the technical people being in charge of the proper operation of the system and its redesign, and educational aspects and day-to-day work with the students being the responsibility of the educators at the center and the experts in educational technology and special education. The only decisions that could affect the system development process and set deadlines were those related to the schedule and requirements of the educational center, due to the number of sessions that could be held each week, and available times, rooms, students, or therapists. However, project-staff at the center was fully committed, facilitating system assessment, gathering and recording session data, participating in

meetings, providing feedback in relation to possible improvements, and dedicating their time to work with the system.

Improvements to system usability

Based on the information obtained, usability recommendations were made to improve on the following aspects relating to (Juristo, Moreno & Sánchez-Segura, 2003):

- User interface, with modifications on the graphical user interface. The system was modified to allow using mouse graphic metaphors instead of text on the event bar, and the possibility of placing this bar on various screen positions was added. In the case of those students who still did not understand all mouse functionality, events could be disabled to avoid mistakenly selecting them. In the ergonomics report, the correct use of colors was recommended to prevent opposed color combinations. Therapists requested that the window where the vision process was observed (detecting and tracking the user's nose) was hidden because the students kept looking at themselves and did not focus on the tasks at hand. Since this window was not visible, there was no information on nose detection and tracking, so a smaller image was included within the event bar itself to have information on system status at all times.
- Development process, with changes in techniques, activities, and/or products used in the development process. Since the project was the collaboration of a multidisciplinary group formed by educators, computer science professionals, occupational therapists and physical therapists, know-how, methodologies, and techniques used in each discipline were included and exchanged within the group, which helped improve system implementation and communication with disabled users.
- System design, with changes in software functionalities to improve interaction. A parameter settings file was added to adapt the system to the abilities of the user (waiting time to generate events, position of the events bar, initial event selected by default, etc.). The

visualization algorithm was improved to add robustness to nose tracking and avoid losing it or having the nose position moved due to involuntary or sudden movements that the user might have. In the ergonomics report, different webcam heights and positions were recommended, or the use of auxiliary devices such as articulated arms to move the webcam closer.

For and extended review of the improvements in usability due to user experience, the reader is directed to our previous work (Manresa-Yee et al., 2010)

Conclusions

A computer access system has been presented that allows adding new school activities for students at a special education center. In the design and development of the system, factors that help improve usability have been taken into account, and a user-centered design was used, which means that end users were involved in the process from early development stages: they were observed while working on prototypes and the system was assessed with them. Currently, the students are still using the system at their school center (in occupational therapy sessions and computer rooms), and in some cases, their homes. The students have gained in control and interaction with the computer, therapists can select new educational activities, and a step is taken in the direction of normalization and equal educational opportunities for students with severe physical limitations.

In order to fully achieve educational e-Inclusion, physical accessibility to computers should be combined with Web accessibility and accessibility in the rest of the programs used to work.

The final release of the SINA and training applications are available under a freeware license at the Web page http://sina.uib.es.

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