Development of Software that Supports the Improvement of the Empathy in Children with Autism Spectrum Disorder

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Abstract—Autism is a developmental disorder characterized by a decrease in social interaction, communication, creativity, imagination and organization of daily living activities of those who have this condition. Empathy is a sense of understanding another person's feelings and is an important element within all relationships. Currently there have been no solutions that support the development or improvement of these social skills in autistic children by taking advantage of using multi-touch devices. For this reason, this study proposes to develop software that supports the improvement of the empathy in children with autism spectrum disorder under user centered design methodology.

Keywords- Autism Spectrum Disorder; User Centered Design; Multi-touch devices; Empathy.

I. INTRODUCTION

Autism or Autism Spectrum Disorder (ASD) is not a disease but a clinic syndrome present birth, which may produce alterations in behavior, verbal and non-verbal communication, social interaction and anomalous emotional development [1].

A child with autism usually has a significant delay in language development also known as language delay. He or she uses words in an inappropriate way and with no communicative purpose. On the other hand, autism does not represent only one pathological process but many symptoms that may be due to different disorders. It represents a dysfunction of one or more brain functions which are still not identified and in most of the cases it is a response to static encephalopathy [2].

In most cases autism features persist for lifetime, but people affected by the disorder may also improve their condition [3]. Nowadays, the number of children diagnosted with ASD continues increasing [4], which reminds us of the needs for this community. Despite great developments in early diagnosis and technology intervention have been made, the results of these interventions are still poor [5].

Thus, it is important to rely on different means that can promote integration to sociality for those who have these special needs.

It has been established that technologies can be used with therapeutic purposes in children with ASD. Among these it is worth to mention the use of several software for therapeutic support; or robots, which catch the children’s attention, encouraging their social and cognitive development [6].

Multi-touch devices can be highly relevant in this context, since they offer a natural way to interact with different applications or resources. In addition their portability allows the use of applications that facilitate the professional treatment of autistic children.

Applications that seek to improve more specific abilities in autistic children have been developed. The shift from “traditional” media, like paper cards, to a digital one does not seem to change the interactions between the professional and the child. For example, a collaborative puzzle in a multi-touch screen will seek to improve communication, collaboration, coordination and connect the thought with the visual spectrum [7][8].

Currently there have been no solutions that support the development or improvement of a particular social skill such as empathy in children with ASD by taking advantage of the use of multi-touch devices.

For the reasons explained above, a project it is being developed, at the University of Valparaiso, where an application for multi-touch tablets to support the improvement of empathy for children with ASD is implemented. The application was designed with the purpose of support social independence in children with ASD by increasing their social abilities as well as confidence and interactions with their own environment. The software was developed using the User Centered Design (UCD) Methodology.

II. THE PROJECT

Just as its mentioned on [9], the social independence of a child with ASD can be achieved improving their social ability along with their confidence and interaction with the environment. For example: on [10] a systematic review of software that are supposed to improve reading and writing skills was made. Another line that is in an experimental
phase, is the incorporation of robots in the classroom which relates to our future work [11].

III. METHODOLOGY

For the development of this work we used the UCD, because is a widely accepted methodology for designing usable applications and producing software that truly meets the needs of its users [12]. The stages of this methodology are: 1) definition of target users; 2) analysis; 3) design; and 4) evaluation.

In the following sections we describe how each stage of the methodology is contextualized to this work.

A. Phase 1: Definition of target users and requirements

This phase aims to provide answers to the questions: What are the needs of the user? How can we make a difference? What are we going to develop? The outcomes of this phase are [13]:

- User insights (profiles, context, skills, needs).
- A design brief (problem description, proposition, requirements).
- Opportunities (design direction, first ideas).

A group of children with high functional autism who attend primary school between 8 and 11 years old were selected [14]. Their teachers and parents were also included in the study with the objective of identifying how the integration with other children could be improved and how the learning of disciplines could be facilitated.

On this phase the requirements were obtained based on:

- Consultation with the interested parts (teachers, parents, psychologist, speech therapists).
- Literature about the matter.
- Fieldwork with children who have ASD, through participant observation [15].

B. Phase 2: Analysis

This phase of the project consists of a brainstorming sessions where the members of the team and stakeholders got together to creatively generate and explore innovative approaches to be incorporated in the prototype. Materializing ideas and thoughts that need to be early included in the process. This technique is based on the following activities:

- The exposure of the main problem that needs to be solved.
- Registration of the ideas.
- Exploration and improvement of ideas, and selection of the more feasible ones.

During these sessions, storyboards were created and used to clarify how the system should work in a real scenario. An example of one of the created storyboards is shown on Figure 1.

Some of the main advantages when using this technique are: it centers on the tasks for which the interface will give support and not the interface itself; it allows to discuss about the tasks that the system permits to carry out; it keeps all stakeholders interested on the project, in terms of interface interaction goals.

C. Phase 3: Design

In this phase, visual communication is a strong media to express not only ideas, but also feelings and desires. In addition, during the making process new ideas, that would not come up in a purely verbal process, will develop. The outcomes of this phase are [13]:

- Concepts.
- Demonstrators, alpha and beta prototypes.
- Rich experience information.

A group of preliminary interfaces were developed associated with usage scenarios. The developed scenes are tools that reproduce the real behavior of children with ASD. The first prototype was created on paper and after being approved by the teachers who work with autistic children, digital prototypes (wireframes) were made [16] [12]. An example of the prototypes is represented on Figure 2.

D. Phase 4: Evaluation

This phase test and evaluates prototypes with users to make sure they meet user needs. The aim is to find out whether a product or service could be successfully be used
by a larger group. At the same time the product, service or practice is refined and enhanced [13].

The evaluation process was divided into three parts: the first consisted on a heuristic evaluation by three academic researchers in software usability and accessibility; the second consisted on user tests to detect and verify the interaction between the components and the sequence of screens; the third consisted on interviews with teachers, parents and therapists about the effectiveness of the application. A brief description of each phase is presented below.

1) **Heuristic Evaluation**

As mentioned in the previous paragraph, a heuristic evaluation was performed to detect potential usability problems [17].

This evaluation was conducted by three academic researchers, who detected a total of 21 problems in the first prototype. The three main problems were:

1. The indicators of progress are not clear for the child.
2. There is no training period (or tutorial) for the child to learn how to use the system.
3. The error message is extremely negative and does not support the learning process.

The complete list of problems detected after the conducted inspection is available in [18].

2) **Users Test**

This test was carried out in order to find usability problems. It was based on the observation and analysis of how the group of three children with ASD (8 to 11 years old) used, and interacted with the software (prototype) in a multi-touch device. The users test took place in one of the classrooms of the school, so that the usage scenario was as real as possible. A total of 29 problems were found in all three cases. Among the principal usability problems are:

1. The activities must be explained in a sonorous tale as a mean of reinforcement.
2. The indicators of progress must be similar to the ones the teachers use.
3. The positive reinforcements must be the same as the ones which the teachers use, and they must be personalizable.
4. The speed of the tutorial must be personalizable.

The complete list of problems may be visualized on [18].

3) **Interviews**

On a first interaction we made an interview with three teachers who work with autistic children and a mother of an autistic child. They were asked three open questions related to the apprenticeship of children with ASD and five questions related to their appreciation though suggested software. With regarding to the answers the teachers gave, it is possible highlight the next answers:

- **How is the integration between autistic children?**

  This can change depending on the level of autism that the ASD children present. Some children showing ASD have limited interaction with their pairs, even though others can interact with other children with ASD while being guided; after the few times and then it becomes natural. To achieve this, we work with game stages, empathy, and social relations among others.

- **Which is (are) the method(s) that they use to make a boy or girl with autism improve their integration with other people?**

  We stimulate the social abilities, empathy, and communicative intention among others. Some of the most used according to scientific evidence, are the ABA method (Applied Behavior Analysis) to work with disruptive and appropriate behavior and PECS (Picture Exchange Communication System, CCA) to communicate with others. It stimulates the game and the pragmatic abilities.

- **How autistic children learn the meaning of facial expressions?**

  Each facial expression is explained by the use of pictograms, drawings and pictures among others; in that way they associate the expressions, situations, and interpretation of the emotions.

  Related with the prototype:

  - **Do you consider the prototype effective?**

    Yes, it seems to us that it has been understood during the meetings and the drawings result to be attractive, however, it could include sounds to make it more attractive, plus it should add more speed to the movements.

  - **Do you think that in this way they will learn the facial expressions well and recognize them on other people, improving the integration?**

    No, they will not learn them “well”, because for this we need a lot of time and different situations, but it will contribute to achieve it. It will help them to develop empathy.

  - **Are the elements showing if the response are right or wrong appropriate? If not what changes would you make?**

    There is a lack of sound, but the stars as reinforcement seem to be fine. The reinforcements must change with applause, smiles, happy faces, fireworks, celebrations, etc.

  - **Is it a good approach for the children to choose between only three options instead of more than that?**

    Yes, on the first levels, then they should be more complex.

  - **Which do you think is a good amount by level?**

    It is never enough, the more the better, it will allow to take advantage to each activity, it is more important to follow the sequence of complexity going from simple to more complex and each activity should include reinforcements for success.

IV. **PROPOSED SOLUTION**

After the first UCD iteration cycle, the software was created. An example of the system interfaces is shown on Figure 3. The proposed software can be downloaded at [19].
V. CONCLUSIONS AND FUTURE WORKS

It was possible to validate the cycle of UCD, actively running each phase, with the participation of users, parents and teachers, which was extremely important for the development of this software. In the evaluation phase it was determined that several points could be improved, such as more positive responses, images and buttons more intuitive, output options for the user, insert child's name in the game, causing her to have more confidence, since the treatment is based on approach to Creative Research.

The objective of this work was to improve social skills through multi-touch applications, the collaboration of people involved in the education of these children was indispensable. Future work would incorporate analyses and application of this technical software on the Son-Rise program, a dynamic approach to the treatment of autism. It is a style of interaction, a way to bond with a child that inspires spontaneous participation in social relationships. Parents learn to interact in an enjoyable, fun and enthusiastic way about and with the child, then encouraging high levels of social, emotional and cognitive.

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REFERENCES

[14] Centro de Recursos Educativos GERMINA-, Bitácora del Centro de Recursos Educativos GERMINA- Quilpué - Chile.
[19] R. Muñoz, F. Mancilla, Proyect@Emociones, Software that Supports the Improvement of the Empathy in Children with ASD. Available at: https://play.google.com/store/apps/details?id=air.ProyectoEmociones&featu re=search_result#t=W251bGsMwSwyLDEsmPci5Qem95ZWN0b2Vib2 Npbi5lc3Yd.