Develop educational technology tailored for people with autism: a children's observation grid to build better tools

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Abstract

In the last 10 years there has been a growing experimentation and production of technologies useful to support the learning processes of students with special educational needs (autism, learning disabilities, attention and hyperactivity disorders, severe disabilities). All the technology production of these years has given life to an important number of innovative solutions. These innovation processes made it necessary for software engineers to begin to understand more about the psychological functioning of people with special educational needs. Many observation scales of the psychological functions and behavior of the person with autism have been designed and developed for use in the clinical setting and collect and contain very detailed information that is not necessary for those who have to develop technological systems to support learning processes. For these reasons it is necessary to develop new observation tools that give useful information to software engineers, especially as regards the aspects of sensory-motor coordination, relational aspects, cognitive functions and communication functions.

Keywords 1

Assessment, technology, autism

1. Introduction

Over the past decade there has been a growing interest in technologies that supported the learning processes of people with special educational needs. Professionals dealing with learning processes, psychologists and educators, have tried to develop prototypes and technologies that could meet the needs of people with autism, with specific learning disabilities, with attention deficit and hyperactivity and with severe disabilities [1][2]. The rising interest in these new lines of research did also arise interdisciplinary research groups made up of software engineers, ergonomists, psychologists and cognitive scientists. The establishment of such heterogeneous research groups made up of professionals with very different cultural backgrounds has been a source of wealth for the birth of new knowledge but, very often, the technological products proved to be not very tailored and, at the same time, the great variety of tools that researchers have made available to professionals, made difficult to choose the most suitable tool. In recent years we have witnessed the development of technologies to support learning processes made with particular attention to technology and only later with attention to the human component or, in any case, to the end user. This phenomenon has determined that, especially in the case of complex clinical conditions such as autism, the use of technology was not widely contemplated by professionals. This problem is determined by the fact that is difficult to make a software engineer understand the way in which a person with autism perceives the world, what are

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the motor skills, what is the reaction to environmental stimuli, how a child with autism spectrum disorder manages the perception of sounds or moving images.

In addition, we must consider that autism, or better known as "autism spectrum disorders", is an extremely complex neurodevelopmental disorder that mainly involves language and communication, social interaction, restricted, stereotyped interests, repetitive behaviors and often correct psycho-motricity. The different levels of impairment of these areas make up the general picture of the person with autism and developing technological devices for a person with autism is extremely complex.

Children with Autism Spectrum Disorders (ASD) show difficulties in social interactions and mutual communication, as well as repetitive and restricted behavioral patterns [3].

ASD are heterogeneous disorders and, as the term "spectrum" suggests, have different levels of severity, which may be mild, medium or severe. The prevalence of the disorder is 1 out of 68 children [4].

Considering all the reasons set out in the previous paragraphs, we decided that it was necessary to develop an observation grid of the person with autism that took into account all the essential information that a technologist must know before developing a technology suitable for a person with autism spectrum disorder. This type of approach could overturn the perspective with which the learning support applications of recent years have been developed, namely no longer starting the development of a prototype moving from technology, but moving from how the autism child perceives and acts in the world. It is important to note that the tools developed in recent years must always be adapted to the individual needs of any student. A tool that can adequately support a student at different grades may not be adequate to support another student with the same disability. Generally, in fact, it is advisable never to group and categorize the technological tools around a specific area of disability, in the case of autism, however, since it is a complex neurodevelopmental disorder and with various degrees of severity, we can hazard some form of categorization of application and tools to support learning processes, starting from psychological functioning of a person with autism. In any way, first al any other consideration, there have been several studies that have tried to establish important points in the development of technologies for autism [5] among these points it is important that a technology for autism must be consistent with the needs and requirements of the child, be used by the subject without difficulty, be shareable with care givers, be usable in the school environment, be of real support for the educational tasks to be performed.

2. What should we observe in the person with autism?

The basic purpose of an observation card is to get to know some basic functions of a person with autism. By the term function we mean those activities of the organism that contribute to the prevention of the individual's life itself. Functions are groups of activities that in a development path should gradually detach themselves from the instinctive and instinctive part of an individual and function autonomously [6]. In the context of the development of technological supports to support the learning processes, it is essential to know how these basic activities work and, at the same time, it helps the software engineer to know the necessary areas, and consequently their correct design, to make sure that the person with autism can make better use of a technological support.

To develop an observation grid of a person with autism useful for technologists who develop a learning support tool, we decided to consider some specific areas of psychological functioning of the child with autism: sensory and fine motor area, communication and language area, social competences, organizational competences, general learning area, cognitive and neuropsychological areas [7]. We believe that a clear observation of the person with autism in each of these areas will allow software engineers to develop more tailored and more usable technologies, as well as better able to support the potential of the person with autism. Below we describe these areas and related possible technology solution.

- Sensory and fine motor area: refers to applications that solicit sensory stimulations that require manual skills and oculo-segmentary coordination. This area is generally important for the apps on visual, auditory and audio-visual stimulation, on hand-eye coordination, on manual skills (used for example in activities of drawing, painting or typing), on bimanual skills and on the oculo-motor skills of visual tracking.

- Communication and language area: we take in to account this area because it refers to the applications that stimulate language skills or offer visual support for communication. We therefore indicate apps that stimulate the verbal skills of word-image association, word-color, word-geometric shape, word-action, word-number and word-emotion, of sound-letter association, of grapheme-phoneme association, of reception, of articulation, syllabic fusion, construction of written sentences, narration, vocal emission, communication of sentences by symbols.

- Social competences: it is important observe social competences, because there are a wide range of applications focused on social skills and relational issues. This area is useful for the development of apps/tools that deal with the social problem solving, emotions, role play, and the theme of friendship, of cooperation, care and caring, family, sense of identity, the competitiveness and respect for shifts.

- Organizational competences: we consider this area refers to the applications that offer a visual support for daily organization and adaptive skills, or all apps/tools that support life skills (concerning clothing, personal hygiene or routine), planning (visual agendas), time management and use some money.

- Learning area: refers to the applications that stimulate the pre-requisites for school and consolidate formal knowledge through content of educational and teaching relevance, and that offer tools to support and / or facilitate learning. We therefore consider apps that work on pre-graphism, on the knowledge of the alphabet and numbers, on reading and writing, on teaching subjects such as mathematics, geometry, geography, music; there are also products that contain tools for learning facilitation: speech synthesis, predictive text, voice dictation, maps, abacus, conceptual, calculator, mathematical solver, multiplication table, rules, clipboard organizer and grammar parsing solver.

- Cognitive and neuropsychological areas: observing this area in a person with autism is useful for developing applications that stimulate thinking skills. Therefore, tools that require visual skills, such as perception (in tasks of searching for figures and identifying differences), spatial organization, orientation, constructive practices (puzzle, constructions, copy of drawing and matrices); the logical skills of association, classification, sequence, seriation, relationship; finally, executive functions, such as attention (of type selective, sustained, diffused and shared), memory (visual, verbal, working, perspective, sequential and procedural), planning, flexibility and fluency.

All the areas that have been listed in the previous paragraphs could be considered of importance for a software engineer or a technologist who has to develop a new technological system to support a learning process. If I have to carry out any type of psychological support it is necessary that it has some basic information on the way in which the end user, the child with autism, perceives the stimuli, on how he orientates himself in space, on what are the abilities of nature logic, or associative and on how the. ability to plan actions. In the specific case of the person with autism it is of fundamental importance to understand not only the components of a motor nature, but also the components of an attentive nature, it is often necessary to verify, whether there are stereotypes of a motor nature, which could prevent interaction with a software, both to understand if the subject has a particular adversity towards certain types of sensory stimuli and in this specific case we refer to sounds, colors and

moving images. We could say even more if we refer to complex hardware devices such as helmets for virtual reality, we need to know if a person with autism is able to wear a helmet for virtual reality without particular aversions or without particular difficulties.

2.1. A children's observation grid to build better tools

Below, we intend to join the observation grid that we have structured. We believe that this grid should be filled out, first of all, by a clinical professional or by a teacher and subsequently delivered to a technologist; a software engineer who has to deal with the development of technological supports for learning processes.

The grid collects information on the motor area and in particular on the ability of the person with autism to drag objects on the screen, to use touchscreen systems, or to draw on the same screen. At the same time, it also analyzes the person's ability to interact with peripheral systems, not touch, and therefore to be able to use the mouse and keyboard correctly. This area also takes into account the presence of motor stereotypies that could prevent the use of these latter systems.

Subsequently, the observation grid also evaluates the perceptual sensory area, so as to provide information on the perception of particular discomfort should the person hear sounds or see particular moving images. This area also gives information on the person's preferences and, in particular, if they are attracted to drawings or images of particular shapes or colors. Within the perceptual sensory area, the child with autism's preference for particular rhythmic structures that could accompany any software application scenarios is taken into account. Although in a reduced way there is an area dedicated to expressive and communicative functions since, in the development of an application, it is essential to understand the way in which the person with autism communicates his wishes to the surrounding world. For this reason, it is important to understand if it uses the spoken communication channel or if it uses pictograms or signs. Particular attention within our observational scale was given to the social area, since it also imagines the need for training in the use of hardware software or technological applications for the end user. It is of great importance to understand if there is a way of interacting with the other and at the same time to understand if the person with autism is able to express their emotional constructs by correlating them with the use of particular systems. Finally, there is the cognitive area with a particular interest in the attentional component. This component is of fundamental importance since it will determine the mode of interaction between the technological application and the child. It will be necessary to understand how and if the child manages to maintain sustained attention on a stimulus and consequently, on how the interfaces must be designed and how long they must remain on the screen.

	In now way	Little	Enough	Much
MOTOR AREA				
He has mastered the touch screen				
He is able to drag objects on the screen				
It can hold a tablet with one hand				
He can draw on a touch screen				
He can type on the computer keyboard				
He is able to use the mouse				
Can use the mouse and look at the monitor				
He can draw with the mouse				
It can follow a moving object on the screen				
Presents motor stereotypies				
Simple action imitation				
Imitation of gestures				

SENSORY AND PERCEPTIVE AREA				
It perceives sounds without particular annoyances				
It perceives moving images without particular hassles				
He perceives single instrumental music without particular hassles				
He perceives multi-instrumental music without particular hassles				
Dislike images with too many colors				
Feel aversion to single-color images				
Attraction for strong and / or intermittent lights				
Avoiding strong and / or flashing lights				
Visual attraction for textures, designs and colors				
Search for sources of sound reproduction				
Attraction for particular sounds				
Attraction for particular rhythmic structures				

COMMUNICATION AREA				
It features a form of voice communication				
It presents a form of communication based on pictograms				
It presents a form of communication based on signs				
Indicate what you want				
Use vocalizations to communicate				
Orient your gaze when communicating				

SOCIAL AREA				
Show interest in being with or observing others				
Show age-appropriate social interaction skills, including during play or leisure				
It orients towards an individual who can serve as a security base. What happens when this person is absent?				
He is able to establish and maintain shared attention with others				
Use the appropriate pitch and volume of your voice				
Use appropriate eye contact				
Able to model and imitate the play / leisure skills of others				
Is able to express emotions legibly and appropriately				
He understands the rules of social behavior in different contexts and responds accordingly				
He is able to recognize and understand the emotions that are communicated by others				
Spontaneous production of known actions				

COGNITIVE AREA				
Ability to direct the gaze				
Ability to keep attention on an object				
Ability to keep attention on an action				
Ability to complete what begins				
Too rapid changes from one activity to another				
Excessive attention to details				
Capacity to direct the gaze to a target				
Ability to keep attention on an object				

3. Conclusions

The observations sheet presented is intended to be a first prototype of a useful tool for software engineers in order to understand the characteristics of the psychological functions of a child with autism. Of course, the same card also provides useful information for educators and teachers, but it is more appropriate for the latter to use observational cards dedicated to professionals in the clinical area. The form we wanted to create aims to collect the information strictly necessary for the implementation of an application and therefore only takes into account a reduced set of psychological functions of the person with special educational needs. In the near future we will also undertake to create an extended version that can take into account the possibility of wearing technological tools as you can imagine for the devices you wore or for virtual reality helmets or other tools that can be integrated into augmented reality systems. The observations form in question will be free to use and translated both in English and in Italian and Spanish.

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