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Overcoming barriers to an accessible e-learning ecosystem for people on the autism spectrum: A preliminary design

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Along the COVID-19 pandemic, people with autism spectrum disorders faced additional disadvantages and challenges for continuing with their learning and support therapies remotely. We have carried out research in several phases since the first wave of the pandemic, to obtain the global picture of the benefits and issues that come with online education and assistance for individuals on the spectrum.

Based on our findings, we present in this poster a preliminary inclusive design that address accessibility barriers for people with autism when facing remote learning, so they can have a continuous and independent development of their learning process.

1 INTRODUCTION

Autism spectrum disorders (ASD) are a group of developmental disorders that affect communication and behaviour. The term "spectrum" is used to describe the wide variation in the type and severity of symptoms experienced by people with these disorders. Individuals with ASD have difficulty communicating and interacting with other people, as well as limited interests and repetitive behaviours. People on the spectrum face challenges in their inclusion in ordinary environments, such as mainstream educational contexts. Learning and developmental processes of people with ASD present issues and open challenges to be addressed [7], for instance, the use of methodologies adapted to their cognitive skills and learning style, and tailoring of their learning process to fit their needs [5], motivation and interests, empowering their strengths. Furthermore, they usually require special education programs and behaviour therapies to help them acquire self–determination, social and labour skills. Traditionally, this support has been provided by experts in special education through in–person sessions, but this assistance is not always accessible for everyone due to limited human and economic resources.

In addition, new scenarios have complicated the tasks of special education and assistance, such as the COVID–19 pandemic lockdown. During this period, ASD professionals had to rely on technology to try to continue with their individualized attention remotely. However, people with autism struggled with this new approach due to the abruptness of the switch to homeschooling, the disruption to their routines, and the general uncertainty of the pandemic, meaning

they were unable to benefit enough from online learning and therapies [1]. This shift to remote both education and support also posed accessibility challenges because of technology limitations and digital divide [6], leading to an education disruption in some cases.

In this paper, we contribute to the research by proposing a first inclusive design of an e–learning ecosystem for the continuous and independent development of people with intellectual functional diversity, with a special focus on people with autism disorder, so that learning is accessible even in scenarios where in–person interventions are not possible.

2 BACKGROUND

We have researched on different approaches and mechanisms to help individuals with disabilities to become more independent by means of technology. The use of Information and Communication Technologies (ICT) has demonstrated to be a suitable tool for people with ASD, as it helps improving their levels of focused attention and fine motor skills, while decreasing their agitation and self–stimulatory behaviours [4].

Therefore, we aimed to design a new educational ecosystem solution for people with ASD that addresses accessibility barriers when facing remote learning, and that allows people on the spectrum to improve their learning process, self-awareness and independence. We have used a multidisciplinary collaboration between engineers, psychologies, educators and experts in the field of intellectual disabilities and ASD as a key factor for the success of the project.

Our research has been carried out in several phases:

(1) Data collection. We used as a base methodology for our study a survey aimed at ASD specialists, as well as caregivers and relatives of people with autism. We collected first–hand information about how the first wave of the COVID–19 pandemic (and the subsequent lockdown) impacted daily live and education of our target population, and its relationship with ICT. The 295 respondents provided evidence about the learning experience and the applications used both before and along the health crisis. After applying a quantitative and a thematic analysis of the data, our main results were:
   (a) The themes related to education, assistance and daily life, in which COVID–19 had the greatest impact for people with autism and their use of ICT.
   (b) A mapping of technological categories specially oriented to meet the needs of people with autism in scenarios where face–to–face interaction is not possible: attention, calculus, e-learning, emotions, entertainment, experience of self, authoring tools, language and communication, memory, planning and time management, social networking, and social skills.
(2) Exploring remote special education and its challenges, plus a mapping study of the technologies involved [2].
(3) In–depth analysis of the applications mentioned in the survey (top 100 of 212) to identify challenges and opportunities for e–learning for people with ASD.

3 INCLUSIVE DESIGN

3.1 E-learning ecosystem

Our previous research steps have identified both pillars, benefits, as well as drawbacks and challenges in remote learning and support for people with autism. Based on these results and in the literature review, we propose building an accessible and structured remote learning environment for people on the spectrum that covers the challenges found, so that special education and support are not interrupted in possible future scenarios that prevent attendance. This

system also acts as an integrative solution for the different assistance applications that were used during the pandemic to simulate the desired learning environment.

This assistive platform will be developed using agile methodologies to create project increments that will be periodically validated by the professionals participating in our multidisciplinary collaboration. Our e-learning ecosystem will be built as a Progressive Web App (PWA), which means it will be coded once using a web programming language and it will offer both a web and native app experience, adapted to each operating system. There will be 3 possible types of users on the platform: ASD specialists, relatives, and students. For professionals and parents profile a desktop view will be more desirable, meanwhile a mobile view for the student profile, particularly adapted to tablets, will be preferred.

The inclusive design of the complete ecosystem includes the following components, resulting from our analysis and aimed at meeting the specific needs of people with ASD detected, which will be developed following a modular approach:

- **Authoring tool**. A simplified widget will allow to create or import meaningful activities for cognitive training, without having to resort to several different tools. The authoring tool guarantees creating diversified activities adapted to the special needs of each student.
- **Activities dashboard**. The activities created will be displayed in a repository available to professionals and parents. This will increase the visibility of the work carried out among the specialists and provide family members with tools to reuse to support learning.
- **Communication and messaging**. There will be a messaging system (internal or integrated) to enhance communication between all parties. In addition, it will be possible to configure the reception of notifications and alerts of certain events (e.g. interrupted activity). We seek to maintain transparency, communication and cooperation between professionals, parents and students. Family involvement in the learning process has been proven to be a key factor to continue with homeschooling throughout the pandemic.
- **Concentration and time management**. A visual timer could be configured to stimulate concentration during activities and encourage time management. This timer could have a fixed or adapted to the user pace time.
- **Attention**. A mechanism will detect periods of inactivity during the performance of activities and will generate an audiovisual stimulus. This will support people with autism regain attentiveness after spending some time using screen devices.
- **Tracking and reports**. Automating activities' monitoring is critical to assess progress, especially when performing remote learning, as it minimizes having to rely on feedback from home. The monitored values (activities carried out, result, time spent, number of distractions, etc.) will be available to everyone and can be exported into reports.
- **Reinforcements and motivation**. The platform will have an avatar that will accompany the student throughout the complete learning process. In addition, there will be a configurable reinforcement and reward system so that the stimulus given to each student can be personalized, increasing their motivation.
- **Assessment**. A self-assessment module will be included to provide self-perception of the learning progress, so that people with ASD are aware of their own evolution.
- **Planning and accessible support activities**. The platform must consider the accessibility needs of people with ASD at a cognitive level, that is, those related to understanding the environment, the activities and what is expected of them. This subsystem will be discussed in depth in the next section.
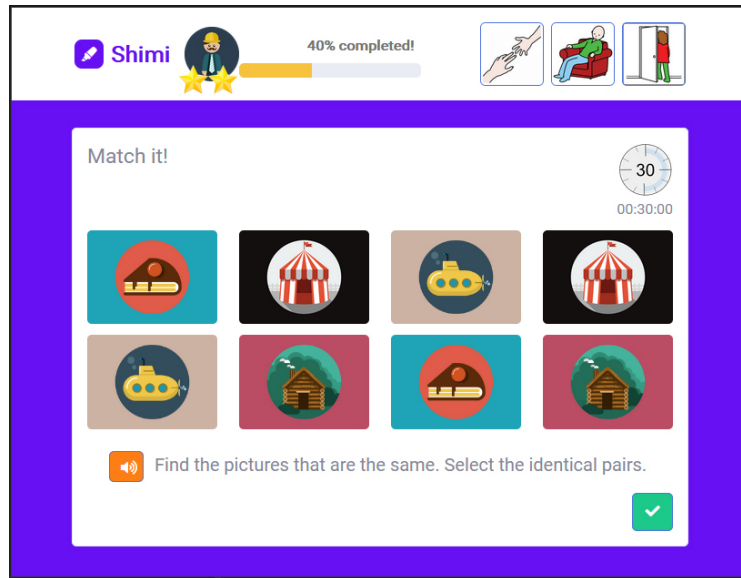
Fig. 1. Preliminary design for accessible support activities

Our e-learning ecosystem also aims to achieve a digital transformation, by including ICT in the education and daily lives of people with ASD in a more active way, regardless of whether the platform is used to support face-to-face or fully online learning.

3.2 Planning and accessible support activities

One of the most important sections of the e–learning ecosystem is the one dedicated to the student profile. Our design will have a strong visual support, as people with ASD usually process information easier when it is provided visually [3]. In particular, the use of pictograms for Alternative and Augmentative Communication (AAC) is one of the most widespread practices. For this reason, it was decided to use the Aragonese Portal of Augmentative and Alternative Communication (ARASAAC) [8], which provides a wide database of pictograms and animations, commonly used in traditional environments and technological supports.

Figure 1 shows the initial design of the activities' development screen. On the right side of the top bar, we used pictograms to clearly indicate the user the actions that can be carried out. There is a 'help' pictogram for the student to communicate with the specialist, a 'break' pictogram to take a short rest (limited to a certain number of times), and an 'exit' pictogram to leave the activity. This interface reflects the attention to diversity applied through the configuration options, adapted to each student, chosen when assigning them an activity: Typographic customization, game mode (with or without timer) and inclusion of text with pictograms and/or sound. In addition, attention options (configuration of stimuli to be displayed) and reinforcements customization are included.

Once a person with ASD completes an activity or enters the platform for the first time, the main planning screen (Figure 2) will appear. Our initial design includes a daily agenda with the scheduled activities, distributed by times of the day. This planner visually displays the activities that are pending or completed and provides a link to them. Thus, the ecosystem helps individuals with autism to manage their daily workload, improving their planning and time
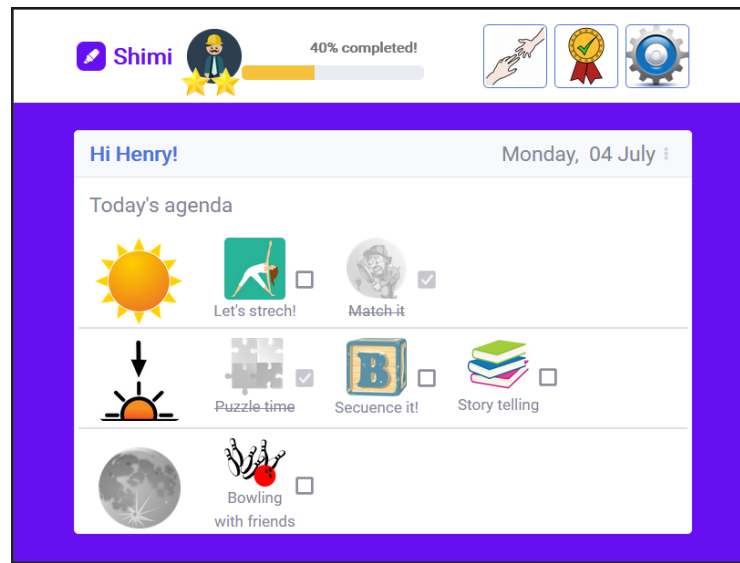
Fig. 2. Preliminary design for activities planning

management, while reducing the feeling of uncertainty and providing independence. To support this management, there is also a daily progress indicator on the top bar. Finally, this bar contains the pictograms for communicating with the professionals, to navigate to the rewards and self-assessment screen, and to enter the system settings.

4   CONCLUSIONS AND FUTURE WORK

In this paper, we have presented a preliminary inclusive design towards a complete e-learning ecosystem, focus on enhancing accessibility of remote learning and support for people with autism. This assistive platform looks promising for encouraging self-management in the different processes associated with learning, such as self-assessment of the progress, planning of work sessions and the selection of activities to be carried out. In addition, the system will allow the development of autonomy and digital skills of both people with ASD and their relatives.

The evaluation of the platform will be, as the development, iterative. We will test every project increment with all the parties involved (people with autism, professionals, and relatives) to extract quantitative results, and we will conduct surveys and satisfaction questionnaires to obtain qualitative measures. This continuous validation will allow us to improve and focus the proposed solution to the specific needs of people on the spectrum.

Our future work will be to maintain this approach to develop and test the remaining modules of the complete ecosystem, while respecting any ethical policies and the privacy of the participants.

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