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# Designing an e-learning ecosystem to support people with autism spectrum disorders. A digital transformation in special education

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## ABSTRACT

COVID-19 pandemic has greatly exposed the inequalities in the access and use of Information and Communication Technologies and exposed also existing challenges in assistive technologies. Schools closure and the switch to online education revealed limitations in the education system, particularly, in the case of special education needs. This PhD research intends to analyse the challenges of remote learning and to provide applicable solutions to build an e-learning platform for people with autism that can enhance and enable special education in a collaborative setting for professionals, relatives, and students, considering also the cases when face-to-face interactions are not possible.

In addition to this analysis, some more contributions are provided such as the themes where COVID-19 impacted autistic people the most and their relationship with technology, a mapping of technological categories that define the working areas specifically aimed to cover their needs, the challenges faced in special education along the pandemic and their possible solutions.

## CCS CONCEPTS

• **Human-centered computing** → **User interface programming**;  
• **Applied computing** → **Interactive learning environments**;  
**E-learning**.

## KEYWORDS

Autism; Assistive technologies; Digital transformation; Special education

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## 1 INTRODUCTION

Since COVID-19 reached the pandemic category in March 2020 [18], many countries declared the State of Alarm, subjecting the population to lockdown, social isolation, and quarantine measures

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to prevent the spread of the virus. Only one month later, schools closure worldwide in 189 countries [17], limiting the access to important resources to vulnerable populations such as people with disabilities, which represent an estimated 15% of world population [13]. People with specific social and learning disabilities were specially affected by outbreak's restrictions in comparison with others [6], due that remote education and assistance system requires not only a proper access to IT resources but also access to specific tools and special education methods that fit their needs [10]. Thus, individuals with disabilities could not benefit enough from remote learning and assistance [3] as many of them are not familiar with online technology [12], they require a more scheduled environment, face-to-face interaction with their classmates, teachers and caregivers [16], and most online learning and assistance platforms are limited.

For people with Autism Spectrum Disorder (ASD), the shift to remote education and support, added to a disruption of their routines and the uncertainty brought on by the pandemic, posed a particular challenge [14].

According to Diagnostic and statistical manual of mental disorders: DSM-5 [1], people with autism are characterized by having deficits communication and social interaction, along with repetitive patterns of behaviour and restricted activities and interests. In addition, a third of people with ASD have associated intellectual disabilities [8] and require multimodal treatments with specialized professionals to acquire autonomy and have an independent and empowered life [2]. This individualized attention from specialists was also affected by shifting to remote both education and assistance, as caregivers had to deal with technology limitations and because some individuals with ASD struggled to understand the pandemic situation [5].

Going through this exceptional and tough scenario along the first wave of COVID-19, I decided to run out a study to analyse how daily life and special education oriented to children on the spectrum was orchestrated, both school learning and support therapies, when in-person interventions were not possible. My research aim to answering the following research questions:

- What components are essential for keeping and supporting online learning, remote assistance, and daily life activities for children with autism during COVID-19 pandemic?
- What challenges did people with autism spectrum disorders face during the shift to online education due to the COVID-19 pandemic?
- How technology could be designed to build an enhanced special education platform, such that people with special

needs can continue with their learning even in scenarios when in-person interactions are not possible?

## 2 BACKGROUND AND RELATED WORK

The term “Autistic Spectrum Disorder” derives from the identification of the formerly called “autism” as a wide group of heterogeneous neurodevelopmental disorders [11]. These issues influence a specific aspect of their development that has attracted attention in the recent years, due to the popularity and relevance of the self-determination theory [15]: their personal independence.

In the literature, we can find relevant works carried out to explore the suitability and validation of technological ecosystems to improve the learning process of people with ASD. If we look for evidence-based educational interventions the most common practices are [7]: visual supports, video modelling, reinforcement, Discrete Trial Training (DTT) and self-management.

Despite of the individual efforts and practices, comprehensive programs are usually valued as one of the best intervention methods [9]. Therefore, a combination of some of the interventions to cover the whole learning process of the user seems to be the next step.

In this sense, my goal is to research on different approaches and explore mechanisms to help people with ASD (and other intellectual disabilities) to become more independent by means of technology. While some studies have analysed the general factors that affected e-inclusion and the impact of the pandemic on the physical and mental health of people on the spectrum, there is no much specific information focused on the performance of Information and Communication Technologies (ICT) in assisting individuals with autism during the health crisis.

## 3 RESEARCH PROGRESS TO DATE

### 3.1 Stage One: Data collection (Completed)

COVID-19 pandemic and its consequences worldwide were an unprecedented scenario. For this reason, I decided to collect first hand information by running a survey among relatives and caregivers of people with ASD, as well as ASD specialists. The survey asked common demographics questions and then, according to their profile (relatives or professionals), it asked different questions regarding the learning or teaching experience and the ICT applications used both before and along the health crisis.

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I applied a quantitative analysis, and a qualitative analysis over the open-ended questions the survey had. Particularly, I used a thematic analysis [4] to identify associations in the data and put forward propositions; I was looking for emerging knowledge from the data itself.

We got a total of 295 respondents, of which 75 (25%) were relatives and caregivers of people with autism, while the remaining 220 (75%) were professionals and ASD experts.

The results of the first stage of my thesis research were very revealing and could be divided in 2 main parts:

- (1) Our thematic analysis identified 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: remote communication, learning, emotional management, entertainment management, executive functions, activities of daily living, and physical activity and motor skills.

- (2) A total of 212 applications mentioned in the survey allowed me to create 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.

### 3.2 Stage Two: In-depth analysis of applications and challenges (Completed)

In the second phase of my research, I decided to deeply analyse the technologies involved in the special education orchestration along the pandemic, the impact they had and the challenges arising from the new learning way.

Throughout this period, all implied parties relied on technology to be able to continue, as much as possible, with online learning and assistance. In fact, ICT applications usage increased by as much as 78%. However, less than 20% of the many and different resources used to achieve the desired learning environment were assistive applications while the rest were adapted for its use in special education. There was not a clear metric of which applications to use.

According to the responses provided in my research, special education was orchestrated online and, particularly, the interchange of educational activities through different tools such as email, instant messaging or virtual classrooms was the most popular approach. Video calls, activities proposed by relatives and the use of specific apps were also popular among the answers. This learning methodology was conditioned on the availability and collaboration of family members, necessary both for the learning process and for its follow-up, since it relied on the feedback provided by relatives and caregivers.

Some other highlighted challenges of this learning methodology were: Digital divide, assistive technology limitations, ICT customization options, interaction limitations, attention and concentration issues, monitoring and tracking options, and home support.

## 4 FUTURE WORK AND CONTRIBUTIONS

### 4.1 Stage Three: Modular implementation (Ongoing)

The final goal of my PhD research was not only to analyse the described scenario along the pandemic but to provide applicable solutions to build a learning platform adapted to people with autism, that covers the challenges found. The idea is to design and build an e-learning ecosystem in a modular way, using agile methodologies to create increments of the product which will be periodically validated by ASD professionals. This ecosystem will also serve as an integrating platform for assistance applications, increasing the visibility of them. For doing so, I will first create an authoring tool module which will allow both the creation and integration of resources, without having to resort to several different tools. The

second module under consideration will be a visual timer module to stimulate concentration in the activities, that could be activated or deactivated by configuration and that will have a fixed or adapted to the user pace time. Other considerations of the system are so far: A monitoring module that allows detecting periods of inactivity and generates stimuli to recover attention (alerts, sounds, etc), a tracking and self-assessment module to provide self-perception of the learning progress, and collaboration options to keep both professional and relatives involved in the learning process.

## 4.2 Stage Four: User validation (Under planning)

As I will work using an iterative and incremental development methodology, I will have users' validation (final users and ASD specialists) at the end of every sprint. This would help me to improve and focus the proposed solution to the specific required needs.

## 4.3 Contributions

To summarize, my doctoral research has contributed so far to provide a list of applications, focused, or adapted to special needs, mapped according to the needs they cover, to offer a selection criterion for ICT that support skills development of individuals with ASD. Furthermore, the impact topics and the proposed technological categories help detecting where we should review and adapt ICT according to the deficiencies found in each part and ensure technology is accessible to people with special needs. In addition, the research has also identified the required components, challenges and the possible solutions of both remote learning and assistance.

Our final contribution would be to overcome the barriers towards an effective implementation of remote or hybrid learning and assistance. COVID-19 global emergency could be the catalyst to improve basic education and support through a strong inclusion of ICT, rather than letting current learning and assistance systems 'domesticate' new technologies. The bigger the challenge, the bigger the opportunity for a no-go-back digital transformation that allows to build a more autism-friendly ICT environment.

## 5 ACADEMIC STATUS

I am a second-year Ph.D. student in Computer Science at the Autonomous University of Madrid, supervised by Dr. Germán Montoro and Dr. Javier Escribano. Before this, I worked as an IT consultant in the industry for 8 years. By the time the Doctoral Consortium takes place, I will be developing the first modules of the proposed platform and it would be very helpful to receive feedback at that point so that I can achieve a solid design base.

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