

# Opportunities and challenges in the use of educational apps as a support tool in the development process of people with Autism Spectrum Disorder (ASD)

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**Abstract.** *The use of mobile applications and games as educational tools for people with Autism Spectrum Disorder (ASD) assists in the learning process and in the development of skills. This article presents two case studies involving institutions that offer support for people with ASD. Through literature reviews, interviews and observations, teachers' experiences regarding the use of mobile applications as support tools were verified. It was possible to observe that the educators interviewed are adapted to the use of technology in the classroom but recommend controlling time to avoid excessive use. The challenges and methods for implementing the activities, guidance and encouragement for the use of applications, the sharing strategy and distractions are also discussed.*

**Keywords:** *Accessibility, Digital Inclusion, Mobile Devices, Applications.*

## 1. Introduction

Applications and games on mobile devices and computers have been used as support in the development process of people with Autistic Spectrum Disorder - ASD and motivate their initiation into technology. It is possible to observe the engagement in the use of Information and Communication Technologies, even with limitations in some skills [Hasan and Islam 2020, Papoutsis 2018]. In this scenario, the creation of specific digital spaces for the public with ASD has been proliferating especially for therapeutic and educational uses [Dominguez 2021, Montes 2021, Ismail 2021, Kraveva and Kravev 2018, Vega 2022].

According to American Psychiatric Association (2013), Autism Spectrum Disorder (ASD) is a condition that affects the development of people with delays and problems in different skills. ASD is characterized by difficulties with social interaction and communication, such as difficulty with transition from one activity to another, a focus on details and unusual reactions to sensations [WHO 1992].

The difficulties observed in ASD can make interaction with technological devices challenging. Focused attention on details of a visual scene is emphasized, causing the person with ASD to neglect other surrounding stimuli [Alzahrani 2021, Robertson et al. 2013]. The characteristic of attention focused on details, also studied under the terms tunnel vision, over-selectivity or as atypical attention, can inhibit the ability to obtain a broader perspective of the context [Alzahrani 2021, Ploog 2010, Robertson 2013]. In the sensory aspect, hypersensitivity or hyposensitivity to specific colors, lights, textures, sounds and smells are observed [Alzahrani 2021].

From this perspective, the use of educational applications as auxiliary tools enables the improvement of communication skills, social skills, cognitive skills and recognition of emotions [Rodrigues 2020, Gobbo 2019, Ismail 2021, Kraveva and Kravev 2018, Leung 2021, Papoutsi 2018]. However, for the efficient use of educational applications, which cover several teaching areas and different methodologies, it is necessary to combine accessible interfaces, user-instigating activities and real-time feedback [Mercado 2021, Papoutsi 2018]. Despite the promising results, the technology is not yet consolidated, due to the limitations of the studies, sample variability and little attention to the specific challenges encountered by digital technology for people with autism [Goosen 2019, Groba 2021, Alzahrani 2021]. At the same time, there is a growth in publications that aim at the efficient use of technologies in teaching and learning for this audience [Goosen 2019].

In this scenario, this article reports the results of an extension project developed at the Federal University of Santa Catarina entitled Accessibility and Digital Inclusion extension project: the dynamics in the use of games and mobile applications by children with ASD [Cardoso 2023]. The experiences of undergraduate scholarship students at two institutions in the city of Blumenau, in the state of Santa Catarina, are presented.

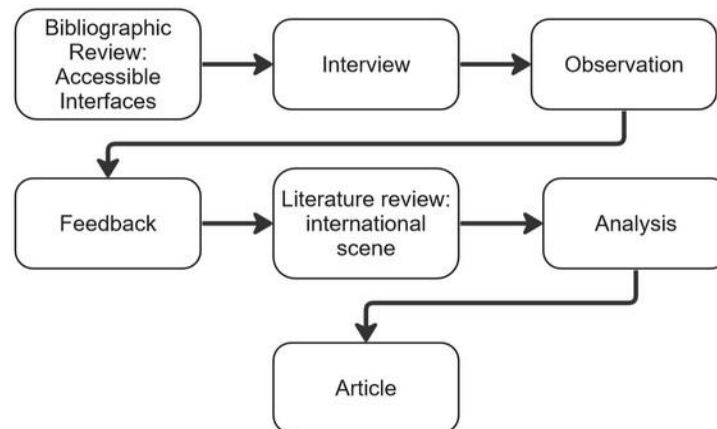
Institutions were visited after conducting a thorough literature review on mobile applications for individuals with ASD. Data collection included website analysis, interviews with institution staff, and observations during autism-specific classes. Interviews and classroom visits revealed key themes aligned with findings from the literature review. Aiming to share the material found during the Project with the public, a website hosted in the institutional environment was created [Cardoso 2022]. The site offers material for consultation, links to institutions dedicated to ASD in the state, as well as an overview of the activities carried out in the project.

## **2. Methodological procedures**

The development of the project was based on agile methodology strategies for project management and development. Through well-defined objectives and goals, small deliveries were made in weekly team meeting. At each meeting, the deliverables were analyzed and the objectives revised, seeking to verify the necessary adjustments. The initial plan made it possible for team members to share responsibility for activities, with each member's deliverables being peer-reviewed and adapted if necessary.

To identify key institutions supporting individuals with ASD in the region, a Google search was conducted. Four institutions were contacted via email, with only one aligning with the project schedule. Additionally, a school already affiliated with the university was approached to expand project opportunities.

Aiming to verify the best practices for approaching the institution and the school, and to develop data collection instruments, data from a systematized bibliographic review carried out previously were used [Vega 2022]. It was decided to apply semi structured interviews and face-to-face observations, given the good reception found for the project. Although it was an extension project, in the methodological procedures there was a commitment to obey the ethical precepts in research involving human beings, as regulated by the National Health Council (2016). A summary of the Project stages is shown in Figure 1. Aiming at confidentiality, throughout this article the institution and school that collaborated with the project will be called Institution 1 and School 1.



**Figure 1. Flowchart of project stages**

At first, the value of 1.205.701 articles was obtained. After applying Filter 1: Reading the title and period of publication (2018-2022) of the first 15 articles of each search tool, and Filter 2: consistency with the project objectives, and elimination of duplicates, 31 publications were selected.

Data from interviews and observations were shared with participating institutions. Keywords were selected and grouped thematically following participant feedback. A second literature review explored international perspectives on mobile applications for autism, broadening the project's scope. Utilizing Scielo<sup>1</sup>, Web of Science<sup>2</sup> and Google Scholar<sup>3</sup>, a search was carried out for keywords such as User Experience, applications, technology, and mobile devices alongside Autism. The research spanned 4 months, from April to July 2022.

## 2.1. Interviews

Interviews can provide primary data, with direct information from the interviewee, and deal with their own reflection on the reality they experience. Semi-structured interviews combine closed and open questions and allow the interviewee to discuss the topic without being attached to the questions asked [Deslandes 2007].

The semi-structured interviews, carried out face-to-face at Institution 1 and School 1, made it possible to learn about the experience of teachers and guardians regarding the use of mobile application as support tools for the teaching and learning process. Still, it was possible to know the living environment of students with ASD.

The interviews followed a sequence of questions divided into 3 categories: data about the institution/school, data about the use of games and apps and validation of use. A cell phone and a printed sheet with the Interview Script were used, also used for notes on responses and observations. All questions were read by the interviewers and detailed when necessary. The collected data are summarized in Table 1 and will be detailed throughout the text.

<sup>1</sup> Link: <https://www.scielo.br/>

<sup>2</sup> Link: <https://www.webofscience.com/wos/woscc/basic-search>

<sup>3</sup> Link: <https://scholar.google.com.br/>

**Table 1. Data collected in interviews**

	<b>Institution 1</b>	<b>School 1</b>
Duration of visit	15 minutes	15 minutes
Local	Pedagogical Advisor's Room 1	Principal's office
Interview participants and pseudonyms	Pedagogical Advisor 1	Pedagogical Advisor 1
	IT teacher 1	Principal
	Scholar 1	Scholar 1
	Scholar 2	Scholar 3
Organization of appointments	The institution divides classes by age and level of commitment	The consultations are carried out with an appointment, being carried out with students who have any difficulties
Number of teachers per session	Classroom: 2 teachers Computer room: 1 teacher	Multifunctional room: 1 teacher
Type of care	Classes	Individual service
Used equipment	Tablet Galaxy Tab A7 Lite	Tablet M10A Multilaser

### 2.1.1. Institution 1

Institution 1 aims to provide social, educational and health assistance to people with intellectual and multiple disabilities. Students participate in specific computer classes and during the other classes, tablets are used. The use of tablets doesn't follow a defined frequency and depends on the teacher's planning. Each class is taught by two teachers and up to 4 students.

Students attending Institution 1 have impaired speech, and most are non-verbal. According to teacher's discretion, the use of applications on the tablet occurs at specific times, and the duration of the activity is 10 to 15 minutes. Applications are downloaded by the students themselves, according to their own interests, under the supervision of the teachers. The games used in the apps are puzzles, letters, numbers, shapes, matching and colors.

### 2.1.2. School 1

School 1 serves children and adolescents from elementary and high school, aged between 6 and 18 years. The use of tablets in everyday class is not common, however, the school has tablets that can be requested and used by teachers. According to the Principal, School 1 offers specialized care for students with intellectual impairments, including students with ASD. In addition, all students with ASD are accompanied by a support teacher in the classroom, who can carry out extracurricular activities when necessary.

In the after-school period, specialized teaching activities are carried out in the multifunctional room, where interactive tasks are carried out with a specialized teacher. The activities, aimed at each student with ASD, include motor coordination activities, memory games, cutting, collages, among others.

## 2.2. Observations made

In order to understand certain aspects of a reality, the observation technique offers the advantages of obtaining direct means for the study of a variety of phenomena and sets of typical behaviors. Additionally, it allows highlighting data that are not included in the

interview script [Lakatos 2003].

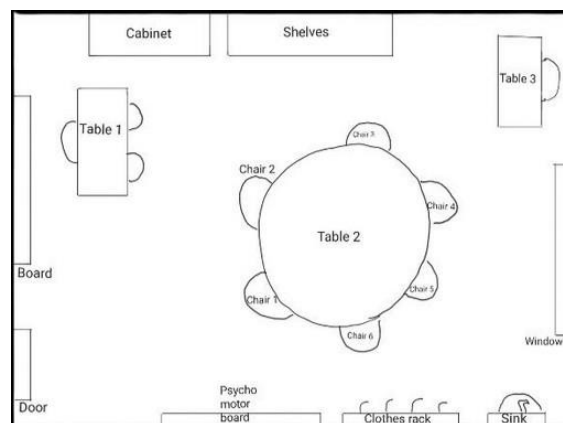
With the technique of non-structured and non-participant observations, it was intended to understand the dynamics in the use of mobile applications in the natural environment of Institution 1 and School 1. Prior to the observations, Scholar 1 and Scholar 2 presented the Letter of Presentation of the project, the request for participation for those responsible for Institution 1 and School 1, and collected the signature of the Free and Informed Consent Form (FICF). To write down the most important aspects during the observations, Scholars used notepads on paper and cell phones.

Consisting of a team effort, some relevant aspects were previously identified that deserved attention during the observations, such as the strategies adopted by the professionals to encourage the use of mobile applications, the ways in which students used the device, the behavior during activities, and the main interests and reactions expressed. In Institution 1, two observations were conducted. The first observation included four students and lasted for 24 minutes, while the second observation included two students and also lasted for 24 minutes. Both observations were attended by Teacher 1 and Teacher 2. The students' ages ranged from 10 to 18 years, all with severe autism, and only one student was verbal. At School 1, a single observation lasting 31 minutes was conducted, with Teacher 3 present. The student involved was 10 years old and verbal.

### 2.2.1. Institution 1

Two observations were made on the same day, at different times. Upon arriving at Institution 1, the Scholars waited for Teacher 1 to call for them. In the classroom, students were sitting around the table, waiting for the activity to begin.

Institution 1 has a multifunctional resource room, containing a round table, chairs around it, cupboards and pictures (Figure 2). Previously, the teachers were asked to conduct the class in the usual way, and the Scholars only observed the progress of the class, without direct interaction with the participants



**Figure 2. Sketch of the Institution 1's multifunctional room.**

The dynamics of the class starts with the students sitting around the table and then Teacher 1 gets the tablet and sits next to one of the students. The student receives the tablet and starts the application chosen by the teacher. After a certain time, Teacher 1 takes the tablet back and hands it to another students, who starts the chosen application. This dynamic is repeated until the class is finished. Teacher 2 is available for assistance.

While Teacher 1 interacts with a student, Teacher 2 attends to the needs of other colleagues or helps Teacher 1.

During the activities, the students used their index fingers and thumbs to perform screen touch commands. The commands were click and drag. There were moments of verbal communication by some non-verbal participants, singing a song or playing the sound of a cat that was present on the device screen.

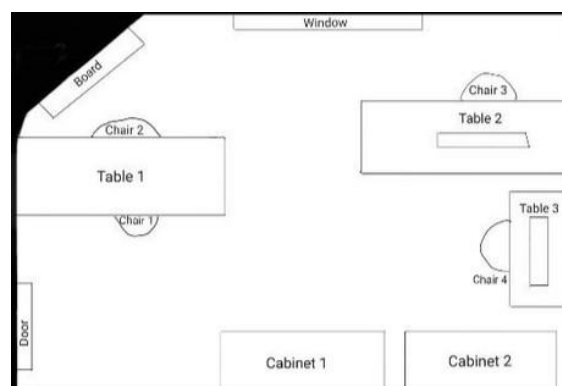
Students are free to install and uninstall apps of their choice at any time during class. During the observation, there was the installation of the Youtube<sup>4</sup> application by one of the students, for example. A total of 11 applications were installed at the end of the observation. Not all apps were used during class.

The applications used by children during classes are diverse and focus on different areas of educational development. A list of applications with their respective activities is presented below:

- GameKids 3: develops skills in numbers, letters and motor cognition;
- Wheels On Bus: focuses on Numbers and Motor Cognition;
- YouTube and Patati Patatá: entertainment;
- Paint Spark and Musical Instruments: focused on motor cognition;
- ABC and Counting, EduKidsJr and Read and Count: concentrates on numbers and letters;
- Bini ABC: emphasizes learning letters;

### 2.2.2. School 1

Upon arriving at School 1, Scholars were welcomed by the school Principal who take them to the room where the observation would take place. School 1 has a multifunctional resource room, containing two tables, one with a computer, chairs at each table for Teacher 3 and the students, lockers and blackboard (Figure 3). The teacher was previously asked to conduct the class as is normally done. Scholars didn't have direct interaction with the participants, remaining in the background during the proposed activities.



**Figure 3. Sketch of the School 1's multifunctional room.**

Before entering the room with the student Teacher 3 warned them that there would

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<sup>4</sup> <https://www.youtube.com>

be two people in the room, and that they would only observe all the activity. The student entered the room wearing dark glasses, and sat down on the Chair 1, in front of Table 1 (Figure 3). The dynamics of the class begins with Teacher 3 entering the application for the proposed activity, handing the tablet over to the student and explaining the purpose of the activity. The student receives the tablet, starts the proposed activity and after the task is completed, Teacher 3 takes the tablet back, starts another application and hands it back to the student. In this second application, three different tasks were performed. After using the tablet for half of the class time, Teacher 3 performed a puzzle and memory game activity, using physical materials, in which the student would have to read the name of a word and match it with the image of the word they read. At the end of the observation, the use of two different applications was counted, with four activities being carried out in total, as well as two activities carried out with physical material.

The applications used by children during classes offer different approaches and focus on various areas of educational development. The applications with their respective activities are presented below

- MITA and Smile and Learn: engages children in learning letters, numbers, and motor cognition.

These applications are chosen to provide a comprehensive and cohesive educational experience, targeting key developmental areas to enhance cognitive and motor skills.

The content observed at Institution 1 and School 1 was compiled and sent to those responsible for validation. After obtaining feedback, thematic clusters were selected that addressed the challenges and methods for applying activities, the strategies for conducting and stimulating the use of applications, the strategies aimed at sharing, and the problems with distractions present in the navigation of the applications. These clusters are presented in the following topics.

### **3. Challenges and methods for applying activities**

According to Gobbo (2019), the observation of educational activities in the daily lives of children with ASD suggest some challenges related to impairments generated by the disorder. The authors highlight, among other aspects, *i.* hyperactivity or passivity, when the child has difficulty remaining seated, even for a short period of time, or when he does not respond to verbal instructions; *ii.* the resistance to change the routine and accept a new activity; *iii.* and the habit of acting as if he were deaf when the activity does not generate interest.

For Institution 1, the main challenges experienced in implementing new activities are communication, behavior and adaptability, corroborated by Gobbo (2019). To get engagement in the introducing new activities, Institution 1 uses the following step model:

1. Show the room: the place where the activities will be carried out, its color, the items present, and any other detail must be presented;
2. Present the tools: the tools/materials that will be used in the activity must be presented, as well as their handling. During the presentation, the reactions of interest are observed;

3. Accompanying the student: during the implementation of the activities, a teacher, who the student is familiar with, must accompany and assist with any need that may arise. In the future, the student adapts to the new routine, not requiring follow-up.

During the observation at Institution 1, half of the students were interested in using the tablet. Even with the teacher's stimuli, some of these students did not interact or did not continue with the activities carried out in the applications

At School 1, one student was able to use the tablet without assistance. Teacher 3 stated that the student likes the apps. During the interaction, the student provided positive feedback in verbal and non-verbal form. He communicated lines like "I know!", "It's easy" and showed interest in carrying out the proposed activities again.

In this context, Mercado (2021) point out that games that offer clear objectives, combined with topics of interest, provide more chance of keeping participants motivated. The authors state that participants are more aware that performance will lead to achievements and reward, contributing to greater attention in the interaction.

#### **4. Guidance and encouragement to use apps**

When a new game is presented, initially students may not be interested, and there may even be some kind of aversion [Rodrigues 2020]. However, as an adaptation is suggested, the game begins to captivate the user's attention, and allows the beginning of an interaction. Corroborating the argument of Rodrigues (2020), at Institution 1, when a student doesn't follow the proposed activity, or is inactive to start the interaction, Teacher 1 guides the student's hand through the device's interface, demonstrating how to interact. After releasing the student's hand, Teacher 1 observes if the interaction is correct, or if it is necessary to repeat the previous action. According to Teacher 1, the accompaniment of an adult, with whom the student is familiar, contributes to making the activities more dynamic.

According to Pedagogical Advisor 1 (Institution 1), students show interest in using devices and applications, with a notable difference in behavior and mood before and during use. Before using the devices, the students can be scattered or agitated, but when interacting with an application they can demonstrate focus or remain calm. The interviewee agrees with the use of applications for teaching since, in addition to developing communication, applications can serve as means of communication. However, despite the benefits, some control is necessary, as "addiction to cell phones" is pointed out by Pedagogical Advisor 1 as a serious problem for all ages and people. To avoid this dependency, it is necessary to delimit time and place of use.

At School 1, Teacher 3 stayed behind the student while he performed the activity. When the student had doubts, remain thoughtful for a few seconds and without interacting with the application's interface, the teacher helped him, giving tips on how he could perform the activity. The use of incentive phrases, such as "It's easy" and "You can do it", increased the chances of engagement. In the work of Gobbo (2019), the association of sound and visual stimuli helped in the participant's communication process and vocabulary gain, a characteristic that can be replicated in other activities.

#### **5. The sharing strategy**



Institution 1 seeks to use mobile device apps to explore some aspects related to ASD. More specifically, Teacher 1 uses only one mobile device, sharing it with 6 students. With this strategy, sharing, time limits, communication and attention are encouraged.

During the activities, when the tablet is shared among the students, Teacher 1 makes one student pass the device to the other, and a time of use is established for each one. In this way, socialization among classmates and respect for time limits is encouraged. Developing the habit of respecting device usage times promotes the management of negative feeling, such as frustration at not being able to continue using the tablet. These limitations in socialization and daily interactions, require, according to Leung (2021), ability and persistence in problem solving. In these cases, flexibility and the ability to accept change are required.

Limitations in communication skills [Gobbo 2019] are superseded by Teacher 1 with instruction to complete the activities, verbally and non-verbally. Still, some words are repeated, to encourage students to repeat them too. The student must understand the teacher's instructions so that the class continues, and the activities are completed as expected.

On the other hand, people who exhibit autism spectrum features may be prone to atypical patterns of attention deficit [Alzahrani 2021]. In this regard, Teacher 1 uses the term hyperfocus, and emphasizes that this feature works in sharing the mobile device, limiting the time of use, encouraging communication and encouraging students to pay attention and concentrate on the activity. In this way, the student is led to follow the steps of the activity correctly and, at the same time, avoid repetitions of activity.

Considered as a strong feature of autism, superselectivity or enhanced perception of details can lead to difficulties in the interaction of some systems. By neglecting pieces of sensory information, people with autism may have difficulties with certain devices and with more complex interaction methods [Leung 2021].

Although overselectivity is not determinant in ASD, and not all people with ASD exhibit this characteristic, Ploog (2010) considers it to be a useful conceptualization. The author suggests, however, that the notion of superselectivity of stimuli be expanded to the notion of atypical attention, emphasizing that this characteristic may be present in ASD symptoms regardless of their causes.

## **6. The distractions**

Considering that one of the objectives of using educational apps is to contribute to the daily work of teachers, family members and professionals specializing in autism, it is emphasized that these apps must relate to activities that complement each other. In this regard, apps can include both reading text and offering narration with audio and sounds for user who do not have the ability to read [Montes 2021].

It's important, however, that the interface manages to avoid distractions and help the user to stay focused on the activity [Groba 2021]. In this way, the design of the interface, the elements or objects offered for interaction, as well as the degree of interactivity, must be specifically defined for people with special needs [Kraleva and Kraleva 2018].

Teacher 1 mentions the advertisements that appear while using the apps and treats them as an adversity. Ads overlap the interface, reproducing flashy elements or activities

unrelated to the game or application. Additionally, ads are diverse and don't follow a pattern, compromising the constancy of the elements reproduced on the screen and causing a break in routine. Some ads are uninterrupted, needing to wait until they are played in full to be able to return to the dynamics of the game. These events, considered as distractions or distracting stimuli, occur unexpectedly and compromise the rhythm of the class.

The consequence of the ads can be labeled as visual interruption. As highlighted by some authors, people with ASD show a clear perceptual enhancement of visual details [Dominguez 2021, Groba 2021, Robertson 2013]. This greater predisposition to visual stimuli can justify breaking a routine and compromising the progress of the activity and the pace of classes.

## **7. Final considerations**

This article presents experiences of teachers who use mobile applications as support tools in the development process of students with ASD. Visits were made to an institution that provides care to people with intellectual and multiple disabilities and to an elementary and high school. During the visits, the use of applications on tablet-type devices for educational activities was observed. During the period in which the visits took place, the main themes found were divided into thematic groups and analyzed considering the bibliography previously found in systematic bibliographic reviews.

The main challenges are highlighted, such as the protocols created by educators to overcome the impairments of students with ASD in communication, behavior, and adaptability to new tasks. The techniques used to achieve the engagement necessary for completing activities, to establish time limits on mobile devices, and to promote socialization among peers were discussed.

For the issue of hyperfocus, worked on in the classroom, understandings obtained from the reviewed literature on atypical attention deficit and enhanced perception of details were incorporated. Distractions present in educational applications, such as the unpredictable overlapping of ad windows, often compromise the pace of classes and disrupt the routine. In this regard, recommendations are presented for the development of applications specifically designed for people with special needs.

One of the results of the study was the creation of an institutional page to disseminate the content of the extension project, enabling the engagement of other institutions, potentially forming partnerships or sharing knowledge. Links to institutions that support individuals with ASD and reference materials are provided, assisting families and specialized professionals.

For future work, it is suggested that extension actions involving the university community with the theme of autism be expanded. Additionally, more in-depth studies on the use of educational applications for people with ASD can be developed in research projects. It is hoped that this article will contribute to educators, researchers, developers of educational applications, and policy makers relevant to the process of teaching and learning supported by technology for autism.

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