

Toy Solutions for Children with Autism Spectrum Disorder Using Gamification

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Abstract:

Toys may make learning enjoyable for kids and can be used to teach a lot of concepts that are hard to teach in other contexts. It is also possible for toys to improve young children with ASD's learning. As a result, they are more receptive to learning and psychologically more receptive. Toy solutions with interactivities and animations are visually appealing, inspiring, hold kids' interest, and extend the learning process. When it comes to commercial toys, the market typically offers generic toy solutions that address the unique, complicated educational needs of kids with ASD. Many of the commitments made in the process of building ASD therapies center around encouraging the creation of playfully designed toys that offer crucial flexibility. During interventions, this method provides educators and caretakers with easy access to various stages of the developing cognitive processes in the children, such as specific information on the methods the children employ. In order to directly assist interventions, the teacher can have direct support for behavior and learning content through the vast set of data that has been acquired. **Problem Statement:** Would the implementation of gamification might improve toy solutions that contribute to enhancing the learning habits of children with ASD? **Significance:** This will be accomplished by assessing a set of put into practice toy solutions that were created in accordance with the preliminary exploratory study of learning behaviors while engaging in commercial toys that are part of the educational learning objectives of the ASD preschool curriculum and the physical circle skill set. **Objective:** The purpose of this study is to determine whether gamification might improve toy solutions for understanding the learning habits of children with ASD. This will be accomplished by assessing a set of put into practice toy solutions that were created in accordance with the preliminary exploratory study of learning behaviors while engaging in commercial toys that are part of the educational learning objectives of the ASD preschool curriculum and the physical circle skill set. **Results:** By including the above factors in toy solutions, it has been possible to create certain products in the form of toys that are especially designed to meet the learning needs of kids with ASD and hence improve their learning. Those findings should help develop pedagogical strategies and optimize design principles and guidelines for additional toy solutions with gamification that serve the aforementioned educational learning goals of children with ASD in a more complex and comprehensive manner. This will result in a deeper and more substantial contribution to the research on ASD teaching tools.

Keywords:

Toys, Autism Spectrum Disorder ASD, Gamification, Education, Therapy

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1. Introduction

To date, autism is defined as a pervasive, lifelong developmental condition that is characterized mainly by challenges in social interaction and communication and the presence of a level of repetitive behavior at various severity levels. It is within this framework that games-oriented technologies such as gamification emerge as an opportunity to intervene with viable solutions, reducing human resources and speeding up the

child's cognitive skill acquisition. A playful learning model of this nature is intended to distract the child at a cognitive level and facilitate their learning. (Klin et al.2020)

1.1. Autism Spectrum Disorder (ASD)

Toys are a sustainable support tool for children with ASD that can help get a child back on the traditional track. Hence, parents and therapists use them as a medium to deliver effective intervention programs for children with ASD. There are many

guidelines and suggestions suggested in the intervention programs, but the current digital educational games still lack cultural, entertainment, and understanding of children's real-life, which may lead to a decrease in children's interest in learning and attract their attention to play. Just like traditional toys or even interactive toys, they are eye-catching to every child and play a vital role in entertaining and educating. (Elbeltagi et al.2023)

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in social communication and the presence of repetitive and restricted behaviors and interests. The core deficits of ASD refer to impairments in social communication and social interaction, in addition to repetitive interests and behaviors. Apart from that, individuals with ASD have difficulties in verbal and non-verbal communication, such as sustaining a conversation, developing peer relationships, reciprocal interaction, adjusting communication to the social context, or sharing emotions and experiences. Early recognition, assessment, and intervention are critical to promoting recovery and improving the daily lives of individuals developing autism. (Rosello et al.2022)

1.2. Importance of Early Intervention for Children with ASD

ASD is a neurodevelopmental condition that appears within the first three years of life and is generally associated with a combination of genetic and environmental factors. Recently, studies have shown that there is an increase in the number of children with ASD and in the severity of its symptoms. It is a pervasive developmental disability of central nervous system development that affects social interaction, communication, and emotional modulation. The prevalence of ASD has increased from one case per 1,000 children in 1996 to nearly one in 59 children in 2018, according to the Centers for Disease Control and Prevention (CDC, 2018). (Kilmer & Boykin, 2022) The etiology of the disorder is a hybrid of environmental and genetic interaction, something that epigenetics can explain. The genetic aspects are extremely complex, with hundreds of genes contributing to the disorder phenotype. Currently, ASD is primarily assessed by its main behavioral characteristics, using scales that are used by mental health professionals. There is no blood test, neuro-imaging, or other objective diagnostic procedure that aids in knowledge of the cause. Considering the complexity and multidimensionality of ASD, a comprehensive approach for diagnosis and treatment that involves a multidisciplinary team is preferable. The earlier such intervention is implemented, the better the individual outcomes

will be. There is an important window of therapeutic opportunity from the moment the disorder is detected to the age of six years. From this early age to the age of forty, a critical period occurs for brain plasticity in which the circuitry is still ready to learn. After this period, attempts to treat and socialize children, adolescents, and adults are constantly made, but therapy becomes more challenging. (Rosello et al. 2022)

1.3. Gamification as a Tool for Learning and Development

Interest in Gamification has been growing in different areas over the last five years. Many companies in different markets are already implementing these systems. The growing interest is due to the increase in quality, pleasure, and meaning. It helps achieve project objectives and stimulates development and problem-solving skills. It enables new and innovative ways to interact with different environments. There are several definitions and benefits of Gamification, and it is applied in various areas, including learning. Gamification is a term that is not yet well defined in the literature. Its definitions give various interpretations and meanings. It is often explained as a method of using game mechanics and dynamics to increase user communication or interest in a specific task or learning. It involves interaction and public participation through the design thinking process. In this study, we address it as a set of techniques used to increase engagement in an activity by changing behaviors and developing longer timetables to achieve higher performance in a particular activity. (Oliveira et al. 2021)

The use of games has always been recognized in early childhood education, which has made significant contributions to the development of logical-mathematical thinking, language, and social aspects. It works through the pedagogical principle of pleasure. More recently, in adult training, game-related methodologies have begun to explore a new horizon called Gamification. It applies interactive principles and compels the learner to develop different behaviors and interact with the learning environment dynamically. However, it is a design process that gradually enables the user to excel in behaviors that are consistent with the requirements set by the task. The player is involved, interested, and absent from dangerous things. In the game, they activate a state of flow. (Čujdiková and Vankúš2021)

2. Understanding Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is known as a complex neurodevelopmental disorder. It influences

functions in social interaction, communication, and repetitive behavior. These behavioral symptoms may present in a variety of combinations and different levels of severity. In addition, many people with ASD have different ways of learning, paying attention, or responding to the environment. Changes in the way children respond could be a cause for concern, but may also identify children with different characteristics. For example, they may not react to their names, avoid eye contact, demonstrate unusual attachments to objects, rarely express their feelings or emotions, have sustained unusual repetitive body movements, and other health issues. With these indicators detected for the child, it is important to introduce support at an early stage for the child to prevent or reduce the severity of the condition. (Ghanouni and Jarus2021)

2.1. Characteristics and Symptoms of ASD

We collected voice data for generations of soundscapes, animals, transportation, and everyday tools, and collected title data on the previously prepared speech-board to increase the efficiency of data collection, data for all twelve videos are collected simultaneously. Since it is labor-intensive to extract 512 frames from 60 videos, instead of collecting videos for all items at the same time but enlarging the size of the training data, after training to solve the problems of body movement and transgression, utterances from 60 videos are collected systematically and synthesized with faces, voices, and videos. All voice scenarios are recorded by twenty-five female and male speakers in their twenties, and training data are collected as many as 75 for each scenario. (Neuvonen et al.2021)

2.2. Utterance Collection and Preprocessing

This experiment is based on the characteristics of ASD. According to the DSM-V, there are three main features of ASD. First, children with ASD have a substantially different reward response than children without it, and the model learns that children with ASD have little interest in rewards, or that previous rewards have no impact on their new choices. Second, children with ASD have the lowest voice-eye response. It is the ability to determine changes, as humans usually look where the speaker is looking, not paying attention to the speaker when the speaker's voice and gaze are different, or if the speaker follows only the gaze, it is believed that the speaker with ASD is neuropathological due to gaze-related impairment. Finally, children with ASD cannot follow the current conversation topic as phonological and visual stimuli are understood in separate streams. (Neuvonen et al.2021)

2. Materials and Methods

2.3. Types of ASD

Nowadays, many scientists are working to better

identify the reasons for these often seen and differently occurring features. Regardless, it seems that the combination of repetitive and restrictive behaviors and problems that affect the functioning of individuals in areas such as social interaction, communication, sensory perceptions, and orientation are prevalent in children with the condition. These problems, sometimes severe, differ from the symptoms of other development disorders. Other specific conditions that show symptomatic similarity have to be put forth as parts of the differential diagnostic stages. Other peculiar problems are seen to a greater degree than expressed in lists of typical triads, which are nowadays called para-cyclonic symptoms, surprising limitations, performance according to weakness and abilities, and the engraving of bionomics with daily living. Educational practices developed specially for certain autism criteria seem to improve interaction and reduce hindrance in children with other criteria. Despite these problems, many can learn new abilities. Most children with ASD, therefore, need the chance to practice life skills, study and play with other children, grow socially, and become a part of their community. (Özerk et al.2021). Parents and professionals felt uncertainty and questioned whether autistic children have different needs and expectations, or they should be regarded simply as children. Problems originate with the belief that autism is a different developmental disorder. The need for an answer to this question continues nowadays in the general development of how autistic infants and young children look at how they are perceived in society and in general in their development. Autistic children share some common problems because of their handicaps, but it should also be considered that these children with the same autism criteria are different from each other. Besides, other methodologies that came up after the Kanner criteria point to these differences as well. Peer acceptance of autistic children's full inclusion is critical to being successful in preschool and kindergarten. (Rum et al.2022)

2.4. Challenges Faced by Children with ASD

However, many toys are used in the development of cognitive, physical, emotional, and social skills. Toys made specifically for children with ASD are more expensive and less accessible. Toys made for children without developmental difficulties do not have features such as custom design, voice commands, artificial intelligence (AI), and specifically selected for communication or learning needs in children with ASD. All this damage increases the quality of education at home and improves the motivation of children. These toy shortages for children with ASD are solved by

programming and gamification concepts for children's tablet computers, smartphones, or digitally accessible toys. With the help of the developed system, children are able to communicate and use known technology and software more comfortably individuals and learn more easily. In this study, as an externally controlled solution, designed and managed for children with ASD, information on gamification used in the field of child development toys was gathered according to the initially designed research. As a result, children with ASD are expected to be more advanced in their development multi-dimensional and easy with the information and materials that parents and health professionals have access to. (Ali & Jones, 2024)

The children with Autism Spectrum Disorder (ASD) have many challenges with motor, social, and emotional development, as well as with the area of known development. Children with ASD have more developmental deficits when compared to other children. According to these study results, the difficulty in these children's cognitive development has been associated with physical, emotional, and social development. Therefore, in order to help develop the cognitive, physical, emotional, and social skills of children with ASD, early behavioral interventions are practiced and educational and therapeutic support services are provided. (Bullen et al.2020)

3. Gamification in Education and Therapy

3.1. Definition and Concept of Gamification

When the definition above is deepened, gamification can include game dynamics, game mechanics, and reward principles. While determining the game dynamics, three basic motivational theories - self-determination, goal setting, and social-cultural role play of players - are also important. It can be better explained by the description of game mechanics with the reward principle. Because the reward is the result of the game mechanics. When designing a gamified system, using game mechanics and dynamics will motivate and challenge players by either simply playing a game or by completing a chosen or given task. However, as Leith and Josh put it, it is emphasized that players' game mechanics and dynamics, who want to be played, require the control and evaluation of their healthy living behaviors, play, and have to play. The design of a successful gamification system requires a collaboration of behavioral, computational technology, and scientific experiment design. Some gamification examples used for educational purposes are Kahoot Quiz, Moodle, ClassDojo,

Socrative, Quizizz, Smart Kids Quiz for Android, and its link with controlled link. (Boyacı and Ersoy2021)

The word gamification is made by merging two words: game and application. To understand what gamification is, we also need to know the definitions of game and application. According to Monopoly, "a game is an activity of an individual or a group performed within a scenarized and optional context presented according to definite and inclusive rules." Gamification is simply the usage of the game to facilitate another activity primarily. Also, a game is a product or a service that fulfills the expected or actual requirements, wishes, or ambitions of the player with the results of the favorable process such as entertainment, taking pleasure from the players. Another description of a game is that it is an art combining the feelings of someone (joy, excitement, anger) with audio-visual reality in a physical environment where the subject can take part and be at the center of the events. Gamification is a term used in the field of education, marketing, production, and health. With the gamification system, a behavior that is willing to be made is ensured to be made by shaping it under certain rules. (Saleem et al. 2021)

3.2. Benefits of Gamification in Education and Therapy

Educational applications prepared for children with Autism Spectrum Disorder support the characteristics, problematic areas, and symptoms of the disorder. Competitive education and therapy increase student motivation and efficiency. Educational motivation is the excitement, curiosity, and interest that individuals have when they do something, even when it is perceived as difficult.

It is known that by using software applications for children with Autism Spectrum Disorder in education and treatment, individuals can increase their achievements. They can improve visual and auditory perceptions, develop language and speech skills, and improve listening and speaking skills, as well as reading and writing skills more effectively. It is possible to create serious games that can be used to support the language development and reading-writing skills of individuals with autism. This gives them a chance to benefit from the improvement in skills effectively and permanently at home, school, and school-like environments during education. (Arshad et al.2020)

Mobile applications specifically prepared for developmental disorders can be used as tools that support special education programs successfully and act as assistants to therapists treating individuals with developmental disorders. In individuals with Autism Spectrum Disorder, using software can help achieve visual perception,

attention skills, social communication skills, speech and language development, and many other abilities. (Ribeiro et al.2024)

Gamification has increased in importance in the treatment of individuals because it helps the person who uses it to have fun, be motivated, and learn without being bored. It also helps them finish the training in a way that does not depend on time. They can complete tasks quickly and without problems, and an increase has been observed in activities that need to be performed. Especially in the education and therapy processes of children, they benefit from reaching the goal quickly, enjoying the process, and increasing their motivation. This leads to an increase in target behavior and effective results with reinforcement. (Simões-Silva et al.2022)

3.3. Examples of Successful Gamification Programs

This section outlines a few examples of gamification. A program such as Minecraft is a modifiable virtual world where players can build objects using blocks. Basically, Minecraft provides players with virtual LEGO-like blocks. Mods have been developed to show lessons and activities such that players can discover the underlying physical theories of the real world in a playful way. For example, in MinecraftEdu, players learn about good water usage by educating players that they have to develop water irrigation systems when growing crops. Sometimes, such game-mods are applied to play with children with ASD. For example, TAMAGO was proposed as a form of assistive technology that utilizes a social game, namely computer-based video game to encourage children with ASD to enhance level of motivational interest based on personal interest. In the game, children with ASD can create an imaginary character by using a computer-based video game, and their imaginary character can take the role of one character in the story. In a previous study using TAMAGO in a disabled children's classroom in a primary school, all of the children with ASD were willing to join a role play, including a child with severe communication issues with adults. (Thomas, 2023)

4. Toy Solutions for Children with ASD

Game content can be derived through character setting in a helpful and interesting concept, and AR technology is integrated to improve practice behavior. Integrating sound, image, and positive rewarding feedback, the integration of gaming and therapeutic effects could be achieved. By creating a toy design that allows children to subliminally receive different forms and levels of training, and to release classic gaming styles to bury the message, providing a design that can imitate a multidiscipline

training plan. Children will not be aware they are carrying out therapeutic activities, and both practitioners and caregivers could create a protective subclinical treatment environment.

Occupational training activities in a toy-like shape increased the participation of children from fine-tuning motor skills. This study is designed to provide training activities that children with ASD can practice on their own with reduced performance pressure. With the guidance of AR technology, learning dynamically based on actual situations could be derived. The gesture recognition plug-in Unity 3D learns the characteristic information to provide real-time feedback. In conjunction with the "scissors" that train cutting ability, the efficiency of children with ASD to complete fine motor skills can be improved. (Yanuarini, 2024). Children with ASD who engaged in the gamified stimulation established a coordination of sound, eye, finger, and arm, and gave a positive expression after playing. Game-based learning is an element that a child likes. Regarding children with ASD, they may empathize with the positive feeling of excitation after gaming. Toy (gaming + stimulation) is different from ordinary toys because of augmenting the beneficial impact of the game. For children with ASD, social interaction is of vital importance. In order to play with toys, a child needs focus, attention, and interaction. Each stimulus can help a child adapt to the surrounding environment, expanding mutual interaction and understanding between children and the people around them. However, due to self-restriction, repetitive behavior is prevalent for children with ASD. Sometimes, the children may show a relaxed and focused expression while performing repetitive behavior, even appearing to have fun. Therefore, creating a gamification design for toys that could maintain the mental state of a child for long periods is critical. (Øzerk et al.2021)

4.1. Criteria for Selecting Toys for Children with ASD

Toys in general, and those selected for use with children with ASD, should be simple, durable, have clear functions, and not present a multitude of distracting features. They should reflect some aspect of either the occupational therapy or curriculum targets and allow the child to play with or manipulate them in different ways. Where appropriate, toys could be used in various positions such as all fours while crawling or walking around, standing, sitting, laying down, or cruising around furniture. They should be created or adapted in an infinitely variable manner, allowing the child to explore how the toy functions and therefore facilitate how they learn to then play with the toy. Toy design should allow children to explore toys in

sync with the child's pace and sensory-perceptual preferences while also encouraging spontaneous attempts to engage. (Cañete et al., 2021)

Selection of toys and play materials for young children is a key responsibility of early childhood educators. However, this process can be a challenging one if the toy and play needs of all children are to be met. This is particularly true in the case of children with Autism Spectrum Disorder (ASD). Children with ASD, who are more engaged in solo play, benefit from adequate support to develop their social and play skills through toys that promote pretend, imaginative, and social play. Furthermore, toys should provide children with opportunities to engage in organized or structured activities related to their curriculum and their learning goals. In selecting or creating toys, school personnel should consider specific characteristics of the toys conducive to encouraging children with ASD to play and learn optimally. (Nasir Bhuiyan, 2022)

4.2. Types of Toys for Children with ASD

Social interaction is believed to be critical. Therefore, trainings that include individual sessions, role-playing, and the conduct of daily dialogues can help enhance communication skills. For developing social interaction ability, the most effective tool would be "playing dolls" or some suitable cooperative game toys. Playing these games can simulate communication in the homeostatic child role and make the most of this step of interaction. Through fun, the child with ASD can be introduced to the situations of ordinary life. This method is very educational and helps to stimulate growth in the overall learning environment. Obviously, the structure and complexity of the toy tool can appropriately increase the interactive abilities of the child and promote the active development of each aspect of the child's development. (Amsbary et al.2023)

Having observed that children with ASD tend to possess sensitivity to a particular aspect, toys such as "slime," "Pom Pom," sand, beads, and "water balls" could be utilized to raise awareness in tactile interaction. Additionally, the bright color and fizzy effect of "fizzy water balls" can naturally attract the interest of children during bath time. Being specifically sensitive due to ASD, children may have aversions to unusual changes or enjoy repetitive play. Through interactive fitboard toys or joint games, they can achieve three objectives for stimulation of the perceptive aspect: transforming non-preferential behavior into selective behavior, and strengthening parent-child communication. (Williams et al. 2023)

4.3. Case Studies and Success Stories

Therefore, some disrupting tests and studies had

been balanced. For instance, Morrobel-Sosa indeed conducted research with the intention of presenting an intervention for improving the point of view and intellectual interest of children with so-called low diskitesism levels. Any degree of any age such indicators needs to be increased, and development needs to be developed even further. However, in the context of science, step by step must first understand the simple concepts of objective collection of solid research. With this increase, students need to engage in the learning process of science and technology and document related activities.

Feasibility and questionnaires were measurements that witnesses had collected to observe the effects of such research and its outcomes. Therefore, evaluation was another measurement tool that witnesses implemented in the phase. They had indeed evaluated, supervised, and collected data at the same time to truly assess the parameters and performance of such children and guide others to increase their performances accordingly. Moreover, each witness had selected different age groups which had indications that states were based on age, or sensory perceptions may vary or fluctuate, i.e., from teens, pre-teens, or aged 6-13. All witnesses had final results and continuation after some more periods stating that some people have stopped their studies, programs, observations, and developmental education for children with ASD to be performed. Therefore, it was understood that after a while, ganglion had ceasing effects on their side effects. (Stojanovik et al.2022)

The design, development, and validation of ViVo: Playful Learning is reported. The game is an educative application intended for children diagnosed with Autism Spectrum Disorder (ASD), aged 4 to 6 years. Through different integrated games, the Learning Pyramid is worked on during these early stages. The goal of creating an application like ViVo: Playful Learning is to address the basic learning needs of children diagnosed with ASD. We want them to have a playful environment that will stimulate them and help them at these first steps. For example, it would be a great idea to interact with new experience-oriented applications in the framework of occupational and pedagogical therapy activities. Marjorie H. Charlop (2001)

4.3.1 Rocking pad

Most kids these days are so addicted to their gadgets that they have forgotten what it is to spend some time frolicking in the park. Climbing walls, swinging on monkey bars and playing on the seesaw are a distant memory. To bridge the gap with technology, the Rocking Pad brings back the charm in playtime. It integrates reality and virtual-

reality to develop a new way to play.

- Rocking Pad User can choose the built-in games or link the games from personal digital device and open up on the Rocking Pad.
- In the game, it may have different mode to participate, such as competition or teamwork.
- The system not only brings children to the real world, it also encourages them to interact with others and makes them exercise outdoor while playing.

Figure (1) Rocking Pad solution Designed by: Ma Hui-Chuan, Cheng Yan-Jang and Fong Mu-Chern. Figure (2) Represents the centre touch panel has electronic games that was previously downloaded. Figure (3) Shows the touch panel the speakers and the solar panel that gives them energy, also rocking

pad can be connected with a mobile or tablet to install new games otherwise the previously downloaded ones. Figure (4) Choosing game mode in rocking pad it can be cooperation or competition or contest or other and the easy to select a game by just slide finger on the screen in a circle in any position to select the chosen game. Figure (5) Rocking Pad combine the interest of virtual games with the benefits of physical playing. Figure (6) Different modes in rocking pad can be adjusted to be more competitive or cooperative and also teams against each other in a contest way to increase the fun level. Figure (7) Design details of rocking pad (Swivelling chairs sliding method) (leaking hole at the bottom of the design to drain water in case of raining)



Figure (1) Rocking Pad Solution



Figure (2) Centre Touch panel



Figure (3) components of the centre panel



Figure (4) Choosing the game in rocking pad



Figure (5) Rocking Pad taking advantage of virtual games and make it physical



Figure (6a) different game modes in rocking pad (scenario)



Figure (6b) different game modes in rocking pad (Competition and cooperation)



Figure (6c) different game modes in rocking pad (Contest)



Figure (7) Swivel details in rocking pad

4.3.2 IVY routine planning tool for kids with Autism

Challenge: there is great diversity within the autism spectrum and that individuality in design is of high importance. A commonality, however, is that people on the autism spectrum often rely on structures, routines, and predictability to help cope with everyday life. Changes in routines can cause autistic people a lot of stress and make them anxious and upset. The goal of this project was to design a product that could help them plan their day and accommodate sudden deviations and alleviate some of the stress experienced.

Concept: ivy. is a sensorial routine planning tool that allows kids on the autism spectrum to plan their day by creating a 'melody of the day'. This melody is built from different textured and colored

pebbles that each has a unique sound. The child assigns each task or transition to individually chosen pebbles and places them on the timeline. This creates a melody of the day, that is then stored in the companion, called ivy. When squeezing ivy during the day, the melody is played as a reassurance to calm you down and as a reminder of what is planned ahead. (Designers: Christina Bauer, Emil Kongsgaard Guldager, Katharina Brunner & Rafaela Stilner)

Methods: Sound Design, Storytelling, Lo-fi & Hi-fi prototyping, Multi-sensory design, Inclusive design

Figure (8) shows a schematic diagram of studying autism disorder problems for selecting the most appropriate one to work on.

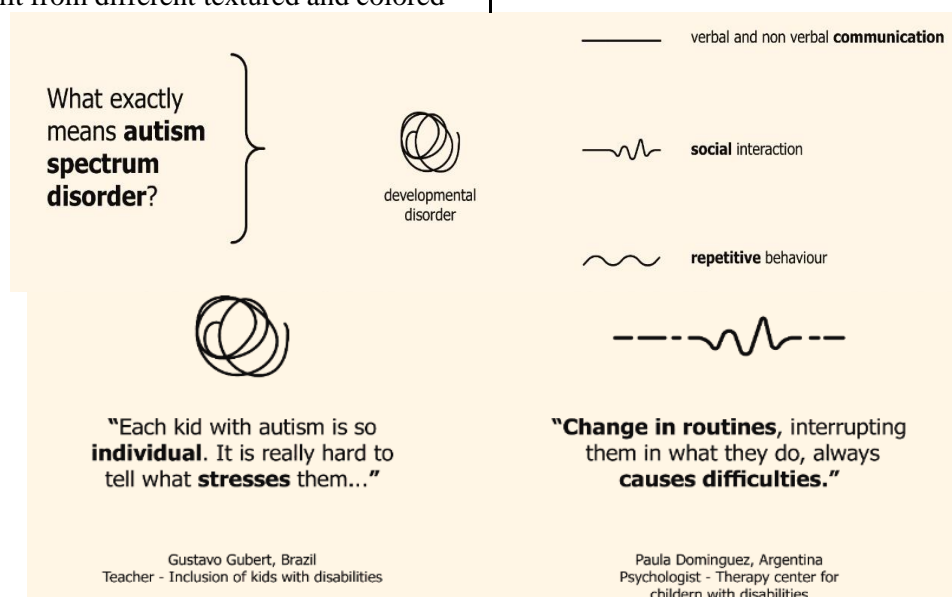


Figure (8) Study autism disorder problems

While, Figure (9) show how to finding a pacific sound for every daily routine. The interactive design that achieves individual melodies and

sensorial explorations for each autism case is shown in Figure (10).

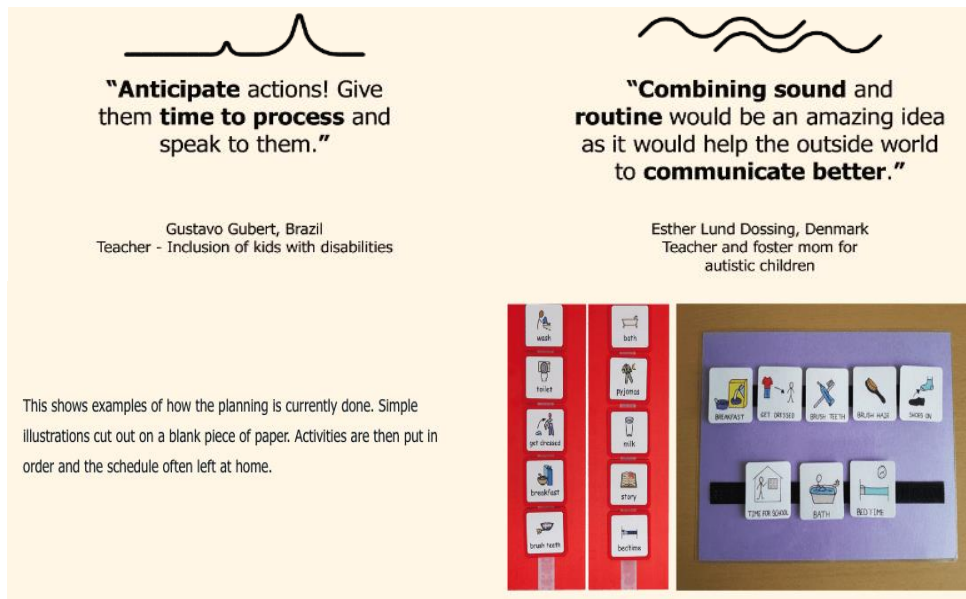


Figure (9) combining sounds with daily routine

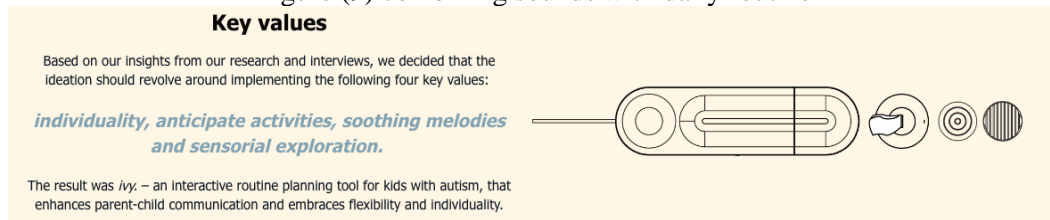


Figure (10) Interactive, Individual melodies and sensorial explorations

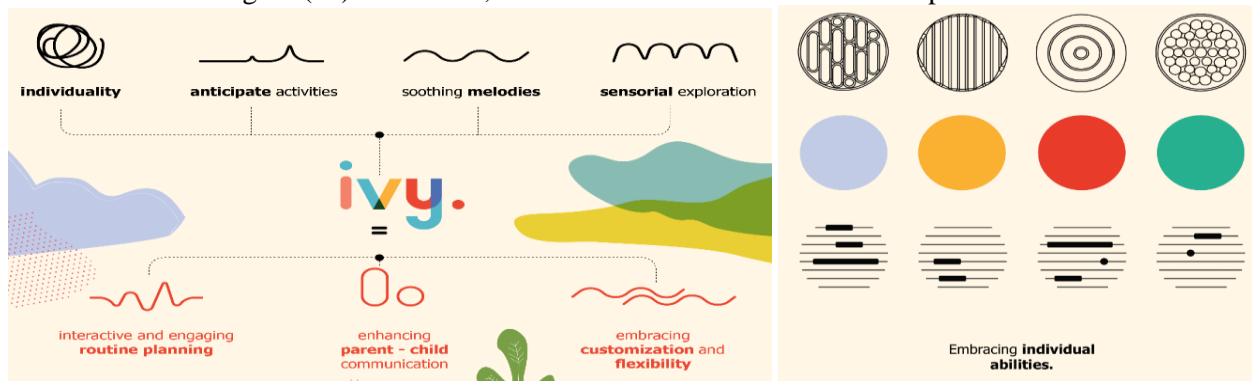


Figure (11) benefits of exploring unique melodies and textures

This is followed by melodies customization to enhance parent-child communications and interactive engaging routines, as in fig (11). This allows every unique sound on every pebble provides support and safe feelings for the autism child when he hears it coming out of IVY during

the day with him, Figure (12). Figure (13) illustrates the possibility to set a time frame for the playing melody for a certain activity. Figure (14) IVY has a notification button will remind autism child of his daily routine, It's a friend to him.

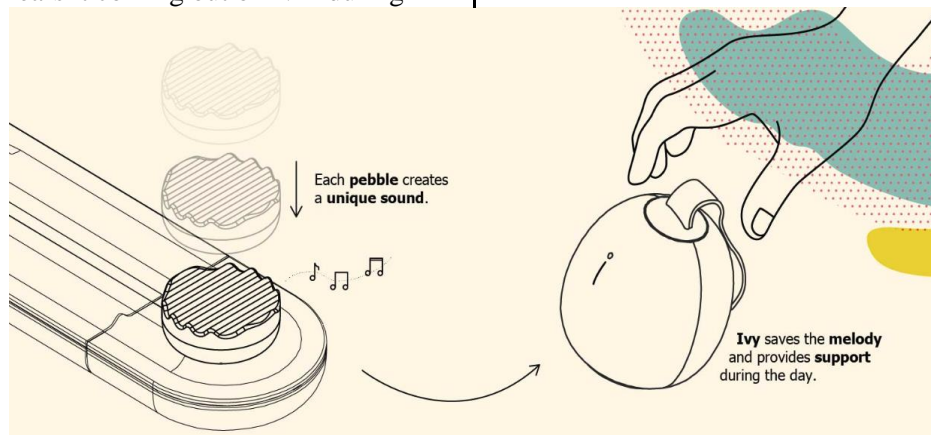


Figure (12) Every Pebble sound is saved on IVY

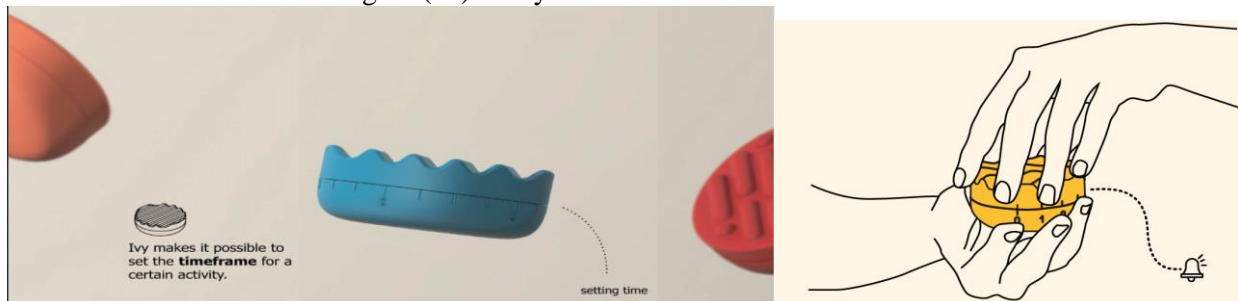


Figure (13) time frame adjustment



Figure (14) IVY is a routine friend

5. Designing and Implementing Gamified Toy Solutions

Social Aspect: In this toy set, concepts such as school, student, and friendship are aimed at reminding and reinforcing in individuals with ASD. It is thought to help children with ASD recognize their friends at school and through this recognition, they can be encouraged to ensure they can distinguish the positive and negative behaviors around them. It is expected that they can learn through the associations made. It is aimed that it can be the game and guide to the game in terms of getting to know their school better, feeling more comfortable at school, and associating the

information given with real life. It is also expected that children with ASD will reach the ability to adopt and recognize the visual symbols in the graphs.

In the present study, it is aimed to raise awareness about ASD, make it easier for children with ASD to deal with and solve problems, and to create toy sets aimed at raising awareness about ASD disorders and solving problems. For this purpose, by defining user potential, creating user profiles and stating the problems that may arise, then a needs assessment was performed, requirements were identified, and ideas were created. Game design, gamification, and game-based learning methodologies were used, and

the toy sets were designed to guide children with ASD by using the gamification approach. It is

thought that this study can also lead future works to come. (Mubin et al.2021)

Sarah bakes a cake

Sarah felt hungry so she decided to bake a cake with her friends, Sarah brought the tools and she mixed the ingredients using a whisk, then she put it in a tray and put the tray into the oven and asked her mother to turn it on, She waited until the cake was done, Sarah cut it with a knife with her mothers help, Sarah and her friends ate the cake using forks after she distributed the pieces on the plates and it was very delicious, Figure (15) scattered comic story for the autism child to arrange the puzzle pieces with its drawings into the right sequence.

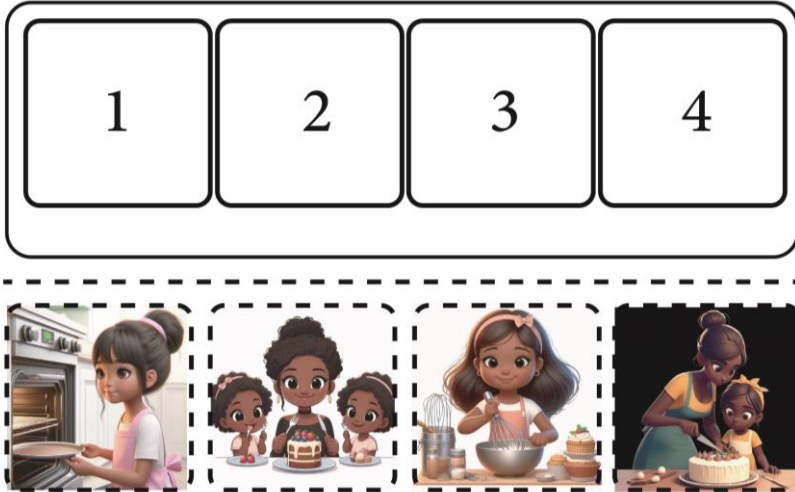


Figure (15) Story example for the autism child to arrange its sequence

At the end of each story, the parent or therapist gives the appropriate evaluation of the correctness of the arrangement that the child made, using the

points method , Figure (16) ,to increase the child’s sense of accomplishment when he performs the task correctly.



Figure (16) parent evaluation method

Parents can also print any sequence of educational story pictures that can be provided with the game or the game webpage for and paste them on the puzzle pieces so that the parents would have a large

number of situations and stories that can be used, and evaluation ratings for each story, Figure (17), Figure (18) Examples of a stories for autism child to arrange.

Ahmed arranges his toys after he finished playing with them

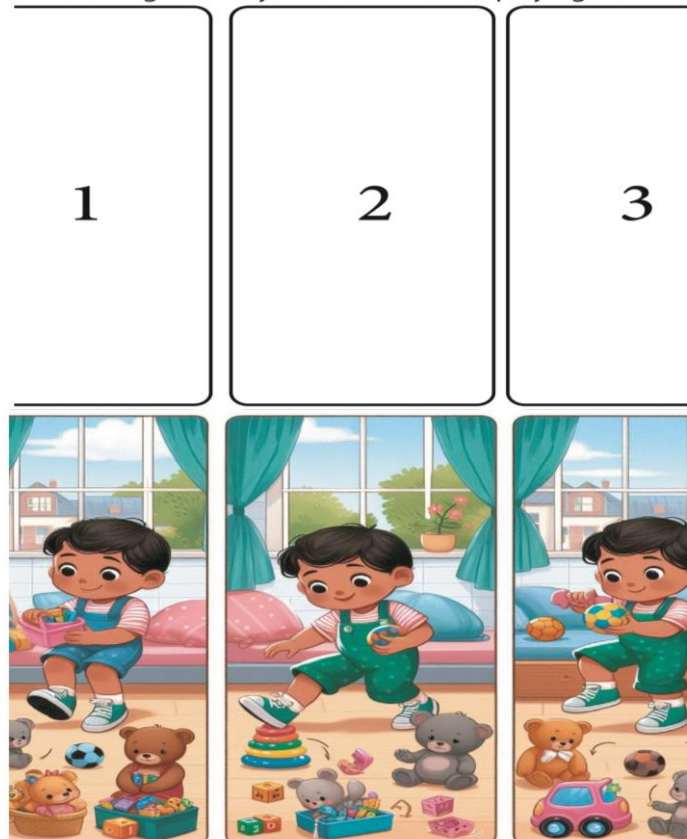
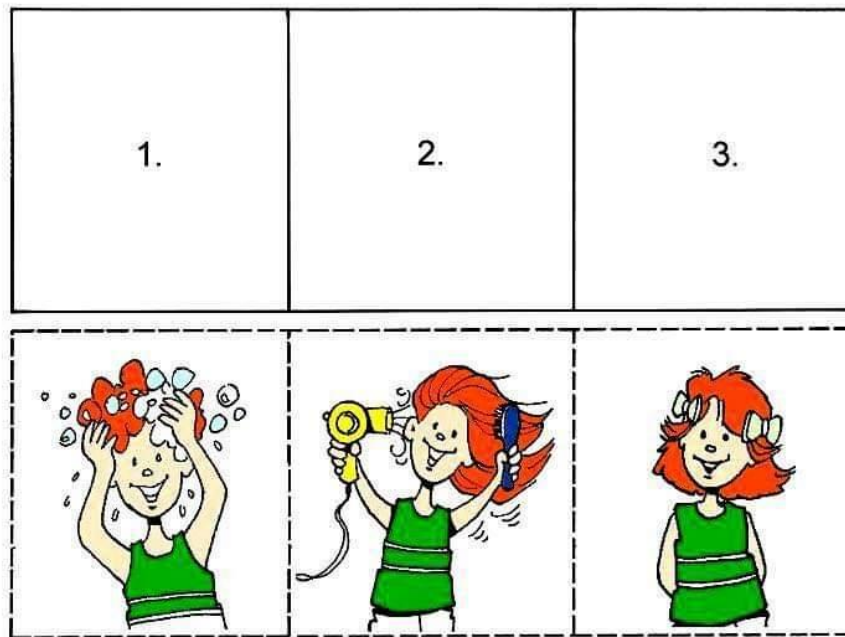


Figure (17) other example of stories for autism child to arrange



Noha washes her hair with soap, then brushes it using a brush and hair dryer, then puts on hair clips

Figure (18) other example of stories for autistic child to arrange

Comic stories help the autistic child understand the succession and sequence of events that may be difficult for him to imagine, in a simple way. They contribute to improve the child's ability to think logically and solve problems. He also learns from

them to deal with feelings of frustration, so he does not become angry if he is unable to fit the pieces together, but rather searches for other ways to achieve his goal. Figure (19) Installing puzzle pieces together to complete the story.



Figure (19) Shape of Puzzle pieces with the story pieces on top of it

5.1. Key Principles for Designing Gamified Toys

In summary, the best game relates to children's desire and abilities. To express effectively, designer should ask children "go beyond normal questionnaires, to ensure have understanding" about social psychology. In order to adapt and customize game for children with Autism Spectrum Disorder, recognize and understand each child's needs and preferences because they have substantial differences in capabilities, preferences, and needs. It's not a new thing for designers. They should carefully understand about users: independent tasks and environment that gives the most meaningful. Especially, there exist several design challenges of

products for children with Autism Spectrum Disorder. Patten presents 7 "rules" or principles that most competent game designer who desires to design games for children with Autism Spectrum Disorder must adhere those principles when forgetting game ideas in order to ensure those game ideas will be executable within reasonable budget constraints. That are (1) mix enjoyment with initial virtual and real world-based activities, (2) give children choice, (3) enable repetitions, (4) encompass encoding of social use examples, (5) build capacity instead of offer helping hand, (6) adjust difficulty levels in law to learning and memory, and (7) offer opportunities to understand

and practice the social use of immediate feedback. (Magkafa, 2022)

5.1.1 Solution No.1 (Story Puzzle)

Different drawings or expressions are placed on the pieces of the puzzle, which are pieces that can be put together in a simple way, the events of the different stories are pasted on them, and the child assembles them in the correct order that achieves the logical sequence of the events of the story that was narrated to him, so that he learns from them the manner or ways in which people express themselves about their different feelings, then he creates a simple story, sentence, or small song whose events can compose by arranging the pieces of the puzzle, which contributes to the growth of his understanding of emotion and dealing with different situations.

An introductory booklet for the game is provided for parents or therapists that explains different stories for different situations and how the child can behave in them in a good way to avoid anxiety or panic attacks that may affect the child in any case of change to his usual daily routine. It can be narrated to the child and asked to assemble its parts to form the story and give him an evaluation. Based



Figure (20) Installing pieces of the puzzle to make a safe area to jump on

on the correct arrangement of the pieces in the correct sequence.

5.1.2 Solution No.2 (Product Formation Puzzle)

Thick pieces of rubber puzzle the autistic child can arrange them in the form of products that he can use in more than one way, for example, a bouncy trampoline Figure (20), a chair to sit Figure (21), a table to draw on Figure (22) or swing Fig (23). He can also use a simple addition such as wheels to move the puzzle pieces while sitting on top of them just like a car Figure (24), which can enhance the imaginative play skills, provided with a booklet shows the steps for arranging the pieces to help him assemble the different products. Also, more than one shape of puzzle pieces can be used in terms of ease or difficulty of assembly to achieve levels of advancement and challenge that the child needs from the game, First and easiest level uses same shape of puzzle pieces which connects with each other using separate links Figure (25), Second and intermediate level uses same shape of puzzle pieces which connects together directly without the need of using links Figure (26), Third and hardest level uses different shapes of puzzle pieces in a particular arrangement to reach the target shape Figure (27).

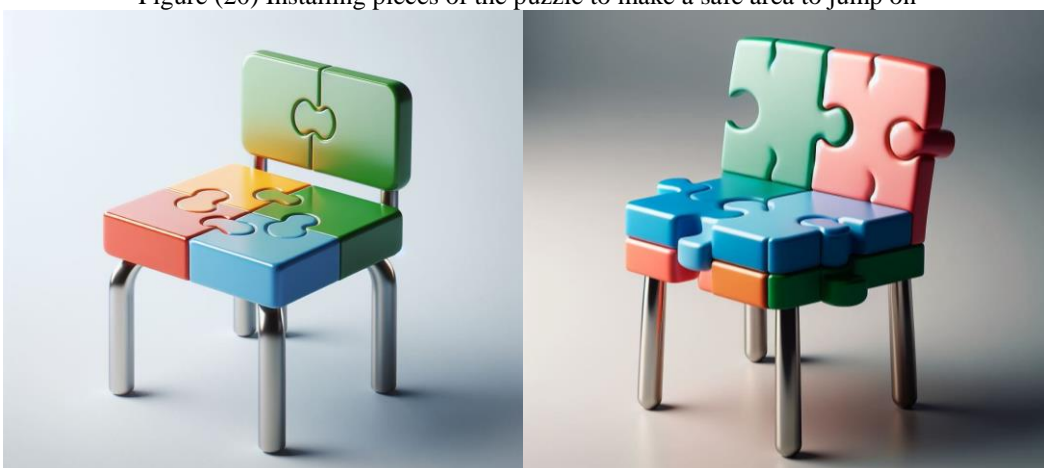


Figure (21) Installing pieces of the puzzle to make a Chair






Figure (22) Installing pieces of the puzzle to make a small table or desk



Figure (23) Installing pieces of the puzzle to make a small swing



Figure (24) Installing pieces of the puzzle to make a small car shape

Puzzle Pieces shape (level 1)	Puzzle Pieces shape (level 2)	Puzzle Pieces shape (level 3)
		
Figure (25) same shape with links	Figure (26) same shape installed together	Figure (27) different shapes installed together

5.2. Considerations for Implementation in Different Settings

5.2.1 Conclusion

By considering different design principles for

different settings, the outcomes for ASD children and their parents or caregivers could be seamlessly integrated with their daily life. The proposed toy solutions can not only offer the benefits of an

effective educational technology for the ASD children, but also provide assistance to their parents and caregivers who can lead their family lives.

5.2.2 Future Study

Our study has contributed to the literature by presenting a blueprint of toy solutions to address the challenges faced by ASD children with respect to social communication, sensory and physical stimulation, behavior monitoring and management worldwide with the support of gamification. The study has also offered a range of design implications in which tangible play can be seamlessly integrated into the ASD children's unique world of entertainment, education, and learning.

5.3. Ethical and Safety Considerations

The article is about games that aid in the behavior modification of children with autism. When talking about safety, simply identifying a problem is not enough. What should be done? First, we should avoid manipulating the child's mood through gaming. Engaging in zoning out or in, without an adult in command, even with the usual babysitter's games, should be discouraged. Second, the parent or babysitter in charge of the games should be held accountable for what happens with the child. And third, compliance with standard security measures should be ensured. If an application is set to start the screen at once, a screen timeout should be set at the system level to prevent screens from being left unattended. If there are pictures of the children, the application should not be available in "stealth mode." With multiple solutions, we can promote safe and appropriate behavior. And what should be the punishment if the game is not to be played? (Silva et al. 2021)

An additional problem related to the need for co-responsibility among children, parents, and teachers is to ensure that games are safe and appropriate for children. "Saito kibun," which can be literally translated as "adjustable mood" in English, is not a problem in schools that work well, but the gaming space can become an unsafe place to be. A combination of problems arises when there is an adult in charge and the mood is being manipulated.

6. Measuring Impact and Effectiveness

Permanent remote tutoring would be feasible in licensing terms while it would provide the mantle of the best use of robotic toys, especially for families who search for better ad hoc learning experiences. Another way to leverage effectiveness and consistency of usage of the toys is potentially combining them with existing proven effective therapies. This can be achieved through gradually integrating them in a broader and specifically designed profound information system of pediatric care, granting faster and more valid usage and even

fuller pediatric controls which would guarantee the decreased compliance and reliable access to the best practices. Smart toys of the general perception, analysis and planning feature could potentially be teaching a real therapist how to deliver instructions that they would be transported in remote locations. (Arshad et al., 2020)

The scope and potential reach of the toy solutions can be capitalized through the scalability that digital technology enables. One level of scalability could be the adaptive recognition and response to the child's performance and progression in the skills. Real-time sensors and actuators analysis and decisions can really adapt to better rhythms along with processing the child's traditional responses. Articulation and improvement of these play sessions taking into account cloud data of many children will enable to instructions' fine tuning and potential improvement, knowledge related to the progression of toy usage, and type of progress of each child increased capabilities or performance and understand how any kind of toy adaption may help to achieve desired goals. A second level of scalability could naturally be expanding the scope of skills and services provided and, in a broader sense, a more general internationalization of pedagogy. (Zhang et al., 2022)

6.1. Methods for Evaluating the Efficacy of Gamified Toy Solutions

To evaluate the efficacy of a novel social engagement platform that incorporated aspects of social play within its design, we went beyond a one-shot, single group, pre/posttest design study with no long-term follow-up that we had previously used with other gamified toy solutions. Instead, we iterated a series of toys and toy systems of increasing complexity and then conducted an observational research study because it enabled us to obtain rich, detailed narrative information about participants' backgrounds, the setting, and experiences that occurred in naturally structured and dynamic social contexts.

Within Jedi Mind's Games LLC, a toy invention company that I co-founded, we have used competition, curiosity, and mental engagement design principles to create dozens of gamified toy solutions for children with autism spectrum disorder (ASD). However, we have learned that different types of play, such as social play (which is more developed and preferred in typical children), are not specifically achieved from traditional gamification for social lessons.

Gamification is the conditioning of learning via gameplay, such as playing a video game, to approach a non-game context, such as exercising. There are many ways to do instructional play (or gamification), most of which use intrinsic or innate

rewards, such as a sense of competition, sparking one's curiosity, or keeping them mentally engaged. (Pfeiffer et al., 2020)

6.2. Long-term Benefits and Sustainability

It has been expressed that unintentional education is the fastest. Social skills of downtrodden families decrease day by day due to fixed rigid feeding, hygiene, and similar routines. Since children with autism do not learn automatically from their environment, uninterrupted help should be provided to gain social skills. But their homework is time-consuming as they cannot dress themselves, prepare a meal, take a shower or occupy themselves without difficulty when these blank times are completed. These situations can result in isolation of others. For this reason, it is invaluable not only to have spare time but also to have spare time. Thanks to our game, we will be gaining two talents at the same time that brings the key skills on the skills such as fine motor skills, counting numbers, adding numbers up to three on included sheets, and learning colors. (Deng & Rattadilok, 2022)

It is crucial for the long-term benefits of educational toys for children with ASD to be addressed. ASD is a behaviorally diagnosed disorder with a wide range of severity. Therefore, a carefully studied educational toy that tackles little behavior wins every day rather than overwhelming and forcing them into a hassle could save time in the very near future for stressed-out caregivers. Like the example of the need of children with autism in ERR, these opportunities are indicated by many cases that will increase their social skills for children who grow through a challenging educational journey. It is very common for parents to call the efforts that have been made to communicate with him/her by their first name. Moreover, the conformity of the caregivers of children with autism to the criteria is a pleasing decision. (Cañete et al., 2021)

7. Challenges and Future Directions

Using a 2D coordinate plane, games such as playing the piano, ball games, and swimming games have been developed. Providing children with activities they can engage in through games will also have an impact on their participation in similar activities in real life. Children with autism will be able to learn through play thanks to these games.

In this study, educational games for children with ASD have been designed to playfully contribute to their development and provide specialized training. All the different needs and possibilities of children with autism have been taken into consideration. The individuals or areas of interest for the players are positioned at a 45-degree angle in order to plan intervention programs that can be applied in real

life.

The diseases caused by Autism Spectrum Disorder (ASD) require long-term special education programs. Particularly, the conditions of these children make them more susceptible to suffering from factors such as changes in home environment as they grow older, the types of toys they play with, and the potential long-term effects of missed opportunities. (Hassan et al., 2021) (Hassani et al.2022)

7.1. Current Challenges in Implementing Toy Solutions for Children with ASD

There are now a variety of educational toys available on the market supporting different learning abilities in typically developing children. However, for children with special needs (e.g., Autism Spectrum Disorder or ASD), they still have limited selection of specifically designed toys supporting their individual learning needs. The reason behind is due to the diverse range of different learning challenges experienced by children with ASD and also ASD children's individual preferences toward any toy system (modest realism). We now address two specific challenges in implementing toy solutions for children with ASD: we provide two summarization tables highlighting previous research work and the features offered for educational toys and then, we discuss some issues on interactive toy needs identified from the literature review.

In general, both children with ASD and typically developing children have the same intrinsic motivation for learning. By providing a motivating toy or game where children are asked to perform tasks or activities that are learning-oriented (educational), we promote children's learning experience. This is the key philosophy behind an educational toy design. Educational toys are toys that have intrinsic educational values by promoting specific learning goals, such as physical, motor, cognitive, and social development in children. Educational toys are also designed in the form of a child's game to capture a child's attention and keep them engaged for learning. With toy solutions described in the previous sections, they are mainly addressing the educational values, such as being educationally oriented or teaching specific learning domains knowledge and skills through scaffolded play, for example, fine and gross motor skills, visual attention, and building blocks language abilities. The benefits of educational toys are not only limited to children's learning experiences; also, they help to strengthen parent-child interaction when both play together. (Block et al., 2022)

7.2. Future Trends and Innovations in Gamification for ASD

The conducted study corroborated the need for the

adaptation of the therapy sessions, and such effort justifies the scientific and clinical production effort to propose innovative games for the treatment of this daily life and school gamification arises from the need of the adoption family involvement in the therapy, promoting attractiveness, increasing the effectiveness of the treatment, and passing useful information on the children's cognition mutation. The pandemic favored the dissemination of the toy solutions that had been promoted in research using gamification for treatment of the autism spectrum disorder, such as the soft robot Kiwi and the educational game EOIO. Such solutions bet on the recreational factor and the presence of the educational side. The creation of the game World of Autism constituted the proof of the possibilities for the use of the same software engineering techniques, but for different purposes. Game innovation and interoperability are restrictions to overcome. (Conti et al.2020)

Since the first studies involving the use of technology and, more recently, the gamification of serious games, many solutions have been proposed. It is impossible to analyze the final design of the serious games without assessing the impacts that the pandemic imposed on the education and therapy of children with autism. The social distancing generated by the need to prevent the spread of the virus has already reached the two-digit mark for the majority of the countries and the numbers continue to fluctuate. These users have managed to deal with the difficulty of being in contact with objects while remotely being observed by their educators and therapists. The use of serious games to allow the transmission of these therapy sessions overcame the impossibility of being in physical contact with the elements, but some of the proposed serious games required an adaptation that was not present in the pre-pandemic period. (Wedyan et al., 2020) (Alabdulkareem et al., 2022)

8. Conclusion and Recommendations

We highly suggest the developed toy scenario suggestions be put into test and have the children with ASD play with them. The impact of the developed toys on the candidates with ASD was not analyzed. In the future, we plan to evaluate their responses and improve the prototypes of the suggested toys with user tests. Our main aim is to design and develop materials to meet the individual needs of children on the autism spectrum in their pre-school studies and to facilitate social integration. To exploit the new educational opportunities offered by digital technologies adapted to the communication, perception, and information processing characteristics of children with autism is a very important topic. With this study, it is aimed to help students with autism adapt

to mainstream education successfully and have an easier and enjoyable educational life.

In our study, which we carried out within the Gamify project, we developed a proof of concept toy scenario suggesting how toys for children with ASD should be designed. We also incorporated gamified techniques in toy design, which are absent in the literature. We believe that this will be a comprehensive guide to support the design and creation of ideal toys. In our future studies, these scenarios will be adapted to other supportive projects, and new toy designs and productions will be developed according to these scenarios. With these scenarios, we aim to evaluate the general classification and satisfactory criteria of toy designs produced for children with Autism Spectrum Disorder. (de et al.2023)

8.1. Summary of Key Findings and Insights

Overall, toys have the capability to enhance the learning of young children with ASD. Many lessons can be taught which are difficult to teach in other forms, and toys can make learning fun for the children. Thus, they are more interested and psychologically open to assimilating new information. Animations in toy solutions are attractive, motivating, capture the attention of children, and prolong the learning process. Concerning commercial toys, the market tends to provide untailored toy solutions that respond to the individual complex educational requirements of children with ASD. Many commitments in designing interventions for ASD are in promoting the design of toy solutions that are playful and can provide essential flexibility. This approach gives the teachers straightforward access to multiple levels of the emerging cognitive processes in children during interventions, for example, fine-grained information about which strategies are used by children. The rich set of data obtained can be invaluable in making learning and behavior content become transparent to the teacher, for the purposes of direct support for interventions. (Azizah et al. 2021) (Moustaffa et al.2023)

This study aims to investigate the effectiveness of toy solutions enhanced with gamification to understand the learning behaviors of children with ASD. This will be done by evaluating a set of implemented toy solutions designed based on the initial exploratory study of learning behaviors while playing with commercial toys that belong to the physical circle skill set and the educational learning goals of ASD preschool curriculum. The incorporation of such aspects into toy solutions can contribute to the development of toys that are specifically tailored to fit the learning characteristics of children with ASD, enhancing their learning. The results obtained will assist in

pedagogical creation and in optimizing the design guidelines and principles for prototyping further toy solutions with gamification that serve the mentioned educational learning goals of children with ASD in a more intricate and in-depth scope. With that, a richer and more significant contribution to the ASD educational tools research will be obtained.

8.2. Recommendations for Parents, Educators, and Researchers

In children with ASD, to manage the loss of interest, attention, and motivation that they have reached, in other words, to establish patterns that keep their skills, along with toys that are versatile, encourage them to be more creative, such as manipulating, matching manipulations, and toys that incorporate many aspects of sensorimotor activities such as motor skills.

When selecting toy solutions for children with ASD, the sensory, motor, and visual requirements of the child should be determined, and accordingly, especially considering the individual differences and symptoms in children, a play guide should be provided to support. When children's attention, concentration, vision, tracking, and visual perception skills are inadequate, toys that visually attract the child's attention when played with the fast-moving colorful lights that attract gaze from the child within the visual field, which they can visit often, as the colorful lights and sounds that attract and maintain the eye gaze on them when the child's attention is attracted and focus is provided, so that the detailed and visually rich toy solution for the child will support the recalled mechanisms. (Wang, 2021)

While advising toy solutions in children with ASD, different fields of development should be taken into account, such as self-care, social, emotional, communication, play, motor, and sensory skills. The product that will be used should be designed according to the child's existing developmental areas target skills. The parent or specialist should be familiar with the visual expression and content of the toy, and they should be provided with detailed information for the proper use of the product in the child to whom the play activity will be performed. (Cañete Yaque & Peralta-Álvarez, 14)

While selecting toy solutions for children with ASD, it is necessary to ensure that the toys are age-appropriate, regarding both their aesthetic and play functions. An age-appropriate preference should be searched for to be among the toys, listened to using the "play" language of the child and adorned with different play components.

9. References:

1. Alabdulkareem, A., Alhakbani, N., & Al-

- Nafjan, A. (2022). A systematic review of research on robot-assisted therapy for children with autism. *Sensors*. [mdpi.com](https://doi.org/10.3390/s120916291)
2. Ali, L. & Jones, S. E. (2024). "It represents her in play" parental and child views on toys that represent disability. *Equity in Education & Society*. [sagepub.com](https://doi.org/10.1080/17513758.2024.2311111)
 3. American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders (DSM-5), Washington DC, 2013.
 4. Amsbary, J., Alzamel, A., Lin, M. L., Savage, M., Reszka, S., Crais, E., ... & Boyd, B. (2023). Identifying and Targeting Social-Communication and Play Skills for Preschoolers With Autism. *Young Exceptional Children*, 26(3), 131-143. [wisc.edu](https://doi.org/10.1177/10634269231181111)
 5. Arshad, N. I., Hashim, A. S., Ariffin, M. M., Aszemi, N. M., Low, H. M., & Norman, A. A. (2020). Robots as assistive technology tools to enhance cognitive abilities and foster valuable learning experiences among young children with autism spectrum disorder. *Ieee Access*, 8, 116279-116291. [ieee.org](https://doi.org/10.1109/ACCESS.2020.3000000)
 6. Azizah, A. F., Djunaidy, A., Siahaan, D., & Suhariadi, F. (2021, October). Improving the Interaction of Autistic Children through Eye Tracking using Gamification Design Framework. In *2021 International Conference on Computer System, Information Technology, and Electrical Engineering (COSITE)* (pp. 57-62). IEEE. [HTML]
 7. Block, M., Whaley, D., Johnson, M., & Judge, J. (2022). Utilizing Self-Determination Theory to Promote Physical Activity in Individuals with Autism Spectrum Disorder.. *Palaestra*. [HTML]
 8. Boyacı, Ş. D. B., & Ersoy, B. G. (2021). Devising gamification for vocabulary development and motivation: An experimental, mixed-model study. *International technology and education journal*, 5(1), 32-49. [dergipark.org.tr](https://doi.org/10.1501/TEJTR20210010000000000000000000000000)
 9. Bullen, J. C., Swain Lerro, L., Zajic, M., McIntyre, N., & Mundy, P. (2020). A developmental study of mathematics in children with autism spectrum disorder, symptoms of attention deficit hyperactivity disorder, or typical development. *Journal of autism and developmental disorders*, 50, 4463-4476. [HTML]
 10. Cakir, J., Frye, R. E., & Walker, S. J. (2020). The lifetime social cost of autism: 1990–2029. *Research in Autism Spectrum Disorders*. Retrieved from <https://www.sciencedirect.com/science/article/pii/S1750946719301904>
 11. Cañete Yaque, R. & Peralta-Álvarez, M. E.

- (14). ASDesign: A User-Centered Method for the Design of Assistive Technology That Helps Children with Autism Spectrum Disorders Be More Independent in Their Daily Sustainability. us.es
12. Clarke, E., Hull, L., Loomes, R., McCormick, C. E., Sheinkopf, S. J., & Mandy, W. (2021). Assessing gender differences in autism spectrum disorder using the Gendered Autism Behavioral Scale (GABS): An exploratory study. *Research in Autism Spectrum Disorders*, 88, 101844. escholarship.org
 13. Conti, E., Chericoni, N., Costanzo, V., Lasala, R., Mancini, A., Prosperi, M., ... & Apicella, F. (2020). Moving toward telehealth surveillance services for toddlers at risk for autism during the COVID-19 pandemic. *Frontiers in Psychiatry*, 11, 565999. frontiersin.org
 14. Čujdiková, M., & Vankuš, P. (2021, September). Development of Mathematical Thinking through Playing Video Games. In *Proceedings of the 15th European Conference on Game-Based Learning* (pp. 160-169). [\[HTML\]](#)
 15. de Carvalho, A. P., Braz, C. S., dos Santos, S. M., Ferreira, R. A., & Prates, R. O. (2023). Serious games for children with autism spectrum disorder: A systematic literature review. *International Journal of Human-Computer Interaction*, 1-28. [\[HTML\]](#)
 16. Deng, L. & Rattadilok, P. (2022). A sensor and machine learning-based sensory management recommendation system for children with autism spectrum disorders. *Sensors*. mdpi.com
 17. Donovan, A. M. & Alibali, M. W. (2021). Toys or math tools: Do children's views of manipulatives affect their learning?. *Journal of cognition and development*. researchgate.net
 18. Elbeltagi, R., Al-Beltagi, M., Saeed, N. K., & Alhawamdeh, R. (2023). Play therapy in children with autism: Its role, implications, and limitations. *World Journal of Clinical Pediatrics*, 12(1), 1. [from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9850869/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9850869/)
 19. F. Livingstone, T. Mason, and S. McNabb, "The relationship between autism and challenging behaviour when expressed by 33 young people," *J. Applied Research in Intellectual Disabilities*, vol. 11, no. 4, pp. 342-346, 1998.
 20. Ghanouni, P., & Jarus, T. (2021). Social Interaction Among Individuals with Autism Spectrum Disorder: Relations with Repetitive and Restricted Behaviors and Interests. *Repetitive and Restricted Behaviors and Interests in Autism Spectrum Disorders: From Neurobiology to Behavior*, 159-173. [\[HTML\]](#)
 21. Hassan, A., Pinkwart, N., & Shafi, M. (2021). Serious games to improve social and emotional intelligence in children with autism. *Entertainment computing*. [\[HTML\]](#)
 22. Hassani, F., Shahrbanian, S., Shahidi, S. H., & Sheikh, M. (2022). Playing games can improve physical performance in children with autism. *International Journal of Developmental Disabilities*, 68(2), 219-226. tandfonline.com
 23. Ibrahim, E. N. M., Jamali, N., & Suhaimi, A. I. H. (2021). Exploring gamification design elements for mental health support. *International Journal of Advanced Technology and Engineering Exploration*, 8(74), 114. [\[HTML\]](#)
 24. K. Dillenburger and L. M. McKerr, "How long does it take to provide early intensive behavioral intervention for autism? Evidence from a nationwide Canadian autism treatment centre sample," *Behavioral Interventions*, vol. 27, no. 1, pp. 51-60, 2012.
 25. Kilmer, M. & Boykin, A. A. (2022). Analysis of the 2000 to 2018 autism and developmental disabilities monitoring network surveillance reports: Implications for primary care clinicians. *Journal of Pediatric Nursing*. Retrieved [from https://www.sciencedirect.com/science/article/pii/S088259632200104X](https://www.sciencedirect.com/science/article/pii/S088259632200104X)
 26. Lee, J. & Wood, E. (2021). Examining parent-child spatial play interaction using traditional toys and touch screen tablets. *Parenting*. [\[HTML\]](#)
 27. Lin, S. Y., Chien, S. Y., Hsiao, C. L., Hsia, C. H., & Chao, K. M. (2020). Enhancing computational thinking capability of preschool children by game-based smart toys. *Electronic Commerce Research and Applications*, 44, 101011. coventry.ac.uk
 28. Magkafa, D. (2022). Exploring the design, development and evaluation of an app for autistic children in a museum setting. worktribe.com
 29. Manjula, R. B. (2024). ECHO: Empowering Children's Healthcare with Humanoid Empathy. *Asian Journal For Convergence In Technology (AJCT)* ISSN-2350-1146, 10(1), 39-44. asiansr.org
 30. Marjorie H. Charlop (2001) A Comparison of Video Modeling with In Vivo Modeling for Teaching Children with Autism, *Journal of Autism and Developmental Disorders* 30(6):537-52, DOI:10.1023/A:1005635326276
 31. Mohd Nordin, A., Ismail, J., & Kamal Nor, N. (2021). Motor development in children with

- autism spectrum disorder. *Frontiers in pediatrics*. From <https://www.frontiersin.org/journals/pediatrics/articles/10.3389/fped.2021.598276/pdf>
- Moustaffa, A. W., Abdel Salam, A. S. M., & Ahmed, M. S. (2023). Using gamification tools in creating design techniques for building products for autism children. *International Design Journal*, 13(6), 521-542. from https://journals.ekb.eg/article_320742_55758ff6eaed5681dc7399f306a5f9cf.pdf
32. Mubin, S. A., Poh, M. W. A., Rohizan, R., Abidin, A. Z. Z., & Wei, W. C. (2021, December). A gamification design framework for supporting Asd children social skills. In 2021 14th International Conference on Developments in eSystems Engineering (DeSE) (pp. 114-117). IEEE. [researchgate.net](https://www.researchgate.net)
 33. Nasir Bhuiyan, K. (2022). Investigation of the ways in which non-speaking children on the autism spectrum play and communicate with each other when playing with toys or iPads in from [ed.ac.uk](https://www.ed.ac.uk)
 34. National Center for Health Statistics. The Health, United States, Chartbook, United States, 2018. Hyattsville, MD. 2019. U.S. Department of Health and Human Services.
 35. Neuvonen, A., Salo, K., & Mikkonen, T. (2021). Towards Participatory Design of City Soundscapes. In *Advances in Information and Communication: Proceedings of the 2021 Future of Information and Communication Conference (FICC)*, Volume 1 (pp. 497-512). Springer International Publishing. from https://www.theseus.fi/bitstream/handle/10024/726243/Towards_Participatory_Design_of_City_Soundscapes.pdf?sequence=1
 36. Oliveira, W., Pastushenko, O., Rodrigues, L., Toda, A. M., Palomino, P. T., Hamari, J., & Isotani, S. (2021). Does gamification affect flow experience? a systematic literature review. arXiv preprint arXiv:2106.09942. from <https://arxiv.org/pdf/2106.09942>
 37. Özerk, K., Özerk, G., & Silveira-Zaldivar, T. (2021). Developing social skills and social competence in children with autism. *International Electronic Journal of Elementary Education*, 13(3), 341-363. from <https://www.duo.uio.no/bitstream/handle/10852/88813/SOCIAL%2BSKILLS%2BAND%2BCHILDREN%2BWITH%2BASD.pdf?sequence=2>
 38. Pfeiffer, A., Bezzina, S., König, N., & Kriglstein, S. (2020). Beyond classical gamification: in-and around-game gamification for education. from [um.edu.mt](https://www.um.edu.mt)
 39. Ribeiro Silva, L., Maciel Toda, A., Chalco Chalco, G., Chamel Elias, N., Ibert Bittencourt, I., & Isotani, S. (2024). Effects of a collaborative gamification on learning and engagement of children with Autism. *Universal Access in the Information Society*, 1-22. from [researchsquare.com](https://www.researchsquare.com)
 40. Rosello, R., et al. (2022). Cognitive, social, and behavioral manifestations of the co-occurrence of autism spectrum disorder and attention-deficit/hyperactivity disorder: A systematic review. *Autism*, 26(4), 743-760. from <https://doi.org/10.1177/13623613211065545>
 41. Rum, Y., Genzer, S., Markovitch, N., Jenkins, J., Perry, A., & Knafo-Noam, A. (2022). Are there positive effects of having a sibling with special needs? Empathy and prosociality of twins of children with non-typical development. *Child Development*, 93(4), 1121-1128. [HTML]
 42. S. Lai, S. Lombardo, and B. Baron-Cohen, "Autism," *Lancet*, vol. 383, no. 9920, pp. 896-910, 2014.
 43. Saleem, A. N., Noori, N. M., & Ozdamli, F. (2021). Gamification applications in E-learning: A literature review. *Technology*. from <https://omeka.urbeuniversity.edu/files/original/2d7df89cef8b9604f6301e839ef0c33f69f84f7a.pdf>
 44. Silva, G. M., Souto, J. J. D. S., Fernandes, T. P., Bolis, I., & Santos, N. A. (2021). Interventions with serious games and entertainment games in autism spectrum disorder: a systematic review. *Developmental neuropsychology*, 46(7), 463-485. from <https://www.tandfonline.com/doi/abs/10.1080/087565641.2021.1981905>
 45. Simões-Silva, V., Marques, A., Pinho, C., Pereira, D. G., Oliveira, J. F., & Barros, M. L. (2022). Gamification applied to autism spectrum disorder. In *Digital Therapies in Psychosocial Rehabilitation and Mental Health* (pp. 163-186). IGI Global. from [ipp.pt](https://www.igi-global.com)
 46. Stojanovik, V., Pagnamenta, E., Seager, E., Breen, M., Jennings, S., Joffe, V., ... & Perry, H. (2022). The ASCEND study: protocol for a feasibility study to evaluate an early social communication intervention for young children with Down syndrome. *Pilot and feasibility studies*, 8(1), 8. from [springer.com](https://www.springer.com)
 47. The National Institute for Health and Clinical Excellence (NICE). National clinical guideline number 170, *Autism in under 19s: Recognition, Referral and Diagnosis*, London, 2013.
 48. Thomas, K. D. L. S. (2023). Curriculum-Makers as Let's Players: A Narrative Self-

- Study of an Educator's Curriculum-Making During the COVID-19 Pandemic. from <https://search.proquest.com/openview/714a01db138ddf8cb500abed9c8d857b/1?pq-origsite=gscholar&cbl=18750&diss=y>
49. Wang, Y. (2021). Toy Design for Children with Autism Spectrum Disorder Based on Existing Therapeutic Training Methods. from <https://repository.rit.edu/cgi/viewcontent.cgi?article=12123&context=theses>
50. Wedyan, M., Al-Jumaily, A., & Dorgham, O. (2020). The use of augmented reality in the diagnosis and treatment of autistic children: A review and a new system. *Multimedia Tools and Applications*. from <https://www.academia.edu/download/101257320/s11042-020-08647-620230419-1-7abbeu.pdf>
51. Williams, A. J., Freed, M., Theofanopoulou, N., Daudén Roquet, C., Klasnja, P., Gross, J., ... & Slovak, P. (2023). Feasibility, perceived impact, and acceptability of a socially assistive robot to support emotion regulation with highly anxious university students: mixed methods open trial. *JMIR Mental Health*, 10, e46826. Retrieved from <https://mental.jmir.org/2023/1/e46826>
52. Yanuarini, S. (2024). Designing Learning Activities for Improving Social and Imitation Skills for Children with Autism Spectrum Disorder Using a Humanoid Robot. Retrieved from http://essay.utwente.nl/98587/1/Yanuarini_MA_BMS.pdf
53. Zhang, M., Ding, H., Naumceska, M., & Zhang, Y. (2022). Virtual reality technology as an educational and intervention tool for children with autism spectrum disorder: current perspectives and future directions. *Behavioral Sciences*. [mdpi.com](https://www.mdpi.com)