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PAPER

Digital Gaming and Autism Spectrum Disorder

Irene Chaidi[1,2](✉), **Athanasios Drigas**[1]

[1]Institute of Informatics and Telecommunications, N.C.S.R. 'Demokritos', Athens, Greece

[2]Department of Special Education, University of Thessaly, Volos, Greece

irhaidi@gmail.com

ABSTRACT

The use of digital games in the educational process promotes interactivity and de-escalation of tensions, promotes active educational models, and offers new possibilities for communication, collaboration, and learning, giving the possibility of introducing the student with autism in a controlled environment that is predictable and without social stimuli to manage the concerned person's attention and concentration in an activity. This paper aims to present the findings for the use of educational digital games in the field of special education and specifically in the education of people with autism spectrum disorder (ASD).

KEYWORDS

digital learning, digital games, autism

1 INTRODUCTION

In recent years, worldwide and also in our country, the opinion has been established that the modern school aims to form complete people, to cultivate and develop their abilities so that they are led to their completion, contributing to society, and so that all students, regardless of any element of differentiation, special need, or characteristic related to national, cultural, or social identity, must have equal learning opportunities within a school open to all. [1] for equality in access to education, including differentiation—an adaptation of the education system.

In today's era, communication and information technology open a new way for learning based on personal discovery and experience and offer interesting and completely new perspectives. For students with special educational needs, the use of the PC contributes significantly to the learning process by providing rich educational experiences.

The incorporation of digital technologies in the education domain is very productive, successful, facilitates and improves educational procedures via mobiles [6–15], various information and computer technology (ICT) applications [16–47], artificial intelligence (AI) and science, technology, engineering and mathematics (STEM) [48–58], and games [59–64]. Additionally, the combination of ICTs with theories and models of metacognition, mindfulness, meditation, and emotional intelligence

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cultivation [65–87] as well as with environmental factors and nutrition [2–5], accelerates and improves the educational practices and results.

The game has been an important psycho-emotional and social need of every child since ancient times. Gaming activities on the computer constitute a realm for seeking and constructing an engaging learning environment. In addition to the pedagogical benefits of games, this environment offers a diverse array of authentic 'connective elements of learning' within virtual spaces of action, cognitive exploration, and problem-solving. It also provides the necessary tools and information to address these challenges [88].

Autistic children show atypical play behaviors, tend to prefer independent play, are often repetitive, show less imitation, and lack joint action and social interaction. Play behaviors allow the child to engage with emerging cognitive skills. [89] observes that children learn concepts such as false beliefs and more structured board games teach reciprocity and strategy, while a competitive or cooperative game offers practice and development of a range of skills, including communication, perspective-taking, emotional regulation, emotional recognition, and athleticism. Games also offer children the opportunity to engage in joint attention and joint action with other social actors, as players will imitate the play behaviors of other partners to facilitate joint engagement [90] and increase the process of developing joint attention through interactions [91].

2 AUTISM SPECTRUM DISORDER

Autism is one of the major developmental disorders on the autism spectrum and a lifelong developmental disorder—a disability that prevents individuals from properly understanding what they see, hear, and generally feel. This results in them facing serious problems in their social relationships, communication, and behavior.

Autism spectrum disorder is a serious, widespread developmental disorder that accompanies the person throughout his life, affecting his perception, thinking, and behavior. It is characterized by (a) significant difficulties in the development of the person's social-emotional and communication skills with his social environment and (b) limited, repetitive stereotyped interests and behaviors [92], [93]. According to [94], [95], [96], a person is diagnosed with ASD when behaviors listed in the above diagnostic manuals and the revised DSM-V are presented, defined by two groups of criteria: a) social communication and b) stereotyped, repetitive behaviors, activities, and interests.

It is a congenital brain disorder that affects the way the brain uses information; there is no cure, and it manifests itself during the first 2 years of a child's life. Every child with autism is different. The main primary disorders he presents are excessive isolation, an inability to establish social contacts, a peculiarity in communication, and a need for the immutability of the environment in which he lives. Autism can exist alone or in combination with other developmental disorders such as mental retardation, learning disabilities, epilepsy, deafness, blindness, etc.

The severity of the features of autism varies from person to person, but usually includes the following: a) severe retardation in language development and communication, and language expression takes a stereotyped, repetitive, idiosyncratic form with echolalia and a typical and monotonous voice; b) a serious delay in understanding social relationships, as the autistic child usually does not have eye contact with those around him and does not seem to want to play with his peers;

c) subsequent forms of sensory reactions, since he may give the impression that he is deaf and cannot react to sounds and at other times become overly disturbed by an everyday sound. It can also present insensitivity to pain and a lack of response to cold or heat; d) present heterogeneous forms of intellectual functions, as an autistic person may have islands of abilities in some specific areas that may concern music, painting, complex mathematical calculations or the memorization of important or unimportant events; and finally e) there appear to be obvious limitations to activities and interests, and they usually exhibit mannerisms such as clapping, spinning, or body shaking [97].

The educational approaches of students with autism should respond to their particular cognitive needs, which vary according to their developmental level and age, to make the most of their abilities and personal interests and to focus on forming thinking students who can solve problems rather than acquiring piecemeal knowledge or functional skills [98], [99].

In particular, students with autism need a structured learning environment, a fixed daily schedule, one-to-one teaching, alternative teaching methods (visualized teaching materials), and enriched educational activities focusing on their preferences and interests [1], [100], [101].

3 AUTISM AND GAME

3.1 The role of the game

Play is inextricably linked to childhood and children's education, as it is the dominant activity of young children that helps the development of the child [102] "play is not just a spontaneous activity and occupation of the child but plays a central role in the developmental course of the child, as it contributes to the cognitive, linguistic, emotional, motor, social development of children, to the development of reading and writing, to visual expression and learning."

Vygotsky states that play precedes development, play with development [103], arguing that the child, through play, projects himself into the activities of adults within the specific context in which he lives, and the child acquires skills, motivations, and attitudes necessary for his social adaptation and participation. Piaget argues that play is necessary for the development of thought and language, and contributes to the transmission of culture, and considers play to be the means of developing a child's social and cognitive development, i.e., play is "a function of life."

According to [104], [105], [106] the game:

- is pleasant, fun, safe
- has no external goals, its motivations are internal and do not serve other purposes
- is spontaneous and voluntary
- involves the active participation of the player
- is "absorbing," so when a child is playing, it is difficult to be distracted from something else
- is the personal, private reality of the child, because in the game the child represents his reality at that particular moment
- is non-literal, it allows children to escape its limitations and experiment
- is controlled by the player
- emphasizes the process rather than the outcome

3.2 The characteristics of play in children with autism

The game is apart from every child's need for entertainment and personal satisfaction and is an excellent tool for education and personality development. The behavior of students with autism in play activities has particular forms and is related to their particular abilities, since a student with autism may use some games for sensory pleasure or engage repetitively with a game. The biggest difficulty is often the lack of motivation and interest, whether for solitary or parallel play or symbolic play.

The characteristics of people with autism about play highlight the educational need for the inclusion of play in the individual educational program of each student.

The forms of play described in the Analytical Curriculum are: a) functional play, where the student develops motor activities and becomes familiar with the actual use of objects; b) constructive play, where the student creates constructions based on a standard design; c) symbolic or pretend play, where he uses objects to attribute individual properties and behaviors to them or learns to play roles; and d) rule-based play, where the student engages in rule-based games.

For children with autism [107], the suggested levels of play instruction are the following: 1) solitary play, where the child plays alone and the teacher's role is to show the student how to use the materials in a symbolic way; 2) parallel play, where the child plays alone but is close to another child using the same materials and toys and may make eye contact or imitate the other's actions; 3) companion play, where children play together, share the same toys, and are connected by activity rather than interaction; and d) cooperative play, where children play the same game with a common goal, where children's cooperation is essential and each has a specific role in the game.

It is important to emphasize that this series of play stages is evolutionary and considered appropriate for students with autism, as the criterion for moving from one stage to the next is the acceptance of the degree of social interaction of the students.

Children with autism, however, do not manage to develop organized symbolic and social-dramatic play until the age of four (Table 1).

Table 1. Developmental stages of play in a typical development of children and those with autism [108]

Chronological Age of Children	Children of Typical Development	Children with Autism
1st year	They start playing on their initiative	---------
18 months	Development of symbolic acts (e.g., pretend to drink, that they talk on the phone)	Very limited game
24 months	Applying pretend play routines to dolls (e.g., feed the doll)	Little curiosity to explore the environment, unusually use games, e.g., twisting them or aligning them
36 months	Game with peers	They are unable to accept other children. They still put the toys in their mouths The symbolic game is completely absent.
48 months	Development of organized symbolic play and social-dramatic play involving other children. They mainly prefer playing with peers rather than with adults.	Functional use of games. Few actions are directed toward the dolls and towards others. Symbolic play, if any, is limited to simple recurring themes. The socio-dramatic play is absent.

Children with autism face difficulties in social interaction, communication, and symbolic thinking, and these are evident from the first year of life as children show severe difficulties in spontaneous socially acceptable play, participation in dyadic play, and group play games. Children with autism usually play alone, avoid playing with other people, and repeat the same form of play in a rigid and stereotyped way with excessive attachment to a very limited number of toys [109].

Children with autism do not develop symbolic play or develop symbolic play to a limited extent by showing an interest in the appearance of objects and their sensory characteristics, in simple handling, and not in their cultural or symbolic meaning, although researchers support ASD. Children with autism have developed the ability to explore and functionally use objects, but they show difficulties in mastering spontaneous and symbolic play during preschool and school age, with the thematic content of their play showing a lack of coherence and creativity and ritualistic repetition [110]. As a result, they find it difficult to join the group of their peers since they have not developed the skills required and cannot participate as equal teammates [111], [112].

Regarding the development of speech, bonding, and focus of attention through play, researchers argue that in children with autism with developed understanding and expression of speech and children with secure attachment, functional and symbolic play occur more often and at a higher level, and that the use of joint attention is associated with the presence of symbolic play in children with ASD [113].

In contrast to children with ASD, children of typical development begin to play on their initiative from the first year of their lives, and by the age of four they develop organized symbolic and social-dramatic play with their peers. Children with autism fail to develop organized symbolic and socio-dramatic play by the age of four.

The essential goal is for the child with autism to learn to tolerate and enjoy a human presence in a play environment. Acquiring play skills is a goal implemented at the first level of instruction, but extending them to a small social group is a didactic necessity.

4 ASD AND DIGITAL LEARNING

4.1 ASD and technologies

The need to teach the knowledge and skills to use the computer as a means of education and entertainment to children with special needs is recognized, as it offers the possibility of introducing the student with autism into a controlled environment that is predictable, and does not contain social stimuli, and helps the student maintain their attention and concentration on an activity. It can also provide the ablest students with autism with channels of 'safer' written communication with other people who are far away since "any person with autism, whether child or adult, can feel comfortable with computers and can develop a good relationship with someone else working on the computer with him" [114].

In particular, computers are considered a suitable medium for teaching people with autism [114] because:

- it limits sensory stimuli
- it is predictable and "law-abiding" "behavior" and are therefore controllable devices
- it do not penalize wrong answers
- it is an educational tool that can be further improved
- it enable non-verbal or verbal expression

To teach how to use the computer, the teacher must, as much as possible, use material with a realistic character, choose activities that are first implemented in the classroom and then appear on the computer screen, and help the student understand that the computer screen and its content are about depicting the real world and not something unreal with the help of visual instructions so that the student consults when needed. The teacher does not have to design the activities every time so that they arouse the student's interest and help him generalize his acquired knowledge.

It is worth emphasizing that the teacher should ensure that the use of the computer does not become an obsession, providing instructions for clear time limits and rotation of use by other students, as well as using the computer as a means of rewarding the desired behavior of the children with autism.

For the education of the student with autism, adjustments may be made to the computers that will be used. Even if these children usually do not have serious motor problems, possibly some adjustments may be required: a) reduction of the sound, b) reduction of the elements of the screen, c) touch screen, d) larger-than-usual "mice", e) external large switches, and f) settings in the computer's operating system [100].

In summary, computer literacy is considered an important area of education for individuals with autism that can be utilized as a recreational activity or a pre-professional skill.

International literature supports the view that computer-assisted education leads to the motivation of children with autism, the reduction of behavioral problems, and more effective learning [81], [115], [116], [117], [118], [119], [120], [121].

4.2 Digital game

Gaming is a dominant component of human existence, and we all play games according to our interests, influences, and abilities, but also the era we live in as our gaming evolves and adapts to the realities of each era.

In our time, in addition to traditional or analog games, digital games such as World of Warcraft, Second Life, and many others show great growth in "playability."

A new virtual world gives pleasure and enjoyment to children who use a different language and experience a new digital narrative [122], mainly through role-playing and adventure games, receive information quickly and easily through video, image, text, and interaction, and socialize through the Internet, mobile phones, and electronic games and learn in a fun and interactive way, developing their imagination and practicing creative and critical thinking in contrast to education, which they find dull and show little attention and interest in. Online games support active learning by turning the student from a passive observer to an active participant.

The development and proliferation of digital games progressed swiftly, mirroring advancements in computer hardware and software [123]. These games are categorized in two main ways: firstly, by the mode of play, such as games played on a TV screen with a dedicated console, on a computer using CD-ROM software, or on a computer using internet software. Secondly, they can be classified based on content into action games, adventure games, strategy games, role-playing games, thinking/puzzle games, and simulation games, as outlined by [124]. Moreover, [125] further categorizes games based on the player's mode of participation into simulation, strategy, action, and role-playing.

[126] the digital game designer and academic, defines a game as "a rule-based activity in which one participates for some outcome (benefit)." The digital realm, on the other hand, is characterized by a plethora of well-structured and dramatic

elements that give it substance. Its main elements are: a) player participation, b) the pursuit of a goal, c) the procedures, which entail the instructions of the game, d) the rules governing the permitted or prohibited movements and procedures e) the resources, f) the conflict—the obstacles that appear during the game, resulting in a conflict between the player and the game, g) the boundaries, which create a space with special rules, different from the rules of the real world, thus allowing the players to separate the imaginary world of the game from the real one, and h) the result, which is characterized by uncertainty, a key component of the entertainment value of the game, and depends on the player's skills and the luck factor.

In addition, digital games need a story in which to develop and from which the role that the player will assume, as well as the dramatic elements that give meaning to the conflict and are necessary to connect the player to the game and the characters, into the fantasy world of the digital game. These are: a) the challenge, which is realized through conflicts and leads the player to engage with the game; b) the feeling of "playing"; c) the theme, which facilitates the immersion of the player in the game world and gives meaning in his choices; d) the protagonist, a character that allows the player to experience his anxieties and can increase the immersion of the player in the fictional world of the game; and e) the story, the scenario, that emotionally involves the player and increases his immersion in the virtual world.

4.3 Pedagogical use of the digital game

Educational games are a pedagogical "tool" that enhances active participation and facilitates interaction between students. They are a technological tool that can be used in education. Also, educational games are a source of motivation for students; they enable them to test knowledge and consolidate new concepts while having fun [127], and especially educational electronic games [128], as they argue that they are environments that support basic principles that favor learning, such as active engagement, social participation, constructive activities, developing a strategy for understanding and solving problems, self-control, and reconstruction of pre-existing knowledge. They are environments that have the potential to support all of the above key learning principles while motivating students to engage with them, offering them an enjoyable virtual world in which to interact either individually or collaboratively with their other students, apply them, and learn things that they do not know.

[129] states that in an attempt to determine whether a game can be educational, based on Žižek's Internet objectivity theory, [130] believes that games can become educational if they are related to social interests. Educational games delight and entertain students who learn by playing [131], while they have the potential to cultivate cognitive skills such as information retrieval, prioritization, and critical thinking.

Games can be categorized by various criteria. According to [132], it can be categorized into action games, strategy, sports, adventure, simulation, role-playing, and chance. [131] argues that an important role in the design of educational electronic games is played by the ability to connect the learning object with learning techniques and the types of games that can serve this purpose, a point of view supported by [133], who consider that for the design and implementation of the educational software to satisfy its goals, it must decide on the pedagogical approach, defining the actions in an environment model, working out the details, embedding the pedagogical method in the game–support linking learning actions to interface actions, and associating learning concepts with its interface objects game.

[134] considers that there are two spaces within which the learning process takes place: the formal learning environment (school, university, seminars, and exercises) and the informal learning environment (home, company, free time, entertainment). [135], [136] believe that games are effectively applied in an informal learning environment, are non-strictly-supervised, allow mistakes, have available time, arouse the interest of the user, and the teaching method matches modern learning theories (social-cultural, discovery, and experimental), and can be part of the overall educational process.

Students who do not actively participate in traditional teaching find it easier to express their questions. Average students question, investigate, and try to understand and clarify concepts in depth to be able to answer game questions. Conversely, some entirely disinterested students remain unstimulated by this activity.

[137] emphasizes that learners are asked to evaluate the learning environment based on the characteristics of the game (scenario imagination, curiosity about how the computer will react to the learner's actions, challenge through graded difficulty), the computer, the nature of the learning object, a form of education, and the educational environment. That's why educational games are designed to be attractive in terms of design, cross-surface use, and scenario.

[138] believe that the educational game can be adapted to any level of formal learning: memorization (practice and presentation games), understanding (role-playing, action, adventure games), combining knowledge, realizing their value, applying them at the level of predictions, making judgments, exploiting opportunities, calculating risk, being able to predict (strategy games), and being used as a learning tool both in standard general school classes and in special education classes.

4.4 Serious games

Serious games are a category of digital gaming that has seen a lot of growth in recent years. There are various definitions of serious games, such as "a serious game is defined as an intellectual competition, played with a computer according to specific rules, that uses entertainment to promote governmental or corporate goals, education, health, public policy, and strategic communication objectives" [139]. "Serious games" are defined as digital games and equipment with an educational design agenda and beyond entertainment [140].

Serious games, like simple digital games, combine art, storytelling, and programming [139], but they differ in that they contain pedagogical activities intended to educate, impart knowledge, and support the development of different skills, using entertaining principles, creativity, and technology in setting up the game to fulfill specific purposes such as problem-solving, which is the core purpose of serious game design. [141] identified that the ability to provide feedback directly to students about their performance is important and should be provided according to the needs of students, and this is an advantage of using serious games for education as there is immediate and timely feedback [142].

Research [143] performed a systematic review with selected articles from 2002 and 2011 that addressed the use of digital serious games for people with ASD. In research, the term serious games, in research, is limited to digital games aimed at developing skills or knowledge other than pure entertainment, as the term "serious" is used to refer to "products" used in: education, defense, health care, scientific exploration, religion, engineering, and politics.

The research led to the following classification of games serious games about autism: online computer game, virtual reality, mobile devices, touch screen computer and tabletop and interaction games. (Table 2).

Table 2. Autism games technologies classification [143]

Technologies Classification	Author/Year
Computer	Arshia et al., 2011
	Emily Barakova et al. 2007
	Samantha et al. 2009
	Anika Anwar et al. 2011
	Maite Frutos et al. 2011
	Mohammed E. Hoque et al. 2009
	Min Young Choi et al. 2010
	Md. Mustafizur Rahman et al. 2010 Md. Mustafizur Rahman et al., 2011
Mobile devices	Zelai et al. 2011
Touch Screen Computer and Table Top	Alberto Battocchi et al. 2009
	Megan Davis et al. 2007
Interaction	Qiang Wang et al. 2010

According to [143], serious games can be enjoyable and entertaining. However, their primary purpose is to educate, explore, or advertise. Every once in a while a game will purposely sacrifice fun and enjoyment to facilitate the player's desired progression.

Serious games can be classified into several types such as:

- Edutainment: Combining education and entertainment
- Game-based learning or "Game Learning": The learning and training games
- Simulation games: Games used to acquire or practice different skills, to teach effective behavior in the context of simulated conditions or situations
- Health games: such as games for psychological therapy, games for cognitive training or physical rehabilitation uses.
- Exergaming: Games used as a form of exercise
- Art games: Games used to express artistic ideas or art are produced through video games
- Productivity games: Games that reward points for completing real-world tasks using to-do lists.
- Gamification: Use of game design techniques and engineering to solve problems and engage audiences [144]
- Advergames: The use of games for advertising

The genre of video games is categorized by gameplay, in contrast to serious games that are categorized by purpose and include simulation games, educational games, advergames, political games, or evangelical games [145]. Finally, [146] tried to classify serious games into five main categories: advergaming, edutainment, edumarket games, diversion games, and simulation games [147].

4.5 Serious games for ASD

Until now, the serious games for autism have been developed for two purposes: first, therapy, and secondarily, education, learning, and training. Autism's serious game purpose is shown in Table 3.

Table 3. Purpose of serious games [143]

Purpose		Author/Year Education
Education	(Concept of money)	Arshia et al. 2011
	(Social skills)	Emilia Barakova et al. 2007
		Samantha et al. 2009
	(Communication skills)	Anika Anwar et al. 2011
		Maite Frutos et al. 2011
	(First aid learning)	Zelia et al. 2011
	(narrative)	Megan Davis et al., 2007
Therapy	(Communication skills)	Mohammed E. Hoque et al. 2009
		Md. Mustafizur Rahman et al. 2010
		Md. Mustafizur Rahman et al. 2011
	(Visual motor coordination, social skills, sensory integration)	Min Young Choi et al. 2010
	(Electroencephalogram (EEG) game)	Qiang Wang et al. 2010
	(Social behaviors)	Alberto Battocchi et al. 2009

The purpose of serious games is presented in Table 2. Based on their purpose, they are categorized into two major categories: a) Serious games for education are designed to help the teacher or student during the teaching and/or learning process understand money, develop social and communication skills, learn first aid, and learn storytelling. b) Therapeutic games aim at the development of visual motor coordination, social skills, sensory integration, electroencephalogram (EEG) games, and social behaviors.

Between January 2001 and April 2014, [148] carried out a search for serious games. It was limited to 31 articles. The games were designed to improve social skills. Sixteen of these games targeted facial emotion recognition or production. They argued that "though social skills required in real-life involve rich combinations of perspective-taking, emotional regulation, cognitive flexibility, appropriate use of language and so on, the literature search conducted here emphasized that a significant part of the effort devoted that serious game design has been focusing on the basics ability of emotion recognition, which sustains those more complex forms of social competencies" [81].

5 CONCLUSIONS

The game, whether analog or digital, is part of every child's need for entertainment and personal satisfaction and an excellent tool for education and personality development. The behavior of students with autism in play activities has particular

forms and is related to their particular abilities, since a student with autism may use some games for sensory pleasure or engage repetitively with a game. The characteristics of people with autism concerning play highlight the educational need to include play in the individual educational program of each student.

Digital games help to master the developmental series of game stages as they enable the student to play and have fun at the same time without the stress of achieving the goal. Digital games lead the student to the discovery of knowledge, as they teach him how to learn through the visualization and simulation of the real world; that is, they help the student through the virtual world to make generalizations and understand the real one.

The essential goal is for the child with autism to learn to tolerate and enjoy a human presence in a play environment. Acquiring play skills is a goal implemented at the first level of instruction, but extending them to a small social group is a teaching necessity.

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7 AUTHORS

Irene Chaidi is currently working as a special education teacher in Athens, Greece. She is a Ph.D. Candidate in University of Thessaly, Department of Special Education, Volos, Greece and N.C.S.R. 'Demokritos,' Institute of Informatics and Telecommunications, Net Media Lab, and Mind-Brain R & D, Agia Paraskevi, 153 10, Athens, Greece (E-mail: irhaidi@gmail.com).

Athanasios Drigas is with N.C.S.R. 'Demokritos,' Institute of Informatics and Telecommunications, Net Media Lab, and Mind-Brain R & D, Agia Paraskevi, 153 10, Athens, Greece (E-mail: dr@iit.demokritos.gr).