University of Sindh Journal of Information and Communication Technology (USJICT)
Volume 3, Issue 3, July 2019
ISSN-E: 2523-1235, ISSN-P: 2521-5582
Website: http://sujo.usindh.edu.pk/index.php/USJICT/

Serious Games for children with Autism Spectrum Disorder(ASD): A Comparative Study

Sabila Kousar, Nadeem Qaiser Mehmood, Sohail Ahmed

[1]Department of Computer Science& IT, University of Lahore Gujrat Campus
ch.sam37@gmail.com , nadeem.mehmood@cs.uol.edu.pk ,sohail.ahmed@cs.uol.edu.pk

Abstract: *Autism spectrum disorder (ASD) is one of the major mental disorders in the brain's neurological development. It has been shown by studies that use interventions based computer, using serious games usually, skills numerous developments, allowing children with disabilities to learn that teachers. In this article, we compared various serious games designed for children with autism spectrum disorders (ASD). These games are compared in context of different categories. The article provided a comparative study of serious games related to autism (Fillmeapp, FindMe, Taponme, Minecraft, Portal2, Drawing something2, Go Go, sunny day, collaborative learning app) etc. This comparative study shows the positive side of such games in autism cares and motivates to continue development of serious games. Currently, autism is the means to teach autistic children who are able to create integrated information and communication technologies. Technologies are the important and valuable part of autism learning techniques. We discussed the detailed comparison of different games that is useful for children as well as in the academic field. In the end, we concluded that these games are not only for entertainment purposes, they also help autism children to improve learning ability and social interactions.*

Keywords: *Autism, Serious games for Autism (SG), Autism Spectrum Disorder (ASD), gamification, Social skills;*

I. INTRODUCTION

All Autism Spectrum Disorder (ASD) is defined as a serious undeveloped disorder which delays the acquisition of many basic skills, including social ability and communication, as well as the ability to speak. Children with an ASD process are different and, therefore, they learn differently. The design of the programs was a challenge for these teachers. Ethnic people have an inadequate choice of interests and struggle to establish emotional contact with their parents [1].

These children have problems with social interaction, verbal and non-verbal communication, and repetitive behavior" (Schoenstadt, 2013) [19]. The disorder has three major difficulties, like their condition has a very different effect. The difficulties are: Difficulties in social relationships, social interaction and social imagination. Today, there are applications that help or help children with Autistic Spectrum Disorder (ASD) to develop social and emotional skills [4].

Table1 presents the 5 major types of autism and their characteristics.

TABLE 1. TYPES OF AUTISM

Type	Characteristics
Autistic disorder [2]	A marked and unusual development of social interactions and repositories of activities and at least limited amounts, often observed in the early years of life.
Asperger's syndrome[2]	Serious and permanent infringement of social interaction and the development of forms of behavior, interests and limited and repetitive activities. There is no major delay in the language procurement clinic.
Childhood Disintegrative disorder[2]	Marked back to multiple areas of operation. After normal development period of at least two years.
Pervasive developmental disorder [2]	The progressive illness is pervasive, rather than the other widespread harm to the development of equal social relations, but the standard for widespread disorder
Rett's disorder [2]	A specific and highly distinctive pattern of development regression following a period of normal functioning through the first five months after birth. Has been diagnosed only in females.

Researchers in the field of research computing are making serious games based on children with autism. For 40 years, many people have been using the season of the common game. To illustrate his point, Clark Abt gave his book "Serious Games" in 1968[32]. He has shown his work on curriculum development, school planning, industrial management, technology planning and evaluation, where he examined war games (mix for mathematical analysis of groups and communication) and simulations with coaches, students and teachers [2].

It defines such games as: They have explicit and prudent educational purposes and are not intended primarily for gambling. This does not mean that serious games are not entertaining or they should also help autism children to improve learning ability [2].

Serious game: Serious games is "games that do not have entertainment, enjoyment, or fun as their primary purpose" [2].

Typical games: Typical games are defined as an educational design program and entertainment as well. Because many

methods and definitions, the goals of this article is to reduce serious gaming digital games in order to use certain predefined skills or knowledge for the main purposes rather than pure entertainment. Different serious games are used for some purposes such as education, management, defense, healthcare, scientific exploration, religion, engineering, and politics. The paper aims is to compare serious games with autism [3].
Specific Objectives are described below:

- Compare different serious games about the development of autism.
- Review of serious game rating

A. Autism symptoms

There is no, any specific indication for autism. In general, the child will present a number of indications with following categories [4].

1.1.1 Behavior

- Has mysterious bad temper
- Has infrequent benefits or connections
- Has infrequent motor actions such as flustering hands
  Or whirling
- Has extreme trouble managing through alteration

1.1.2 Sensory

- Scared of particular sounds
- Uses central visualization to stare on objects
- Attraction with touching things
- High patience of fever and pain

1.1.3 Communication

- Not replying to his/her name by 12 months
- Not directing or flapping by 12 months
- Language absent at 18 months
- Rare verbal patterns

1.1.4 Social skills

- Looks away when you speak to him/her
- Lack of attention in other children

The description of this article is as follow: The section II presents the problems of study and section III discussed the research questions. The section IV will include a methodology for serious autism games. The section V describes related work on existing autism games. The section VI presents different classifications for different autism games. The section VII explains the comparison based on games categories and section VIII presents comparative table and finally the section IX discussed the conclusion and recommends future work for the study.

II. PROBLEM STATEMENT

Games are uncharted nowadays, so we need to explore the best games that are helpful for autism children for learning process. Many serious games are developed that claim to be prevention of autism related disorder (Autism, Asperger's syndrome, AD), but most of them don't really address autism disorder and they are just normal entertainment games [14].
Stakeholders like Doctors, Caretakers and Public are interested to know which game is just 'game for health' and which autism fighting tools are so that they can play that and suggest to patients for autism treatment.

III. RESEARCH QUESTIONS

We investigated the following research questions.

- What are the best conditions for obtaining the best results in terms of educational life / social skills in people for autism children?
- Are these serious games has affected life of children with ASD in positive way, negative or neither?
- Why children with autism spectrum disorder keep more focus and pay more attention on cartoons than real images?
- Which is the most suitable game to improve social and learning skills for children with ASD?
- Which platforms are more comfortable for children for autism spectrum disorder?

IV. METHODOLOGY

In comparative study was conducted on the usage of serious games for people living with autism. We high lightened the comparative study of autism serious games in various phases: 1) To search the games that is related to category of education and then finds the best autism-related serious games among those games 2) Study these games to find the ones that provide an article which is published and addresses issues related to autism.3) Our goal is to investigate the usefulness of these educational-based learning activities in students with moderate autistic spectrum disorders.
The following criteria were used for article:
(1) Language: English
(2) Target People: Children with ASD
(3) Games: Autism related serious games
Google search engine was used to search title of games related to intellectual training and also those games are commercially accessible. The literature search was conducted between February and April 2019.
In our methodology, we compared different serious games about autism development and review different serious games related to autism. All the documents we used for comparison are true. We searched for various types of papers and articles related to solve the problem of autism through games.

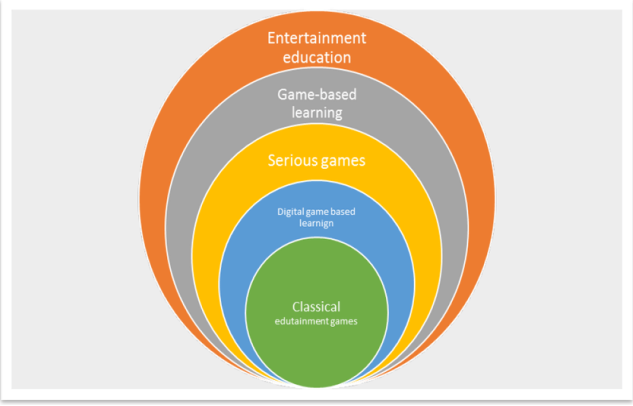

Figure 1. Serious games for autism

V. RELATED WORK

A. *Traditional educational Interventions*

Traditional therapy methods and implements for teaching children with autism include Social Stories ™, based on Personal and Relational Development (DIR) / Regulation of Social Emotional Communication, Outpatient, Transaction Support (SCERTS), Applied Behavior Analysis (ABA)), Acute Behavior Intervention (EIBI), Image exchange communication system (PECS) and Treatment and education for communication disorders associated to autism (TEACCH)[4].

The social stories ™, established by Carol Gray [5], is a tactic to train people with ASD. These are undersized levels that define and offer information about social circumstances or interfaces that can be problematic or puzzling for children. Its key determination is to deliver precise social information to mend thoughtful of events, which can lead to further real and composite responses.

DIR / Floor time intervention [6] for blood relation can help autistic children build emotional bonds and improve social and academic skills. This method shadows the responsive interests of the child and offers for distinct involvement based on strong play. The “SCERTS” is a context that participates observes of evidence-based methods [7]. It is a classic of multidisciplinary support for autistic children that improve social and emotional skills.

ABA therapy is regularly recycled as a cure in children with autism. It is a commonly familiar process to improve appropriate education, communication and social behavior. The key elements are positive reinforcement, which rewards desirable behavior and ignorance of inappropriate behavior [8].

Alternative and increasing communication (AAC), such as PECS, is regularly used to improve useful message in children with ASD. PECS is an operative communication system based on visual icons. Visual aids also refer to the growth of social skills in young children with ASD [9].

The TEACCH is a teaching strategy that is a widely recognized model, which emphasizes an organized and expectable learning environment. It used visual cues to raise individuality and to communicate autistic children with new expertise such as facial expressions. [10].

B. *Computer interventions*

Computers are ironic, unchanging, expectable and reliable training tools that deliver an appropriate and stimulating learning setting for people with autism [11]. There are countless enlightening tools because children with autism regularly feel uncomfortable with an unreliable social atmosphere and desire an exact learning environment. Unique people can learn and recover their expertise through a computerized involvement.

PCs are currently the most adjustable assistive machinery tools accessible for children with autism and a series of PC games have been established to support them and manage their weaknesses. Various games emphasis on their training in social collaboration and in particular emotional learning [12].

Serious games are intended with a main determination rather than purely playful, entertaining or playful. In the case of autism, the covered topics linked to education, communication, psychotherapy treatments and the improvement of social behavior. Serious educational games about ASD are intended to support instructors or students through the teaching procedure [13].

Emotion Trainer [2] is a hypermedia computer program designed to improve the ability of school-age students to know and forecast feelings in others. This has a optimistic impact on the feelings of manipulators, especially when used repeatedly.

The game "What to choose" is another computerized autism training game for teenagers [14]. It is software with humanoid facial expressions, cartoons, 3D images, text and sound to train people with autism to understand conversations with pragmatic subtleties. Children with autism did not consider the fundamental connection among facial expressions and the consequence of the dialogue.

“C Motion” [15] is a PC game that practices computer-generated typescripts to teach children with autism emotions and the concept of programs. The game is intended to communicate manipulators how to identify facial expressions and operate a collaborating computer-generated personality through a scripted and loose program design interface.

“Cara” is the computer intervention for face-to-face training! (LFI!). This program includes seven interactive computer games aimed at specific autism weaknesses. These games are structured in the academic grading of facial treatment areas. Next face! is a program that reflects commitment as a real involvement and alternative treatment tool. Emotion Mirror is a scheme that participates the CERT (Electronic Identification Toolbox) into the Face program. It is a computer supported interference system designed to improve the understanding and presentation of facial expressions in children with ASD. This game could be helpful for the

children with labeling and an understanding of the feelings they have already learned [16].

"LIFE is GAME" is a learning system to identify facial feelings founded on the collaboration among people and 3D avatars[17]. It is a method that practices face-to-face character synthesis in real time to teach people with autism how to identify feelings about facial expressions.
"Bernardini" [18] suggested ECHOES, a serious game for children with ASD to exercise social communication. This scheme shows a clever computer-generated character who works as a partner and tutor in many learning activities.

VI. AUTISM GAMES

There are different autism games that are given below.

A. Fill me app

"Fill Me App" is an interactive mobile gaming application that provides additional educational materials/ skills (e.g Social skill , learning and cognitive skills) to autism children who help them promote their learning. This application of the game is mainly focused on science, mainly on the identification of parts of the human body [19].

B. Untangle

This application provides a visual answer for children with ASD. This application is to promote communication, collaboration, coordination, and visual and spatial thinking in which two children worked together and used Untangle. Children with ASD and children with normal development love to play this game. Most of the time it takes time to solve the puzzle together with other children [20].

C. Photogoo

Photogoo can be done on the touch screen. It also lets you draw the image with a pencil. We understood two types of activities with this software. The first activity is to explore feelings. children who were underperforming and the second activity is with your photogoo, you can express your feelings. They can change the size of the eye [20].

D. Music authoring

An authorized music application has been developed to transform the screen into a harp-like device. Kids are capable to produce individual notes when the music is created. The application gives children the opportunity to make something they can share with others. It is an action that permits them to have fun that does not interrupt their particular interests. [20].

E. Alice

Alice is a collaborating three-dimensional program design interface that uses three-dimensional objects. Using the plan of the lessons of world literature on Alice's literature for pupils and students. In this exercise, students designed the most of the core character where students spent 5 classes in 4 working days[21].

F. Scratch

Scratch is another collaborating program design language for children. In the activity based on autism technology with ages 9-10.Firstly announced the students to the vision-based programming environment. For example, we used video tutorials to first introduce a vision-based programming environment for students. The students were invited to discover the environment independently, with instructions given by tutors. The task assigned to the students was to make a video game or story in which the student would play the role of the main character. The segment was implemented in 5 sessions of Saturday with an hour and a half per session. The final session was used as a performance day for parents [21].

G. Social learning app

There are seven stories shows children in this application. As soon as the child understands the situation, the children will be transferred to another department. The children were helped to choose the missing image from the sequence of stories shown on the tablet. If the child prepared one of the stories, he was allowed to move on to the next one [22].

H. Stories2learn

Many mobile apps have been established to support children with many infirmities. ProloQuo2Go delivers a communication tool and Stories2Learn supports generate graphic social stories that permit individuals with autism the capability to adopt events and future situations [22].

I. Collaborative learning app

Our application "Collaborative Learning" application is based on the idea of the application developed in the Autism software package. Co-operative learning includes a drawing application designed and implemented to foster co-operation and collaboration among children with ASD diagnosis. However, our application enabled the children to save and retrieve their drawings. Children can also clean the drawings. We also use Android tablet [23].

J. SIDES

It is a tabletop PC game for the growth of social skills in autistic people with Asperger syndrome. It is a graphic, collaborative game of four puzzles for four players. It is a collaborating whiteboard surface that can collect many concurrent entries and makes a unique distinction between the contact of each user. This feature permits application originators to bound or request the input of assured users through a board activity [24].

K. Go go game

"Go Go Games" is a series of video games that emerged from hypothesis that games can be an actual means of reducing the gap among the number of interactive therapies suggested for

children with ASD. The educational aim of this game is to teach a technique called multiple answer. The application displays an image (for example, a train, a car or a spaceship) to create visual compatibility when choosing from a collection of similar materials [25].

L. Emotion game

This application allows the child to draw and release elements on a white face to create an expression. In accordance with the instructions for the game using a webcam or with a camera inside. For example, a child is told that the character is happy today since it is a sunny day and then inspires him to make a cheerful face. This design permits your child with ASD to cause happiness and identify their face on the face [26].

M. Happy minion game

In order to solve the problem of hand-eye synchronization and association stay in children with ASD, this game helps repetitive movements with causal fruit. The game teaches eye hand drive to work instantaneously with the suitable speed. Like Feelings, this game permits the child to recognize a joyful and sad face of imaginary cartoon, depending on the situation[26].

N. Tap on me

TAPONME, a therapeutic game built on the iOS platform to help primary school children with autistic spectrum disorders develop their social communication skills. The characteristics of autistic children limit their chances of benefiting from formal education [27].

O. Find me

"Find Me" (for autism) was intended for children with the communication and social problems, including completely false children, with very partial social interfaces and limited game skills. The application was established for children from 18 months of age. The application was developed by a team of investigators from the University of Edinburgh, which combines information provided by several people with relevant information, such as parentages and instructors of children with autism. The application is designed to deliver a forum to practice social skills in a fun and stimulating way. We hope that the real social behavior of children will improve thanks to the application of these skills in practice. No language or reading skills are required, and many of children with autism have access to the iPad [28].

P. Balance ball

"Balance ball" game in which the player must place the balls in small colored holes, when putting the device to reach it, the player must avoid the obstacles. The game will improve balance in autistic children with vestibular dysfunction, and the game uses a separate physical motor [29].

Q. Sky burger game

"Sky Burger" Online is an online puzzle game. Sky Burger game needs the performer to catch the true elements the full form sky, which may increase level of attention in ASD children [29].

R. Minecraft

"Minecraft" is not only fun, but also helps children with autism. Minecraft is a game that consists of breaking and placing blocks. This application is more popular because it focuses on social interaction and operates several platforms, such as Android, iPad, iPhone, Mac, Nation and Wii U, Line, PC, PlayStation 3, PlayStation 4, PS Vita, Xbox 360, Xbox One[30].

S. IF

"IF" is the implementation of social and emotional learning (SEL) for autistic children that enhances social and emotional learning skills. It encourages players to think about what their actions communicate, and imagine how what they say affects others [30].

T. New super Mario bros

This game is good for children with autism. It focuses on self-regulation, regulates our actions, our feelings and behavior, controls anger and frustration. It is targeted motor skills and it works on Nintendo Wii U platform [30].

U. Portal 2

"Portal 2" is a great game for kids with ASD. This app is used for autism that can improve Social communication skills, self-awareness, and self-control and it run on platform like Mac, PC, PlayStation 3, Xbox 360[30].

V. Draw something2

This app is designed for children with ASD where the Motor skills are targeted it runs on different platforms such as Android, iPad, iPhone, iPod [30].

W. AutismXpress

"AutismXpress" is a gaming app for iPad that helps parents and teachers to help their children with emotional autism and self-expression. The design of this application is based on a communications image exchange system. [22].

X. A sunny day

It is a therapeutic treatment for autistic children by offering simple and structured tasks and by renting children in the form of an electronic application for iPad[31].

VII. COMPARISON OF AUTISM GAMES

A. Comparison based on autism symptoms

TABLE2. COMPARISON BASED ON AUTISM SYMPTOMS

Game Name	Symptoms Identification
Minecraft	Behavior
IF…	Social Skill and Self-Control
Portal2	Social communication skills, self-awareness, and self-control
Draw Something2	Motor skills
New Super Mario Bros	Motor skills or Sensory skills
Go Go Game	Communication skills
Tap On ME	Social,Sensory and Communication Skills
A Sunny day	Behavior training
Utangle	Social interaction , physical interaction
Social Learning app	Collaborative and Social skill
Collaborative learning	Communication skills
Stories2 Learn	Social skills
Find Me app	Social Interaction & Communication Skills
Fill Me app	Cognitive
Sky Burger Game	Balance
Balance Ball Game	Emotional and communication
AutismXpress	Social Skill
SIDES	Social Skill
Scratch	Collaborative skill and behavior
Alice	Behavior training

B. Comparison based on autism types

TABLE3. COMPARISON BASED ON AUTISM TYPES

Game Name	Autistic disorder	Asperger's syndrome	Childhood disintegrative disorder	Pervasive developmental disorder
Minecraft	✓			
IF…	✓			
Portal2		✓		
Draw Something2		✓		
New Super Mario Bros				✓
Go go Game	✓			
Tap On ME	✓			
A Sunny Day		✓		
Utangle	✓			
Social Learning app			✓	
Collaborative learning			✓	
Stories2 Learn		✓		
Find Me app	✓			
Fill Me app			✓	
Sky Burger Game	✓			
Balance Ball Game	✓			
AutismXpress		✓		
SIDES		✓		
Scratch	✓			
Alice		✓		

VIII. COMPARISON TABLE OF AUTISM GAMES

TABLE4. COMPARISON TABLE OF AUTISM GAMES

Game Name	Platform	Symptoms Identification	Autism Type	Age	Screen	Year	Category
Minecraft	Android, iPad, iPhone, Mac, Nintendo, PC	Behavaior	Autistic disorder(AD)	Children	3D	2016	Education
IF…	ipad	Social Skill and Self-Control	Autistic disorder(AD)	5+	2D	2010	Emotional
Portal2	Mac, PC, PlayStation 3,Xbox 360	Social communication skills, self-awareness, and self-control	Asperger's syndrome	10+	2D	2011	Puzzle-based
Draw Something2	Android, iPad, iPhone, iPod	Motor skills	Asperger's syndrome	14+	2D	2013	Education
New Super Mario Bros	Nintendo Wii U platform	Motor skills or Sensory skills	Pervasive Developmental Disorder	3+	2D	2006	Education
Tap On ME	ipad	Communication skills	Autistic disorder(AD)	5+	3D	2013	Education
A Sunny day	Ios	Social,Sensory and Communication Skills	Autistic disorder(AD)	children	2D	2013	Education
Utangle	ipad	Behavior training	Autistic Spectrum disorder(ASD)	children	2D	2011	Social learning
Social Learning app	Android	Social interaction , physical interaction	Childhood Disintegrative Disorder	5+	2D	2016	Cognitive
Collaborative learning app	Android Tablet device	Collaborative and Social skill	Autistic disorder(AD)	children	2D	2012	Social Skills
Stories2 Learn	Tablet , PC , Android	Communication skills	Asperger's syndrome	10+	2D	2009	Cognitive
Find Me app	ipad	Social skills	Autistic Spectrum disorder(ASD)	children	2D	2010	Social skills
Fill Me app	ipad	Social Interaction & Communication Skills	Childhood Disintegrative Disorder	8+	2D	2013	Education
Sky Burger Game	Android	Cognitive	Autistic Spectrum disorder(ASD)	children	2D	2016	Balance
Balance Ball Game	Android, IOS	Balance	Autistic disorder(AD)	children	2D	2009	Balance
AutismXpress	Android, IOS	Emotional and communication skills	Autistic disorder(AD)	children	2D	2017	Emotional
SIDES	ipad	Social Skill	Autistic disorder(AD)	children	2D	2011	Social Skills
Scratch	Tabletop Computer Game	Social Skill	Autistic disorder(AD)	children	3D	2006	Education
Alice	Ipad, PC	Collaborative skill and behavior	Asperger's syndrome	10	3D	2013	Education

IX. CONCLUSION AND FUTURE WORK

Technology is clearly part of our daily recreation. However, the education system seems to be reviewing its full potential. All these serious games that are mentioned above helps children with ASD to improve social, learning and behavior skills and the provided best platforms for children with ASD. Therefore, it is necessary to develop more clear proposals for serious games (educational) and better game developers, covering all the components based on the evidence of the corresponding interactive educational game. Solving a person's problems using serious game, like autism. This article analyzed the comparison of different autism games and provided the best solution for the most appropriate games for children with autism. Studies in the fiction showed that there are real games in the field of education for children with autism.

As stated in earlier studies, there is single game for sensory processing disorder and that emphases only on the vision. Owing to the captivating heterogeneity and multimodal nature of digital vision technology, hearing and vestibular can be combined in games for SPDs (Sensory Processing Disorder).Limitation of other methods of sensory stimulation continuous, olfactory and verbal input. Still, improvements in computer knowledge have explored the probability of integrating technology with adjacent and digital technologies.

REFERENCES

[1] Hulusic, V. and Pistoljevic, N. (2017). A curriculum for developing serious games for children with autism: A success story. In *2017 9th International Conf. Virtual World. Games Serious Applic., (VS-Games), IEEE*. 149-152.

[2] Zakari, H. M., Ma, M. and Simmons, D. (2014). A review of serious games for children with autism spectrum disorders (asd). In *International conf. Serious Games Dev. Applic.. Springer Cham*., 93-106.

[3] Susi, T., Johannesson, M. and Backlund, P. (2007). Serious games: An overview.

[4] Christinaki, E., Vidakis, N. and Triantafyllidis, G. A. (2014). A novel educational game for teaching emotion identification skills to preschoolers with autism diagnosis. *Comput. Sci. Inf. Syst.*, **11.2**: 723-743.

[5] Gray, C. A. and Garand, J. D. (1993). Social stories: Improving responses of students with autism with accurate social information. *Focus on autistic behave.*, **8(1)**: 1-10.

[6] Pajareya, K. and Nopmaneejumruslers, K. (2012). A one-year prospective follow-up study of a DIR/Floortime™ parent training intervention for preschool children with autistic spectrum disorders. *J. Med. Assoc. Thailand*, **95(9)**: 1184.

[7] Prizant, B. M., Wetherby, A. M., Rubin, E. and Laurent, A. C. (2003). The SCERTS model: A transactional, family-centered approach to enhancing communication and socioemotional abilities of children with autism spectrum disorder. *Infants Young Children*, **16(4):** 296-316.

[8] Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *J. Autism Dev. Disord*., **42(4)**: 512-520.

[9] Kaldy, Z., Kraper, C., Carter, A. S. and Blaser, E. (2011). Toddlers with autism spectrum disorder are more successful at visual search than typically developing toddlers. *Dev. Sci.*, **14(5):** 980-988.

[10] Mesibov, G. B., Shea, V. and Schopler, E. (2005). *The TEACCH approach to autism spectrum disorders*. Springer Science & Business Media.

[11] Goldsmith, T. R. and LeBlanc, L. A. (2004). Use of technology in interventions for children with autism. *J. Early Intens. Behav. Interven*., **1(2)**:166-178.

[12] Ploog, B. O., Scharf, A., Nelson, D. and Brooks, P. J. (2013). Use of computer-assisted technologies (CAT) to enhance social, communicative, and language development in children with autism spectrum disorders. *J. Autism Dev. disorders*, **43(2):** 301-322.

[13] Noor, H. A. M., Shahbodin, F. and Pee, N. C. (2012). Serious game for autism children: review of literature. *World Acad. Sci. Engineer. Techno.*, **64(124)**: 647-652.

[14] Grynszpan, O., Martin, J. C. and Nadel, J. (2008). Multimedia interfaces for users with high functioning autism: An empirical investigation. *International J. Human Computer Stud*., **66(8)**: 628-639.

[15] Finkelstein, S. L., Nickel, A., Harrison, L., Suma, E. A. and Barnes, T. (2009). cMotion: A new game design to teach emotion recognition and programming logic to children using virtual humans. In *2009 IEEE Virtual Reality Conference*, 249-250.

[16] Tanaka, J. W., Wolf, J. M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., Brown, C., Stahl, S., Kaiser, M. D. and Schultz, R. T. (2010). Using computerized games to teach face recognition skills to children with autism spectrum disorder: the Let's Face It! program. *J. Child Psychol. Psychiat.*, **51(8):** 944-952.

[17] Miranda, J. C., Fernandes, T., Sousa, A. A. and Orvalho, V. C. (2011). Interactive technology: teaching people with autism to recognize facial emotions. In *Autism Spectrum Disorders-From Genes to Environment*.

[18] Bernardini, S., Porayska-Pomsta, K. and Smith, T. J. (2014). ECHOES: An intelligent serious game for fostering social communication in children with autism. *Information Sci.*, **264**: 41-60.

[19] Eder, M. S., Diaz, J. M. L., Madela, J. R. S., Mag-usara, M. U. and Sabellano, D. D. M. (2016). Fill me app: an interactive mobile game application for children with autism. *International J. Interactive Mobile Technol.*, **10**(3): 59-63.

[20] Hourcade, J. P., Bullock-Rest, N. E. and Hansen, T. E. (2012). Multitouch tablet applications and activities to enhance the social skills of children with autism spectrum disorders. *Personal ubiquitous comput.*, **16**(2): 157-168.

[21] Dorsey, R. and Howard, A. M. (2011). Examining the effects of technology-based learning on children with autism: a case study. In *2011 IEEE 11th International Conf. Adv. Learn. Techno.*, 260-261.

[22] Ahmad, M. I. (2013). Design and evaluation of a mobile learning application for autistic children in a developing country (Doctoral dissertation, Ph. D, University Paderborn).

[23] Battocchi, A., Pianesi, F., Tomasini, D., Zancanaro, M., Esposito, G., Venuti, P., Sasson, A. B., Gal, E. and Weiss, P. L. (2009). Collaborative Puzzle Game: a tabletop interactive game for fostering collaboration in children with Autism Spectrum Disorders (ASD). In *Proceed. ACM International Conf. Interactive Tabletops Surfaces*,

[24] Piper, A. M., O'Brien, E., Morris, M. R. and Winograd, T. (2006). SIDES: a cooperative tabletop computer game for social skills development. In *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*, 1-10.

[25] Hiniker, A., Daniels, J. W. and Williamson, H. (2013). Go go games: therapeutic video games for children with autism spectrum disorders. In *Proceed. of the 12th International Conf. Interaction Design Child., ACM*. 463-466.

[26] Bhatt, S. K., De Leon, N. I. and Al-Jumaily, A. (2014). Augmented reality game therapy for children with autism spectrum disorder. *International J. Smart Sensing Intelligent Sys.*, **7**(2).

[27] Dehkordi, S. R., and Rias, R. M. TAP ON ME: ATHERAPEUTIC GAME FOR CHILDREN WITH AUTISM SPECTRUM DISORDER FOCUSI GO SOCIAL COMMU ICATIO SKILLS.

[28] Rias, R. M. and Dehkordi, S. R. (2013). Computer game approach for children with autism spectrum disorder: A pilot study. In *6th WSEAS World Congress: Applied Computing Conf.*, 174-179

[29] Ern, A. M. (2014). *The use of gamification and serious games within interventions for children with autism spectrum disorder*. (Bachelor's thesis, University of Twente).

[30] Khowaja, K., Salim, S. S. and Al-Thani, D. (2018). Components to design serious games for children with autism spectrum disorder (ASD) to learn vocabulary. In *2018 IEEE 5th International Conference Engineer. Techno. Applied Sci.*, 1-7.

[31] Yan, F. (2011). A sunny day: Ann and ron's world an ipad application for children with autism. In *International Conf. Serious Games Dev. Applic.*, 129-138.

[32] Djaouti, D., Alvarez, J., Jessel, J. P., & Rampnoux, O. (2011). Origins of serious games. In *Serious games and edutainment applications* (pp. 25-43). Springer, London.