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Faculty of Engineering and Technology

Master Program of Computing

## Implementing a Serious Game for Children with Autism in Palestine

بناء الألعاب التعليمية الهادفة للأطفال المصابين  
بالتوحد في فلسطين

Wafa'a Ihmouda

Supervisor:  
Dr. Mamoun Nawahdah

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**Implementing a Serious Game for Children with Autism in  
Palesitne  
By Wafaa Ihmouda**

**Approved by the thesis committee:**

**Dr. Mamoun Nawahdah, Birzeit University**

.....

**Dr. Rashid Jayousi, Al-Quds University**

.....

**Dr. Nariman Ammar, Birzeit University**

.....

**Date Approved:**

# Abstract

The purpose of this research is to identify the effectiveness of using the developed serious game in empowering social and communication skills of children with autism. Autism as one of the most common disorder which is rapidly increasing in many countries[51]. Often, it is difficult for children with autism to communicate well and normally interact with others. In this thesis, we have developed a serious game to help children with autism to overcome their social and communication problems. The game is implemented based on PECS system which is the most popular intervention system for improving communication and social skills for children with autism, the PECS phases have been gradually applied and mapped to the game levels and sub-levels. In the game design phase, we started by studying the requirements of autism disorder followed by collecting information and data about the participants and suggestions from the therapists and speech language pathologist ended with conducting experiment to investigate our research questions. Three ways were used to collect the data. The first one, collecting real-time data directly from the game presented by targeted variables such as ,response time, playing duration,etc to our server database. The second, observational variables which have been collected by using camera and notes from experimenter and therapist who have attended the game, post-test sessions. Finally, the questionnaire data which was distributed to twenty specialists in two autism centers in Palestine. The experiment results showed a positive impact in promoting children with autism motor skills, their interactive functionality. Paired t-test results showed a significant difference between pretest and post-test on achievement language skills, which proved the effectiveness of the game in improving the language skills in requesting, rejecting, etc. Related to the social impact; the observational data showed the ability of the game in encouraging the social behaviors such as exchanging eye contact and asking for help. In addition, the results from the collaboration levels showed the game ability in getting intentional communication to play it and stimulates the emergence of behaviors lacking in the children with autism. Out of the specialists' answers the majority of them confirmed the ability of the game in enjoying children with autism. Also, they see the ability of the game in helping them to overcome on communication and social problems that they faced in their daily life. The developed game is an educational

game with educational target by containing educational roles based on PECS and attractive factors. Educational roles are given in a form of visual scanning, matching, ability to distinguish, build a complete sentence based on functional communication skills, ask and comments.

## الملخص

الهدف من هذا البحث هو التعرف على فعالية الألعاب التعليمية في تمكين المهارات التواصل والتفاعل للأطفال المصابين بالتوحد. التوحد هو واحد من أكثر الاضطرابات شيوعاً و انتشاراً في العديد من البلدان [51]. حيث يعاني الأطفال المصابون بالتوحد من صعوبات في التواصل والتفاعل مع الآخرين. في هذه الرسالة، قمنا بتطوير لعبة تعليمية لمساعدة الأطفال المصابين بالتوحد للتغلب على مشاكلهم الاجتماعية والتواصل. اللعبة تم تطويرها بناءً على نظام PECS وهو النظام الأكثر شيوعاً لتحسين التواصل والمهارات الاجتماعية للأطفال الذين يعانون من التوحد، وقد تطبيق مراحل PECS تدريجياً لتشكل بذلك مراحل اللعبة و مراحلها الفرعية. في مرحلة تصميم اللعبة، بدأنا بدراسة متطلبات اضطراب التوحد تليها جمع المعلومات والبيانات عن المشاركين واقتراحات من المعالجين و أخصائي اللغة انتهت مع إجراء تجربة للتحقيق في أسئلة البحث لدينا. و قد تم استخدام ثلاث طرق لجمع النتائج. أولاً: جمع البيانات مباشرة اثناء اللعبة وتخزينها في قاعدة البيانات مثل: زمن الاستجابة، مدة اللعب...الخ. ثانياً: المتغيرات التي تعتمد على الملاحظة والتي تم جمعها باستخدام الكاميرا والملاحظات من المعالجين و الخبراء الذين حضروا جلسات اللعبة. وأخيراً: بيانات الاستبيان التي وزعت على عشرين متخصصاً في مركزين للتوحد في فلسطين. وأظهرت نتائج التجربة تأثيراً إيجابياً في تعزيز الأطفال ذوي التوحد المهارات الحركية في التتبع والتفاعلية وأظهرت نتائج التجريب القبلي و البعدي فرقاً كبيراً في المهارات اللغوية للأطفال قبل و بعد اللعبة مما أثبت نجاعة اللعبة في تحسين المهارات اللغوية للأطفال المصابين بالتوحد. وأظهرت البيانات التي تم جمعها قدرة اللعبة في تشجيع السلوكيات الاجتماعية مثل تبادل الاتصال بالعين وطلب المساعدة. وعززت المراحل التعاونية باللعبة التواصل المتعمد وظهور سلوكيات يفترها الأطفال المصابون بالتوحد. من إجابات المختصين أكد معظمهم قدرة اللعبة على إمتاع الأطفال المصابين بالتوحد. أيضاً، يرون قدرة اللعبة في مساعدتهم على التغلب على مشاكل التواصل والمشاكل الاجتماعية التي يواجهونها في حياتهم اليومية. اللعبة المطورة هي لعبة هدفها تعليمي بالاعتماد على نظام PECS وعوامل الجذب. لإكساب الطفل القدرة على المطابقة، التمييز، وبناء جملة كاملة على أساس مهارات الاتصال . الوظيفي، وطرح الأسئلة.



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# Abbreviations

AAC Augmentative an Alternative Communication

ASD Autism Spectrum Disorder

PCBS Palestinian Central Bureau of Statistics

PECS Picture Exchange Communication System

SGD Speech Generating Device

# Chapter 1

## Introduction

“Play is work for children with neurological difficulties”, in this statement Delaney started her book “101 Games and Activities for Children with Autism”[1]. During her experience in dealing with children with autism she concluded that engagement is an important element to motivate them to join in activities. In this thesis we developed a learning module for children with autism by using a serious game approach to achieve engagement and capturing their attention.

### 1.1 Problem Statement and Research Scope

Usually, a person who has good communication and social skills can effectively express his ideas and feelings to others through his gestures, and can easily interact well with others by facial expressions or verbal communication. However, having communication and social skills in the autism world is different and definitely must be converted to other skills; such as realizing the relation between objects, body control (when to start and when to stop, understanding surrounding context cues, basic language concepts, memorization, following instructions, having good eye contact, and turn taking (listening skills))[1]. Limitations in communication and social skills for children with autism consider the main reason for not accepting them in the formal educational system in Palestinian schools[52]. In terms of intervention for children with autism, the more motivations in learning, the more positive effects they will get. The main reason given support for this claim is that they will become more focused and encouraged[53].

In this thesis, we put an intervention system Picture Exchange Communication System (PECS) which is one of the popular intervention systems that is used with individuals with autism who have a functional language problem[36], to be used in implementing a serious game.

## 1.2 Motivation

The main motivations behind working on communication and social skills to make something useful for Palestinian children with autism, helping them to depend on themselves, interact with others and express their feelings, taking into consideration Palestinian context (language, therapy in autism centers, etc...).

## 1.3 Significance and Contribution

The main contribution of this thesis developed a serious game for children with autism to help them in developing their communication and social skills. Our game uses the official intervention system PECS as the core of our game with the integration with the elements of serious game which play an important role in attracting and motivating the children. Understanding the autism requirements and the suggestions from the participants and the valuable improvement from the therapists and speech language pathologist were considered an important contribution in de-levering our game. The educational components which need to be delivered in the game is gradually embedded in order to introduce attractive environment for encouraging the participants to keep on playing and take benefits. Despite the inability to demonstrate the effect of the game on improving communication and social skills in real life for children with autism. The game is successfully stimulated the functional communication skills on request, ask, reject that the participants have not appeared in their life at all. Moreover, the game levels targeted the collaboration skills encouraged the participants to show social behaviours during the game. In the following the key objectives of this research:

- Develop a serious game to improve communication and social skill for children with autism.
- Develop cooperative levels to enhance social skills (eye contact, interaction with others).
- Customize education contents (PECS cards) to be suitable with Arabic language format and Palestinian context.
- Develop methods of instruction aimed to understand how to help them in learning.
- Approve the ability of the game to help the participants in creating complete sentences using real PECS cards after they played with the developed game through pretest and post-test results.



## 1.4 Research Design

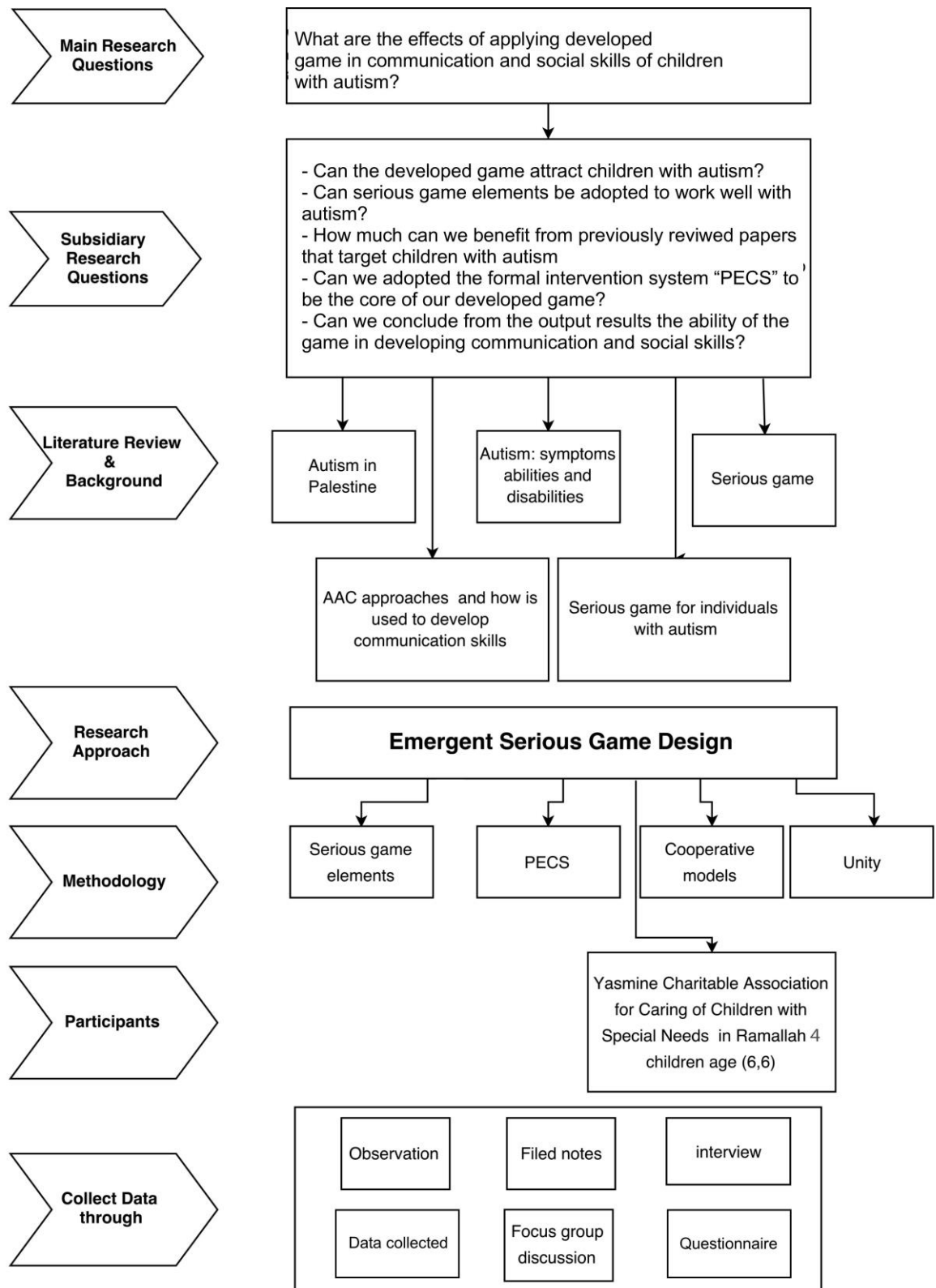


Figure 1.1: Research design

Figure 1.1 presents the main and subsidiary research questions, the role of lit-

erature review to answer these questions. The research followed four board strands to output of emergent design of serious game. The first strand, a serious game elements to determine how these elements can be used to overcome of children with autism disabilities and to what extent we can be used to help them gaining the goals. The second strand PECS to identify the casting of the game and how to gradual in game levels and difficulties. The third strand is cooperative models to overcome on social problems. The fourth strand, collect of data about the current situation relating to children with autism in Palestine through of the interviews and focus group discussion with therapists and involving the children with different activities to examine their abilities and needs. Three main areas of this research have played an important role to format the structure of a serious game, which are autism in Palestine, autism education and serious game. Figure 1.2 shows how these areas intersect and it is the overlap between them reflect the interest of my research.



Figure 1.2: The overlapping areas of the thesis.

## 1.5 Organization of the Thesis

The remainder of this thesis is organized as follows:

Chapter 2: Background. Presents the basic concepts of serious game, AAC approaches PECS, traditional and situation of individuals with autism in Palestine.

Chapter 3: Literature Review. Reviews related works in general educational cases of using serious game, serious for children with autism and PECS.

Chapter 4: Experimental Design. Presents three aspects that the experiment is conducted and game developed based on.

Chapter 5: Results. Presents the collected results for four participants. Chapter 6: Discussion. Examines the effectiveness of using developed game by using three way in collecting results.

Chapter 7: Conclusion. Draws the conclusion and future work.

# Chapter 2

## Background

This chapter introduces the background of autism and the most popular intervention systems in teaching children with autism.

### 2.1 Autism

Autism Spectrum Disorder (ASD) is a neurodevelopmental and mental disorder which effects on development and function of the brain. Usually, ASD symptoms appear on the child before the age of three[2].

#### 2.1.1 ASD symptoms:

People with ASD show different symptoms that vary widely. Nevertheless, the most common symptoms are:

- Weakness in communication and social interactions: Child with autism has social deficits that are summarized with difficulties to appear social attention behavior such as (eye contact, pointing to objects and following speaker's instructions, gazing and appearing social emotional). Moreover, he can't interpret others emotions or behaviors. However, children with autism can create a strong relationship with the therapist[3].
- Language latency: Approximately, half of people with autism fail to develop fully functional speech, some of them are repeated others words "echolalia" or they don't put the words on its correct context. Some studies appear that children with autism with hardiest functionality speech can repeat words in their favorite videos or television shows[4].
- Unusual behaviors and delays in cognition: Repeating and routine are most common features of children with autism activities and interests such as hand flopping also focusing their attention in one direction or flushing light[3].

- Sensory processing disorder: Adoption with the surrounding environment is an important factor to develop the child. However, children with autism miss this, they can't focus to gain new skills or learn. To overcome "Sensory room" concept appears, that is based on immersion the child with stimuli. Indeed, stimuli encourage children to learn, stay focused and explore by offering comfortable environment[1].

### 2.1.2 Autism in Palestine

In 2011, Palestinian Central Bureau of Statistics (PCBS) released an estimation of approximately 2.7% of population has disability (113,000 persons)[5]. In terms of Autism, there is no statistical data of actual percentage of individuals with autism in Palestine. In 2014, the Italian Journal of Special Education for Inclusion published a report called First National Public Opinion Survey: Palestinian Knowledge and Understanding of Autism, that illustrates the number of special education institutions in Palestine to be slightly over 134 institutions[6]. Related to the ASD nine institutions are qualified enough to serve children with autism. In addition, the nine institutions are owned by private sector contribution with ministry of social affairs and provided the following services. (1) Corresponding color, shape and relation (special education), (2) physical therapy (One hour every day doing physical exercises), (3) transportation between the institutions and children's homes, (5) Aware-ness workshop for parents (training workshop to deal with their children) , (6) residential services (only Community Mental Health Center in Salfit), and (7) sensory adaptation (color and auditory).

The mental health and psychology support centers in Palestine: There are nine associations qualified to deal with children with autism in Palestine:

- Jerusalem Association for caring of children with autism in Jerusalem.
- Silwad Center for Rehabilitation in Jerusalem.
- Association for Rehabilitation children with autism and learning difficulties in Tulkram.
- Association for Caring of Children with special needs in Nablus.
- Yasmine Charitable Association for Caring of Children with Special Needs in Ramallah.

- Community Mental Health Center in Salfit.
- Palestinian association Al-Halal Al-Ahmar/ Mental Health Center in Hebron.
- Jerusalem Princess Basma Centre in Jerusalem.
- Ramallah Friends Lower School.

The current Palestine approaches to care about autism "no clear strategies to inclusion children with autism in education, we find ourselves alone to empower their abilities" says Amenh Odeh, a therapist at the Yasmine autism center in Ramallah. And added "communication is an important factor to understand their needs and feeling, contact with others and depend on them-selves". According to learning activities she illustrated that they used cards system of simple matching (size, animals, fruits, transmission, clothes,etc). She noted that, engagement is an effective element to promote their motor and interactive functionality, one way to achieve that by using tablet devices. However, she stated that she didn't find any Arabic educational game application for dedicated for autism.

## 2.2 PECS Approach

AAC strategies allow individuals with autism to communicate through using different strategies such as (communication books, speech generating devices, sign language, picture symbols and gestures)[7]. Table 2.1 represents the definition of AAC methods. PECS is developed in 1994 as one of augmentative and alternative communication (AAC)[4] strategies for solving language deficits of children with autism.

Table 2.1: AAC Methods.

Sign Language	Picture Symbols (PECS)	Speech-generating Devices (SGD)	Tangible Symbols
Uses with individuals who functionally mute needs lower cognitive skills because it's totally depends on gestures of hands, fingers and arms[8].	Have different phases to develop communication skills of individuals. It is based on exchanging the picture symbol with physical item[9].	it is an electronic device uses the same technique of PESC in exchanging pictures with physical items, but the picture is digital. Moreover, it generates sound based on user's action[10]	Uses the same PECS strategy, but the difference in using tangible symbol cards[9].



Figure 2.1: PECS book

Usually, to obtain what they want they use pre-international communication approaches in gazing and behavior[5]. To overcome of these problems PECS is used to teach them to establish communication through using prompting and reinforcement strategies that lead to independent communication, along beside it uses distinguish technique in learning the symbols and ordering the sequence to create a complete sentences. PECS technique has a notably developed with a six phases[6][7]:

- Phase 1: Learning to request for exchanging the picture with preferred object. This phase depends on physical prompt (pick-up, reach and release).
- Phase 2: increasing the exchange distance between the child and therapist and change the environment and therapist.
- Phase3: Child is learned to distinguish between different pictures and learn to match the picture with preferred object.
- Phase4: The child learns to build a sentence strip in order to obtain what he wants
- Phase5 and Phase6: Expand the instruction to include helping, commenting and asking questions. Figure A.4 presents PECS book and symbols to create a strip of sentence. Figure 2.2 detail information about PECS six phases technique[11].

## 2.3 Serious Game

Using game thinking in learning is a way to get rid of boring and frustration feeling of students in classroom. In general, Kapp[12] states that game depends on emotional reaction from the player to obtain outcome by building a mechanism of interactivity, constrains and feedback supporting with realistic elements or casting to fulfill game's

# PECS Phases

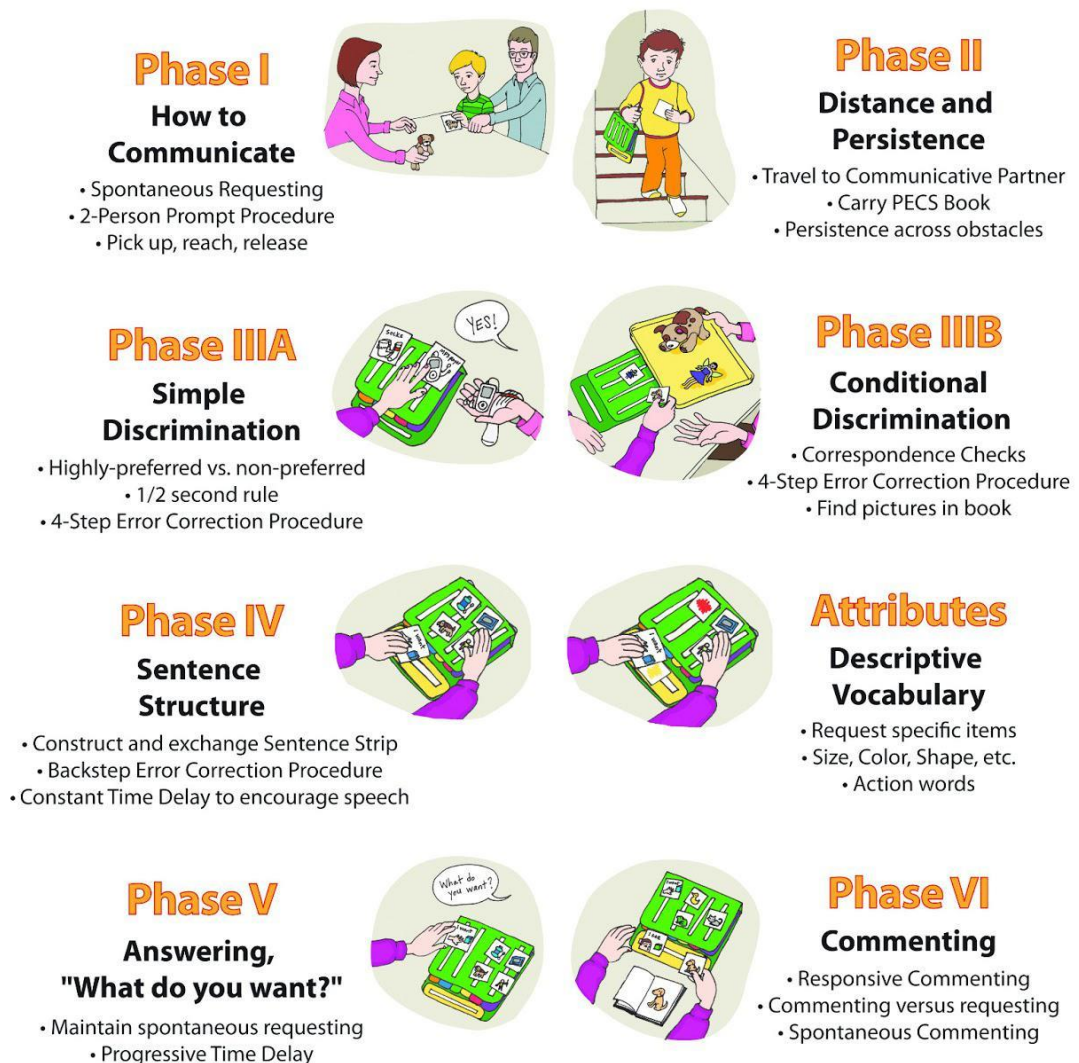


Figure 2.2: PECS phases

goals. Projecting game principles in learning or training environment dubbed as "Serious Game" or "Gamification"[13].

## Serious Game Elements

- Goals: the term of goals in serious game, identified by the collection of game purpose, result calculation and other focuses items. Visual or acoustic indicators to show the progress of game to fulfill these goals[12].



- Rules: in serious game are important element to govern the system of playing. Without clarifying rules game will become arbitrary and ambiguous. To keep the game under control rules are used for restricting player actions and options. Nevertheless, autonomy and freedom features for this player are respected.
- Time: in serious game constrained the player with the time is an important issue to force him to work under pressure[13]. Moreover, Time can be used as reward element based on player actions, such as every time the player participates in the game he will get 20 points[14].
- Reward Structure: such as points and badges.
- Conflict, Competition or Cooperation: actionable solutions to overcome the challenges in serious game through feeding player motivations through different ways (conflict, Competition or Cooperation). One of Competition methods is a leaderboard which ordering the set of players based on their scores. This technique provides a meaningful collection of a set of players to give them a feedback of their progress and social compression. The importance of this board could be used to increase competition[15].
- Levels: levels are used to refine player experience in the game. The initial level is an important starting point to qualify the player to encounter game challenges[14].
- Feedback: in computer games feedback uses to mirror the progress of a player by using to be adapted with user's interaction, discussion and actions[49]. Feedback converts the player actions by using different strategies such as changing game environment, sound, vibration and more points. All of that to reduce overload cognitive processes to analyze the effect of a player's action[50].
- Storytelling: enrich the serious game with the story has a positive impact to spur learners through using meaningful context.

- Aesthetics: the purpose of serious game to capture player's attention, aesthetic is an important factor to achieve that. Delivering learning messages to a player without caring about this side, it makes the game useless and reflect-ing boring and frustration feeling to the player. Aesthetics consists of graphic design, integration between elements in the game, delivering the developer feeling to the player, mapping between purpose of games and what player can do and reflects gradual progression in game levels.

# Chapter 3

## Literature Review

This chapter reviews and summarizes the previous works related to serious area and PECS.

### 3.1 Related Work of PECS Technique

PECS phases have been found to be implemented successfully with autistic individuals[35]. Recent research demonstrates the positive results of PECS and sheds the light to intervention this approach in learning functional communication skills[36][37]. Obviously, PECS is a popular treatment approach for communication problem, whereas some studies indicate that PECS nature isn't promoting a social connections such as (eye contact, attention, oral motor). However, Lerna et al.[38] have proved a positive effects of the four phases of PECS and free time play in developing communication and social skills. By involving eighteen individuals with autism (mean age 3 years), different social-communicative indicators are used such as (Independence, expressive language, engagement, interaction, eye contact, requests initiation ). Preston and Carter[39] also demonstrate how social interaction will be embedded as a long term that can only assess by long time practice and caregiver assessment. The majority of papers evaluated the first four or three phases of PECS, In Ganz et al.[40] they trained autistic children (age 3-5 years) on using the first four or three phases of PECS. Related to apply training for the first three phases Rosales[41]. Although, a few studies examining the effects of six phases of PECS. For example, Gopalan and Piking[42].

Different training techniques are used to train children with ASD to use PECS. In[41] they modeled a training package that consists of three stages. First, baseline (conducted the experiment of three phases with no feedback from experimenter). Second, BST (gradually uses verbal instructions and feedback via teachers). Third, follow-up stage uses the same technique of baseline to observe the progress of chil-

dren. The result demonstrated a positive impact in using this package training to make children's mastery with PECS. Same design approach is used by Achmadi et al.[43] that states using of multiple stages design across the participants . Ganz et al.[44] uses two stages baseline and intervention (using AAC technique) to evaluate the number of trails to select a target words.

AAC has different strategy (PECS and SGD)in requesting behavior, whereas SGD (Speed generating device) is an electronic device uses the same technique of PESC in exchanging pictures with physical items, but the picture is digital. Moreover, it generates sound based on user's action. Related to that, most of references is considering SGD as PECS tablet based program. In[44] they used PECS app to enhance initial-communication (receptive language), but the result shows slightly improvement. However, many papers document and investigate a positive impact of using PECS app and using assistive technology such as [45][46].

Compering between using assistive technology such as (iPads) and traditional way of PECS. The result appears a positive effect of both two strategies, whereas they found that the child in first phase do well in PECS more than SDG. Although with advance phases SDG is the winner[47]. In this paper [14]they address that the type of a system doesn't impact on rate of acquisition for the individual with autism.

## 3.2 Related Work of Using Serious Game for General Educational cases

Serious game has demonstrated a positive impact on engaging and motivating students without violating learning level and skill improvements comparing to other types of learning approaches. Many studies shed light on effect of serious games in learning outcomes. For instance, In[16] the results show a significant effect on serious game comparing with another learning approach based on students grades, In[17] it states positive and effective outcome in applying this approach by motivating and engaging students and [18] shows improvement of participants performance in assignments and examination.

Indeed, serious game is emerging topic in the academic community and can be applied in different sectors. For example, math, science, foreign language, social interaction and programming. In programming, Chen and Cheng[17] used code in game technique for object oriented programming course. By writing the functionality of games to overcome of challenges in games. In this learning approach they found, that students more motivation and engagement based on their fulfillment, depth in understanding the concepts of this course, especially when their code is interpreted to achieve game goals. In[19] they formed a programming platform of serious game

for data structure concepts (Array, stack, queue, tree, etc..), they mapped these concepts to challenging game in order encouraging students to implement robust code to overcome of different challenges.

Serious game can be adapted to be suitable with player age and abilities. Iosup and Epema[20] applied serious game approach to evaluate its impact in higher education courses for both undergraduate students in the computer organization course and graduate students in computing course. Students showed an improvement in success rate and increasing their motivation in the classroom.

### 3.3 Related Work of Using Serious Game for Individuals with autism

Serious game has shown a positive impact to empower autistic children compared with other disability categories. Bartolome and Zapirain[21] evaluated the impacts of using serious games to develop communication and interaction skills of two control groups (children with ASD and neurotypical development), three objectives are identified; knowing the strength points of autistic children to develop a game, that applies to rehabilitate their abilities, evaluating the interaction between autistic children with others through the incorporation environment by using caregiver and distinguishing between autistic children and neurotypical development based on cognitive behavior. The result showed that the reaction time of autistic children is slightly over the neurotypical development group.

Autism serious game can be applied in different sectors. For example, Bosseler et al.[22] found a positive impact of using serious game to teach autistic children new vocabulary by using computer virtual character dubbed as "Baldi". In meeting environment, Strickland et al.[23] worked with adolescent with autism by using "SecondLife" virtual reality application to simulate employment interview to practice autistic teenagers, whereas people with autism unlikely to obtain jobs because of impairment in social interaction. In traveling, Mazurek and Engelhardt[24] developed "Route Mate" a serious game is designed to promote traveling independently for individuals with intellectual disability. In social life, Fernandes et al.[25] designed a Virtual character for helping autistic children to recognize others feeling. They found effective role of context in improving the reaction of autistic children with games.

Serious game can use as an assistive tool for people with autism, whereas games can lead to addict. Fernandes et al.[26] mention of addiction problem of using video game for both individuals with ASD and individual with ADHD. Autistic children

are losing interaction with others, so they stick on tablet devices.

The cooperative game is one of promising serious game interventions approach in enhancing the social skills of individuals with autism. Indeed, most individuals with autism have the social problems even who have acceptable abilities. Social problem is considered as wide variety area to be included poor eye contact, less awareness of others feeling, how to establish a social contact to play with others and conventions of social interaction[27]. Prior work has demonstrated a positive impact of cooperative game to enhance social skills comparing with one player game format[28].

The strength point of cooperative game in creating of collaboration environment, enforcing multi-players to contact with each other to reach a specific goal without neglecting motivation and engagement. Fostering an environment of cooperative game can be created with different ways; (1) social media such as Facebook, (2) using one tablet device, (3) using two tablet devices and make a local Internet connection. Related to cooperative game that tends individuals with autism, Hourcade et al.[29] used a multi-touch screen dubbed as Pymt to allow for two autistic children to practicing together(drawing, music authoring, untangle and photogoo). Ceccon et al.[30] used local Internet connection to contact two tablet devices. However, Bernardo et al.[31] used different strategy in developing a cooperative environment by using two technologies (robot and tablet game) to encourage autistic children to play Tangram game. The robot has two modes tutor and peer; as a tutor (helping and teaching). for peer mode the robot is used to put the child in a cooperative environment to enhance social skills by taking turns, communicating and developing friendships. Autism cooperative games can use different strategies to gradual on level difficult. For example, Boyle et al.[32] developed "Autoblock" cooperative game the idea is using bricks to share in building a tower with three levels. First level, uses the Passive Sharing Pattern where each player has own character and bricks to involve in building a tower in order to develop attention skill. The second level, each player has own character with the sharing of bricks (building resources) to develop dynamic attention and turn taking. The third level, same as the second level. In addition, adding a problem needing collaboration between two players to solve it. ComFim game[30] has three levels. Learning level (using the tutor to present a specific scenario and the player must match the object to complete a scenario). Ask/Receive level between two players with using of PECS concept and phases. Collaboration level to reinforce deep communication degree. Obviously, co-operative game has proved a positive impact in improving social skills. In addition it can reinforce other behaviour such as (imagination, visuospatial, logical, concentration, geometric spatial thinking, and mathematics knowledge)[31]. Bernardini et al.[33] Sharing of game stage with others may be effectively increasing dependence of children with autism. Boyd et al.[34] worked on assessing the impact of using

collaborative iPad "Zody" game in enhancing social skills (friendship, membership, partnership) for autistic children without any human intervention. They found that collaborative game encourages autistic children to interact with their partner in the game.

### 3.4 Discussion

In this literature review, we presented many related works in empowering the communication and social skills for children with autism. While the papers have evaluated the effectiveness of traditional PECS intervention system in developing their skills, we observed that most of papers only evaluated the first three phases of PECS and most of studies indicate that the session course take a round three months.

In the following points we present what makes this research different from other researches:

- In first step, we conducted assessment activities and collecting specialists notes about the participants as a primary information which play an important role in constructing the game and to be motivational factors in the game design.
- Prepared a list of preferred items and activities of each participant in order to reinforce the child to play the game and to be sure the participant is familiar for the game items. Moreover, conducting assessment activities to know the resources, strategies and sensory disorders for building robust serious game and to empower children with autism through instructional methods, animation and sounds. According to the reviewed literature[54], to train children how to use PECS cards, the caregiver usually prepared a list of preferred items to be reinforced him/her.
- In this game we make the participant practiced two ways in playing individual and cooperative levels. The participant has two goals in the game. First, he should pass the first four levels of individual game stage that simulate the four phases of PECS. Second, play the collaborative levels that simulated the last two phases of PECS.
- Educational roles in the game are given in a form of visual scanning, matching, ability to distinguish, build a complete sentence based on functional communication skills, ask and comments.
- The only reviewed paper that use one of intervention system to build is[30]. Despite, they used PECS to build cooperative game but they ignore PECS phases or principles to gradual in game difficulties and they only used its

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cards to develop their game and they only focused on measuring social skills behaviors.



# Chapter 4

## Experimental Design

This chapter describes the three aspects that the experiment stands for, game design, participants and environment selection and data collection.

### 4.1 Game Design

This section describes the structure of the game used to support social and communication skills of children with autism. Individuals with autism took part in different sessions (fifteen sublevels). The level of difficulty proportionally increases with the game level; The first thirteen sublevels played as individual to gradually develop his communication and social skills, where the last two sublevels is considered as a collaboration game between two players aiming to improve the social skills.

Based on serious game elements, we are employing these elements: storytelling, goal, feedback, time, rewards, instructional methods and rules:

- Storytelling Coherent the game with meaningful context could motivate the player to start gaming. Good creation of Storytelling in serious game makes this element an effective tool to gain a specific skills. We employed Storytelling in different levels. For instance, the girl wants to pass the bridge. Unfortunately, the bridge is broken and the girl will still move to pass the bridge. If the girl wants to survive and doesn't fall down, the player must help him to rebuild the bridge by matching a series of hint objects to the objects in the top of screen. For more details see Figure 4.1.
- Goal: The goals of this game to promote learning around both communication and social skills. So storytelling should support this and it's important to keep the learner through flow channel.

How we employ the principle goals in the game:

- Levels that practice the first, second and third phases of PECS: the main

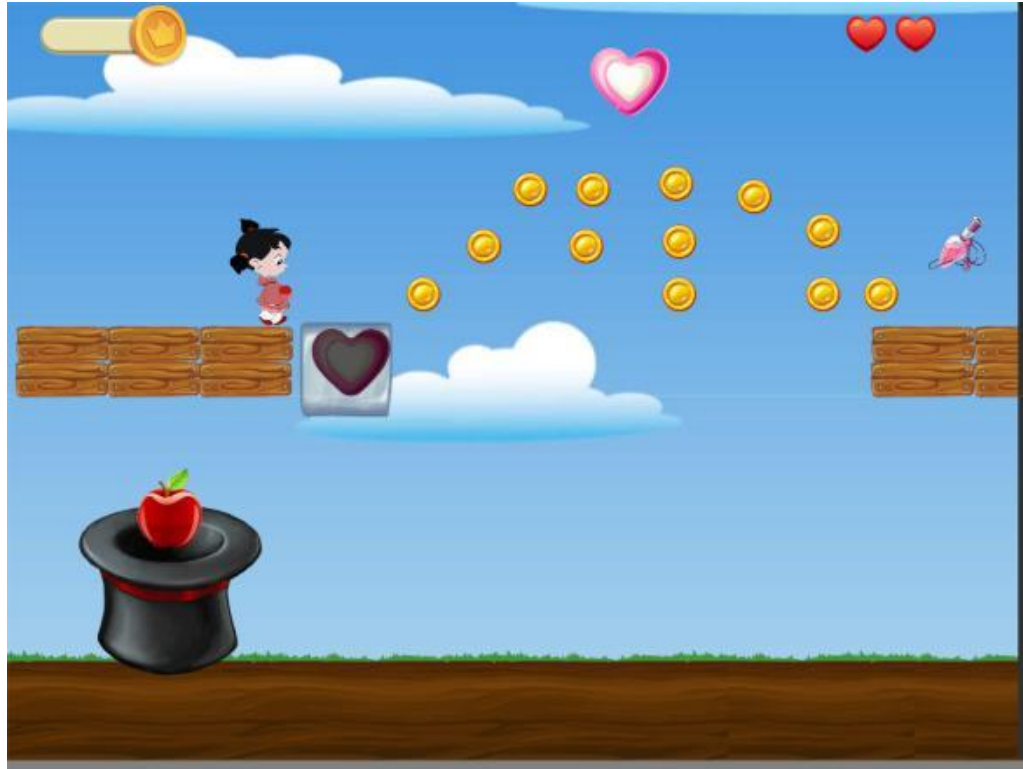


Figure 4.1: The first level of game for practicing the first level of PECS.

purpose to achieve discrimination skills.

- Levels that practice the fourth phase of PECS: the main purpose of this level to make the learner be able to communicate with others and build a complete sentence.
  - Levels that practice the fifth and sixth phases of PECS: Accomplish the progress in communication by giving comments and request a help.
  - Levels of cooperative phase: to be more social whereas the previous levels are lack of social activities, do partnership and have friends.
- The goals take into consideration incremental goals to reflect progress and encourage the player to keep on.
- Feedback: factors such as sounds and animation is essential in creating an interactive environment which motivate the children with autism and give them more sense of control.
  - Time: In this game three types of time where used:
    - In the levels that practice the first two phases of PECS: embedded time is used, where it means the value of time to express how much the child's respond is fast to do the correct action



Figure 4.2: PECS game to practice the phase3 and phase4 of PECS.

- In the levels that practice the phase four of PECS: mapping time is used, where it means link the time with something logical, to give an impression to do the quick required action before the time runs out. In this game we used fire.
- In cooperative levels PECS which practice the phase 5 and 6 of PECS: Using of clear time. Figure 4.3 represents the structure of cooperative game.
- Rewards: coins, souls and gemstones.
- Instructional methods: pictures and written cues can help children with autism to learn. Sometimes oral cues is not enough to deliver a correct message, whereas some of them have problem in understanding language. Instructional methods must take in consideration diversity among children with autism, their abilities and their needs change over time.
- Behaviour rules: are used in cooperative levels. In the following these rules:
  - Two tablet devices are used.
  - Two player should contribute to finish the game.

- Cooperative game aims to increase the interactive social skills of children with autism which is represented by : simple interactive dialog, understand the others , logic prediction.
- Functional rules: PECS concept and phases.

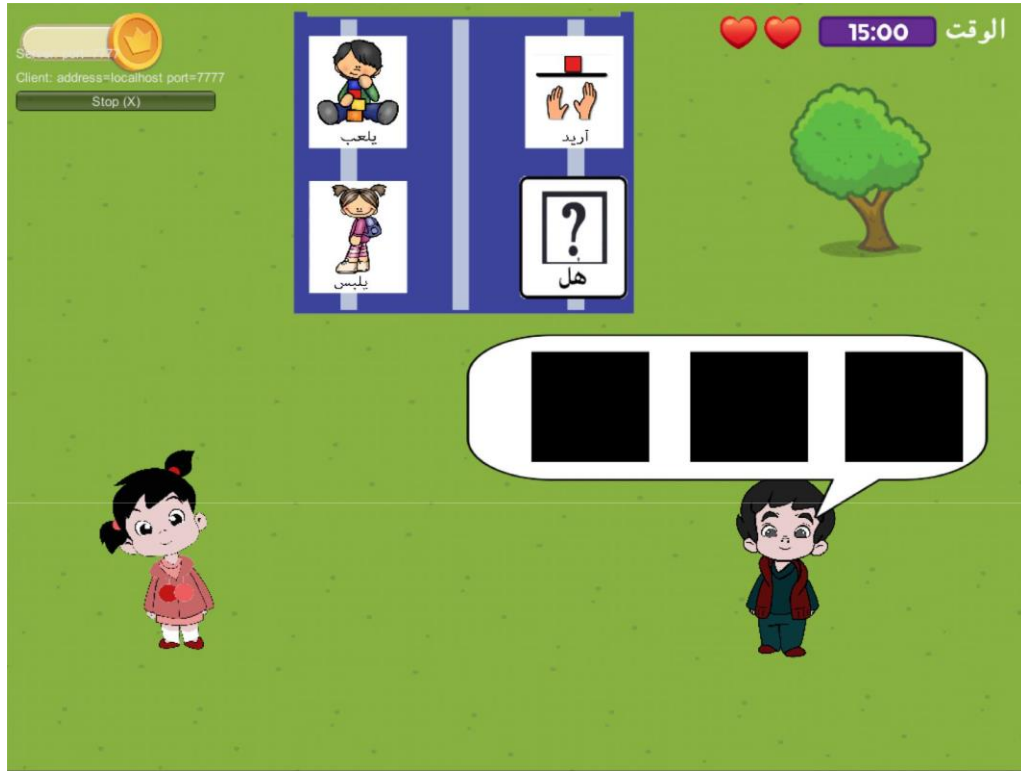


Figure 4.3: Cooperative game.

## 4.2 Participants and environment selection

Before we tested the game model, long processes were conducted by contacting with therapists in three centers and involving children with autism in assessment activities. Despite that the experiment conducted in the classroom of the center, we did not get too many willing participants due to cultural thoughts, no empty rooms and internet connection problems. As a result, sometimes we stay waiting two days until we can test the game in only one child and we went to three centers in order to do the experiment related to these challenges we did the experiment in one center with four participants.

### 4.2.1 The participants

Based on the therapist notes and the experimental activities that we did in two autism centers, see Appendix A. We pick up a small sample group consists of four

participants taking in considerations these points:

- Age.
- Diversity of participants' abilities (strong, weak).
- Have a communication problem.
- Have a social problem.
- Prepare a list of preferred items and activities of each participants in order to reinforce the child to play with the game. and to be sure that he/she can know the nature of items. See Table 4.1 which illustrates a subset of participants with their preferred items.
- Gender.
- He/She can use a tablet device.
- Doesn't use PECS before.

Table 4.1: List of preferred item for group of participants.

Participant	Food items	Toy items
Player D	Candy. Banana Cookies. Juice. Popcorn.	Toy drum. Computer. Puzzle. Musical toy. Swing.
Player C	Candy. Potato chips Fruit. Popcorn. Water	Doll. Animal toys. House toy.
Player B	Candy. Orange juice. water Fruit. Honey.	Puzzle. Books. Cars.
Player A	Sandwich. Fruit. Juice.	Toy drum Toy farm Toy guitar Toy car Ball. Bubbles.

### 4.2.2 The environment

Obviously, the conduct environment of individual environment is different from co-operative environment.

Individual game environment of first four levels:

- The experiment conducted to a classroom that equipped with table, chair and tablet.
- Removed any distraction factors that maybe confuse and reducing the attention of a child.
- Removed any other applications exist on the tablet.
- Only the player, therapist and experimenter attended to this room.
- The therapist roles are to help the child to react of changes and guide him if he asked.
- The experimenter roles to deal with any technical issues , observe and take notes
- Without interfering in the data collected.

Cooperative game environment of last two levels:

- conducted the game on classroom that equipped with one table, two chairs and two tablets.
- Removed any distraction factors that maybe confuse and reducing the attention of a child.
- Removed any other applications exist on the tablet.
- Only the two players , PECS game environment of therapist and experimenter attended to this room.
- The therapist roles are to help the child to react of changes and guide him if he/she asked.
- The experimenter roles to deal with any technical issues , observe and take notes
- Without interfering in the data collected.

### 4.3 Data Collection

For gathering the individual and cooperative variables for the experiment; the four participants took part in the game and the data observed and collected throughout different sessions (fifteen levels), while the majority of data is digitally collected directly from the game and posted automatically to the server database, the notes and observations recorded by the camera and manually by both the experimenter and therapist. In this section we define the variables that we measured. Collected variables related to individual levels:

- Response time: it's the required time that the player needs to start doing an activity (moving the objects, moving the actors) after he/she sees an evidence guiding the player to start.
- Language skills parameters. Table 3.1 presents assessment parameters of language.
- Stay focused and engagement time.
- Behavior functioning: Motor skills, ask for help or other interesting behavior that appear during the game.
- Ease of learning.

Collected variables related to cooperative levels:

- Look to the partner.
- Talk to help the partner.
- Talk to correct the partner.
- Talk to encourage the partner.
- Complain verbally.
- Comment.
- Smile.
- laugh.
- Using gestures.

The Pretest of functional communication skill values are filled after we interviewed with the therapists who response on each participant and used PECS cards to evaluate their ability in creating a complete sentences based on ten language skill parameters. The second column during the game are filled during the game and present the ability of the player to pass the game levels. Post-test is filled after the experiment and its used the real PECS cards to present the ability of the child on forming a complete sentence based on the phases 4,5 and 6 of PECS. Table 4.2 shows the collected parameters of language skill during the game. Related to the collected variable of cooperative levels we added them based on the literature reviewed[30], where they worked in enhancing social behaviors by using serious game approach.

Note: N= NO, Y= Yes and E= sometimes.

Table 4.2: Assessment of language skill parameters.

	A	B	C	D
	Skill	Pretest	During the game	Posttest
1	Request-edibles			
2	Request-toys			
3	Request-activities			
4	Request-help/assistance			
5	Request/ item based on its characteristics			
6	Reject-item			
7	Reject-activity			
8	Request-item for task			
9	Affirm/accept			
10	Comment-on activities			

The collected variables for serious game approach posted to the local server with the name of each player to be later analysis.

Camera used to record non predefined parameters to be analyzed along beside observational parameters see observation Tables 4.6 to 4.8 illustrate observational variables of individual and cooperative levels. The final stage of the data collection, after the experiment procedure was performed the questionnaire distributed to the therapists. The questionnaire goal is to measure how much the game facilitates the developing communication skills for children with autism by preparing a list of questions given to the therapists who have attended the testing sessions and other therapists who have tried the game and have a good experience on dealing with children with autism and their abilities. We distributed twenty questionnaires with ten questions to the specialists and caregivers in two centers in Ramallah to



Table 4.3: Level1 collected variables of individual level.

Measured parameters	Variables
# wrong triggers	Motor skills (drag & drop)
# losing spirit	To measure number of tries to complete the whole level.
# Reloading level	To measure number of tries to complete the whole level.
Summation of time on start moving each object /Game whole time	Response time.
Points	Motor skills, ability to distinguish between different objects and measure focusing.

Table 4.4: Level2 &amp;level3 collected variables of individual level.

Measured parameters	Variables
# wrong triggers	Motor skills (drag & drop)
# losing spirit	To measure number of tries to complete the whole level and if he self learning from the first level.
# Reloading level	To measure number of tries to complete the whole level.
Summation of time on start moving each object /Game whole time	Response time.
Points	Motor skills, ability to distinguish between different objects and measure focusing.

investigate the ability of the game on motivating children with autism be developing their social and communication skills, to what extent their feedback is close enough for our data results for long-term as well as short-term in the daily life of autistic children. Appendix B shows the questionnaire.

Table 4.5: Levels4 collected variables of of individual level.

Measured parameters	Variables
# wrong triggers	Motor skills (drag&drop) can be distinct between different objects and correctly matching the relationship within increasing the number of cards.
# losing spirit	To measure number of tries to complete the whole level and if he self learning from the previous levels.
# Reloading level	To measure number of tries to complete the whole level if the first level give him an experience to complete this level.
Summation of time on start moving each object /Game whole time	Response time.
Points	Is the points can encourage the child to take it remove the borders by correctly matching.

Table 4.6: Level1 &amp;level2 Observation parameters of individual level.

Measured parameters	Variables
Laughing	Stay focused and love the game.
Ask for help from therapists to complete a level	Can interact with others to ask for helping.
Engagement time	Time that the child want to keep on and play the other levels.
Correctly using UI	Pause button and effects of embedded time.
Instructional methods	Pictures and written cues can help autistic children to learn.

Table 4.7: Level3 &amp;level4 observational parameters of individual level.

Measured parameters	Variables
Laughing	Stay focused and love the game.
Ask for help from therapists to complete a level	Can interact with others to ask for helping.
Engagement time	Time that the child want to keep on and play the other levels.
Correctly using UI	Pause button and effects of mapping time.
Instructional methods	Pictures and written cues can help children with autism to learn. Moreover, can the voice for each PECS card guide the child to correct matching.

Table 4.8: Social levels (level5,6) observational parameters

Measured parameters	Variables
Laughing and Smiling	Stay focused and love the game.
Communicate with the partner	number of he/she talks with the partner for help, correct and encourage him/her.
Complain verbally	Using of complaint words to express player angry when the partner do wrong action.
Comments	Saying something to express their opinion.
Correct the partner	Using gestures to correct the partner.

# Chapter 5

## Results

As mentioned above, the experimental sample conducted upon four participants divided between three males and one female. This chapter presents the results of experiments that carried out for six weeks and divided into three sections. The first section addressed the relation between the serious game and engagement time, response time, behavior functioning, ease of learning and language skill parameters. The third section focuses on the role of serious game to empower communication skills and pre-test and post-test results. The social skills parameters are presented in the fourth section.

### 5.1 Playing Game Motivations

To measure the relation between serious game approach and learning motivations and engagements of PECS game, the results are collected by using observational notes of both therapist and experimenter. There are different variables can reflect enjoyment of children with autism in this game which are laughing, playing duration, stay focused and number of no response trails. The tables 5.1 to 5.4 illustrate the relation between games sessions and motivation parameters for all players.

Note: Playing duration = (end time - start time) of session, no response= number of no action response during the session, N= NO, Y= Yes and E= sometimes.

### 5.2 Behavioral Functioning

To investigate the effect of the game on the right of behavioral functioning two common functioning behaviors are measured; motor skills and ask for help. The tables 5.5 to 5.8 illustrate the behavioral functioning and other interesting behavior of four players in each level.

Table 5.1: Values of playerA motivation parameters.

Session	Level	Laughing or smiling	Playing duration (min)	Stay focused	# No response
1	1	N	12:04	N	21
2	1	N	14:00	E	15
3	2	Y	9:33	Y	14
4	2	Y	19:00	E	0
5	3	Y	12:20	Y	0
6	4	Y	12:04	Y	0

Table 5.2: Values of playerB motivation parameters.

Session	Level	Laughing or smiling	Playing duration (min)	Stay focused	# No response
1	1	Y	13:00	N	10
2	1	Y	7:18	N	25
3	2	N	12:27	E	4
4	2	N	12:27	E	2
5	3	Y	13:30	Y	1
6	4	Y	7:19	Y	0

Table 5.3: Values of playerC motivation parameters.

Session	Level	Laughing or smiling	Playing duration (min)	Stay focused	# No response
1	1	Y	7:20	Y	2
2	1	Y	15:6	Y	5
3	2	Y	6:05	Y	3
4	3 and 2	Y	9:01	Y	0
5	4	Y	4:48	Y	2

Table 5.4: Values of playerD motivation parameters.

Session	Level	Laughing or smiling	Playing duration (min)	Stay focused	# No response
1	1	Y	6:51	Y	1
2	2	Y	11.16	Y	3
3	2 and 3	Y	10:25	Y	0
4	3	Y	6:11	Y	0
5	4	Y	7:40	Y	0

Table 5.5: Values of playerA behavioral functioning.

Level	Motor skill	Ask for help	other interesting behaviour
1	Difficulty in drag and drop. Not interesting on collecting coins	N	exchanged eye contact with the therapist. Properly using UI.
2	Difficulty in drag and drop objects	N	-
3	Good controlling object movement.	N	-
4	Good controlling object movement	N	-

Table 5.6: Values of playerB behavioral functioning.

Level	Motor skill	Ask for help	other interesting behaviour
1	Not interesting on collecting coins. Very good skill on moving objects	Y	Sensory disorder on background music . Properly using UI.
2	Very good on moving objects	Y	-
3	Very good on moving objects.	N	-
4	Very good on moving objects.t	N	-

Table 5.7: Values of playerC behavioral functioning.

Level	Motor skill	Ask for help	other interesting behaviour
1	Not interesting on collecting coins. Excellent skills on moving objects.	N	-
2	Excellent skills on moving objects.	N	-
3	Excellent skills on moving objects.	N	-
4	Excellent skills on moving objects.t	N	-

### 5.3 Ease of Learning

This parameter reflects how fast the child who has never used the game before is able to learn and practice the game and estimate how much previous levels is helpful to

Table 5.8: Values of playerD behavioral functioning.

Level	Motor skill	Ask for help	other interesting behaviour
1	Not interesting on collecting coins. Excellent skills on moving objects.	N	Express winning through gestures and facial expressions.
2	Excellent skills on moving objects.	N	-
3	Excellent skills on moving objects.	N	-
4	Excellent skills on moving objects.t	N	-

Q1									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest – posttest	-.97500	.05000	.02500	-1.05456	-.89544	-39.000	3	.000

Figure 5.1: Paired t-test analysis of Request-edibles.

build a good experience for the child which paving the way to successfully pass next levels. Different variables are used to test the effectiveness of ease of gaming (number of wrong triggers, successful rate and response rate).pretest-posttest performed to compare participant groups and measure the degree of change occurring as a result of applying the developed game in helping the children on creating complete sentences. Tables 5.9 to 5.12 illustrate quantitative results of pretest, during the game and post-test also 5.1 to 5.9 show the analysis of paired sample t-test to evaluate the effectiveness of the developed game in helping children in dealing with advance phases of PECS cards in their daily life. To investigate the effectiveness of the game on encouraging the player to keep on and struggling to win Figure 5.10 shows the relation between the success rate of each player and levels during gaming duration. To present the decision making process by player and how the player thinks Figure 5.11 illustrates the relation between wrong trigger and response rate in level2 for each player we should mention that low response rate means high speed in taking decision while low wrong trigger rate means less wrong clicking. Note: N= NO, Y= Yes and E= sometimes.

Related to instructional methods different parameters are used to investigate

Q2									
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	pretest – posttest	-.97500	.05000	.02500	-1.05456	-.89544	-39.000	3	.000

Figure 5.2: Paired t-test analysis of Request toys.

Q3									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest – posttest	-.90000	.14142	.07071	-1.12503	-.67497	-12.728	3	.001

Figure 5.3: Paired t-test analysis of Request-activities.

Q4									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest – posttest	-.75000	.28868	.14434	-1.20935	-.29065	-5.196	3	.014

Figure 5.4: Paired t-test analysis of Request-help/assistance.

Q5									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					the Difference				
					Lower	Upper			
Pair 1	pretest – posttest	-.87500	.25000	.12500	-1.27281	-.47719	-7.000	3	.006

Figure 5.5: Paired t-test analysis of Request-item based on its characteristics.

Q6											
		Paired Differences				t	df	Sig. (2-tailed)			
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference						
					Lower				Upper		
Pair 1	pretest – posttest	-.75000	.28868	.14434	-1.20935	-.29065	-5.196	3	.014		

Figure 5.6: Paired t-test analysis of Reject-item.

Q7									
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	pretest – posttest	-.81250	.23936	.11968	-1.19337	-.43163	-6.789	3	.007

Figure 5.7: Paired t-test analysis of Reject-activity.

Q8									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest – posttest	-.87500	.25000	.12500	-1.27281	-.47719	-7.000	3	.006

Figure 5.8: Paired t-test analysis of Reject-item for task.

Q9									
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	pretest – posttest	-.81250	.23936	.11968	-1.19337	-.43163	-6.789	3	.007

Figure 5.9: Paired t-test analysis of Reject-Affirm accept.



Table 5.9: Assessment of language skill parameters for playerA.

	A	B	C	D
	Skill	Pretest	During the game	Posttest
1	Request-edibles	10%	5 out of 5 trails (100%)	5 out of 5 trails (100%)
2	Request-toys	10%	5 out of 5 trails (100%)	5 out of 5 trails (100%)
3	Request-activities	10%	5 out of 5 trails (100%)	5 out of 5 trails (100%)
4	Request-help/assistance	Never(0%)	1 out of 4 trails (25%)	2 out of 4 trails (50%)
5	Request/ item based on its characteristics	Never(0%)	2 out of 4 trails (50%)	2 out of 4 trails (50%)
6	Reject-item	Never(0%)	3 out of 4 trails (75%)	4 out of 4 trails (100%)
7	Reject-activity	Never(0%)	2 out of 4 trails (50%)	4 out of 4 trails (100%)
8	Request-item for task	Never(0%)	2 out of 4 trails (50%)	4 out of 4 trails (100%)
9	Affirm/accept	Never(0%)	4 out of 4 trails (100%)	3 out of 4 trails (75%)
10	Comment-on activities	Never(0%)	0 out of 2 trails(0%)	0 out of 2 trails (0%)

the role of instructional methods in guiding the child to understand the core of the game and to start doing his first action. In some cases the player didn't show any response on moving the objects. Figures 5.12 to 5.15 illustrate the distribution of no response of all players in level4 trails.

## 5.4 Collaboration Levels

For playing collaborative levels two groups are formed based on player performance on previous levels to be the first group A with B and the second group C with D. During the level's different parameters are collected tables 5.13 and 5.14 present the intentions of communications observed by level1 and level2 of both groups.

## 5.5 Questionnaire Results

The questionnaire used to investigate the ability of the game on motivating children with autism be developing their social and communication skills, to what extent their feedback is close enough for our data results for long-term as well as short-term in the daily life of children with autism. The data tables (Table 5.15-5.24)

Table 5.10: Assessment of language skill parameters for playerB.

	A	B	C	D
	Skill	Pretest	During the game	Posttest
1	Request-edibles	Never(0%)	5 out of 5 trails (100%)	5 out of 5 trails (100%)
2	Request-toys	Never(0%)	5 out of 5 trails (100%)	5 out of 5 trails (100%)
3	Request-activities	30%	4 out of 4 trails (100%)	4 out of 4 trails (100%)
4	Request-help/assistance	Never(0%)	Never(0%)	2 out of 4 trails (50%)
5	Request/ item based on its characteristics	Never(0%)	3 out of 4 trails (75%)	4 out of 4 trails (100%)
6	Reject-item	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
7	Reject-activity	Never(0%)	4 out of 4 trails (100%)	3 out of 4 trails (75%)
8	Request-item for task	Never(0%)	1 out of 4 trails (25%)	2 out of 4 trails (50%)
9	Affirm/accept	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
10	Comment-on activities	Never(0%)	0 out of 2 (0%)	0 out of 2 (0%)

Table 5.11: Assessment of language skill parameters for playerC.

	A	B	C	D
	Skill	Pretest	During the game	Posttest
1	Request-edibles	Never(0%)	5 out of 5 trails (100%)	5 out of 5 trails (100%)
2	Request-toys	Never(0%)	5 out of 5 trails (100%)	5 out of 5 trails (100%)
3	Request-activities	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
4	Request-help/assistance	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
5	Request/ item based on its characteristics	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
6	Reject-item	50%	4 out of 4 trails (100%)	4 out of 4 trails (100%)
7	Reject-activity	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
8	Request-item for task	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
9	Affirm/accept	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
10	Comment-on activities	Never(0%)	0 out of 2 (0%)	1 out of 2 (50%)

Table 5.12: Assessment of language skill parameters for playerD.

	A	B	C	D
	Skill	Pretest	During the game	Posttest
1	Request-edibles	Never(0%)	5 out of 5 trails (100%)	5 out of 5 trails (100%)
2	Request-toys	Never(0%)	5 out of 5 trails (100%)	5 out of 5 trails (100%)
3	Request-activities	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
4	Request-help/assistance	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
5	Request/ item based on its characteristics	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
6	Reject-item	50%	4 out of 4 trails (100%)	4 out of 4 trails (100%)
7	Reject-activity	50%	4 out of 4 trails (100%)	4 out of 4 trails (100%)
8	Request-item for task	Never(0%)	4 out of 4 trails (100%)	4 out of 4 trails (100%)
9	Affirm/accept	50%	4 out of 4 trails (100%)	4 out of 4 trails (100%)
10	Comment-on activities	Never(0%)	1 out of 2 (50%)	1 out of 2 (50%)

show the distribution of answers to our questionnaire presented as percent's across the values ( A lot / Average / Neutral / A bit / Not at all).

To investigate how much the game can gradually help and develop the children skills through the game levels tables 5.18,5.19,5.20,5.21. To investigate if the game is mapped well and covered the PECS phases and principles most of them answered 70% on average.

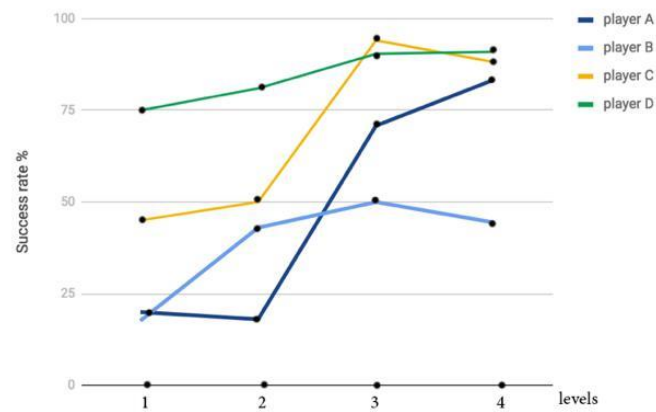


Figure 5.10: Paired t-test analysis of comment-on activities.

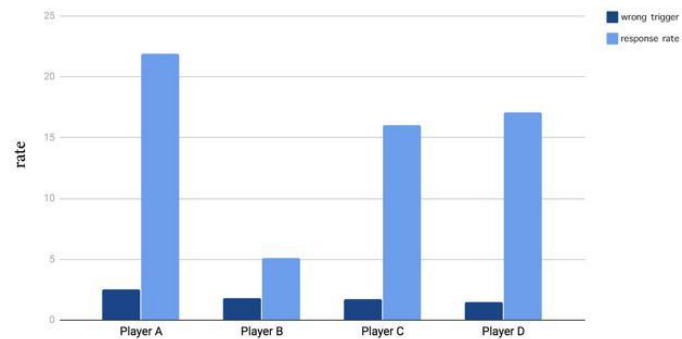


Figure 5.11: The relation between response time rate and wrong trigger in level2.

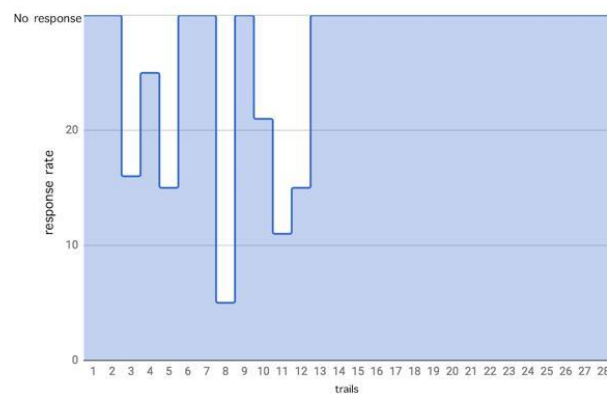


Figure 5.12: Response time distribution of player A in level4.

Figures 5.16 to 5.23 present some interesting behaviors that participants appear during the experiment.

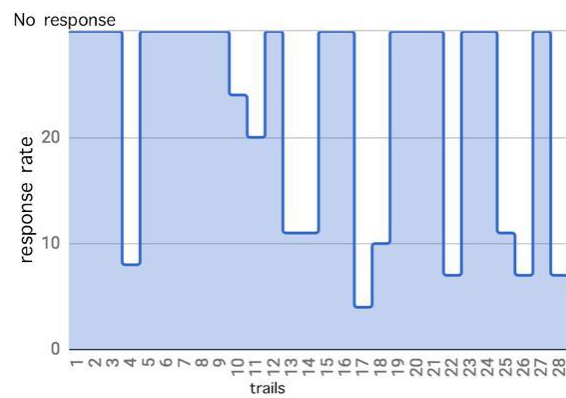


Figure 5.13: Response time distribution of player B in level4.

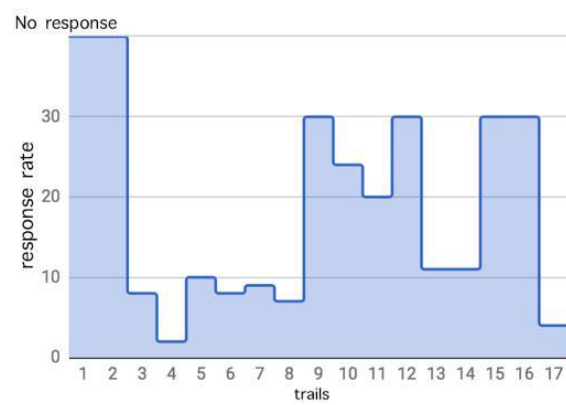


Figure 5.14: Response time distribution of player C in level4.

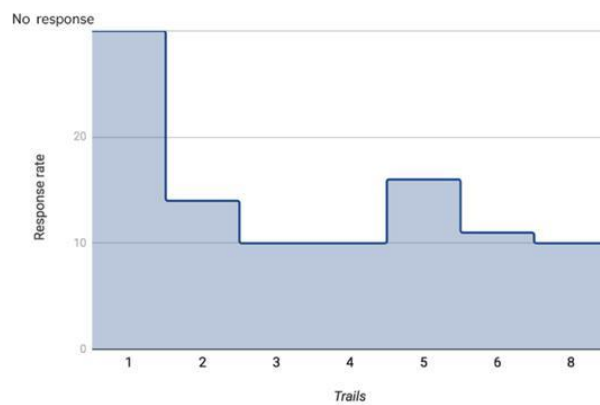


Figure 5.15: Response time distribution of player D in level4

Table 5.13: Intentions of communications of group 1 in level1 and level2.

	Level1	Level2
Look to the partner	15	8
Talk to help the partner	0	1
Talk to correct the partner	2	2
Talk to encourage the partner	4	2
Complain verbally	0	0
Comment	1	2
Smile	13	15
Laugh	3	4
Using gestures	9	7

Table 5.14: Intentions of communications of group 2 in level1 and level2

	Level1	Level2
Look to the partner	10	20
Talk to help the partner	3	3
Talk to correct the partner	1	5
Talk to encourage the partner	4	7
Complain verbally	0	0
Comment	0	0
Smile	14	30
Laugh	2	2
Using gestures	3	9

Table 5.15: Question1 results.

Q1.Do you think that the child can understand the rules of the game?		
Valid	Frequency	Percent
A lot	4	20
Average	10	50
Natural	0	0
A bit	6	30
Not at all	0	0
Total	20	100

Table 5.16: Question2 results.

Q2.Do you think that the child doesn't feel comfortable with the game environment?		
Valid	Frequency	Percent
A lot	0	0
Average	10	50
Natural	2	10
A bit	6	30
Not at all	2	10
Total	20	100

Table 5.17: Question3 results.

Q3.How close the game is in developing communication skills of child with autism?		
Valid	Frequency	Percent
A lot	4	20
Average	10	50
Natural	6	30
A bit	0	0
Not at all	0	0
Total	20	100

Table 5.18: Question4 results.

Q4.How close the game is in developing social skills of child with autism?		
Valid	Frequency	Percent
A lot	2	10
Average	14	70
Natural	2	10
A bit	2	10
Not at all	0	0
Total	20	100

Table 5.19: Question5 results.

Q5.Do you think that the child enjoys in playing the game ?		
Valid	Frequency	Percent
A lot	12	60
Average	8	40
Natural	2	0
A bit	2	0
Not at all	0	0
Total	20	100

Table 5.20: Question6 results.

Q6.Do you think the child's communication skills have been developed gradually through the game levels?		
Valid	Frequency	Percent
A lot	2	10
Average	12	60
Natural	0	0
A bit	6	30
Not at all	0	0
Total	20	100

Table 5.21: Question7 results.

Q7.Do you think the child's social skills have been developed gradually through the game levels?		
Valid	Frequency	Percent
A lot	0	0
Average	12	60
Natural	2	10
A bit	6	30
Not at all	0	0
Total	20	100

Table 5.22: Question8 results.

Q8.How close the game is in applying the PECS phases and principles?		
Valid	Frequency	Percent
A lot	2	10
Average	14	70
Natural	2	10
A bit	2	10
Not at all	0	0
Total	20	100

Table 5.23: Question9 results.

Q9.Do you think the game is suitable for all chil-dren and match enough with their abilities?		
Valid	Frequency	Percent
A lot	6	30
Average	6	30
Natural	4	20
A bit	4	20
Not at all	0	0
Total	20	100



Table 5.24: Question10 results.

Q10.Can the game helps the children with autism in their daily life?		
Valid	Frequency	Percent
A lot	6	30
Average	12	60
Natural	2	10
A bit	0	0
Not at all	0	0
Total	20	100

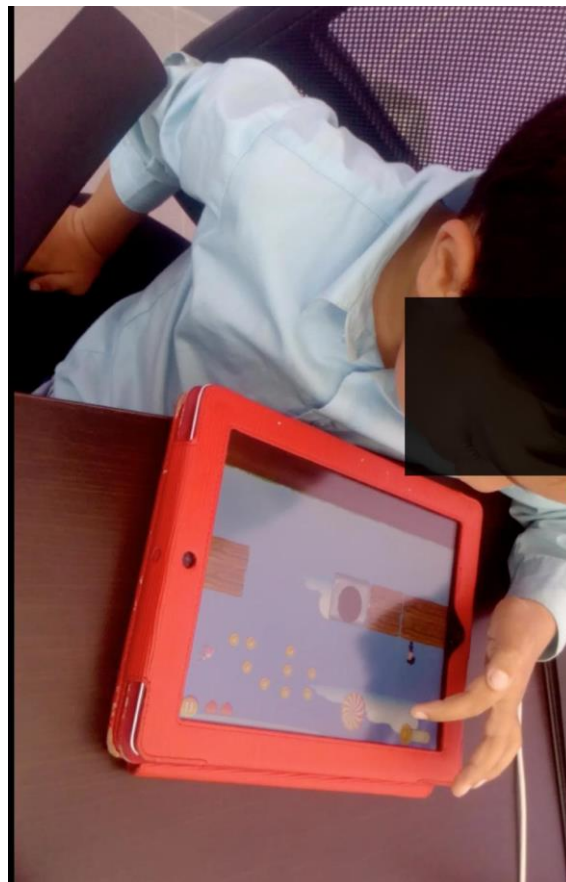


Figure 5.16: Player A is looking at player B.

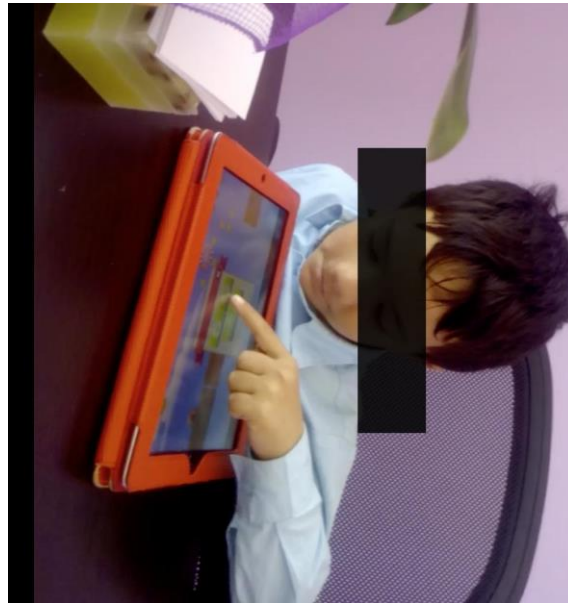


Figure 5.17: Player D is playing first level.

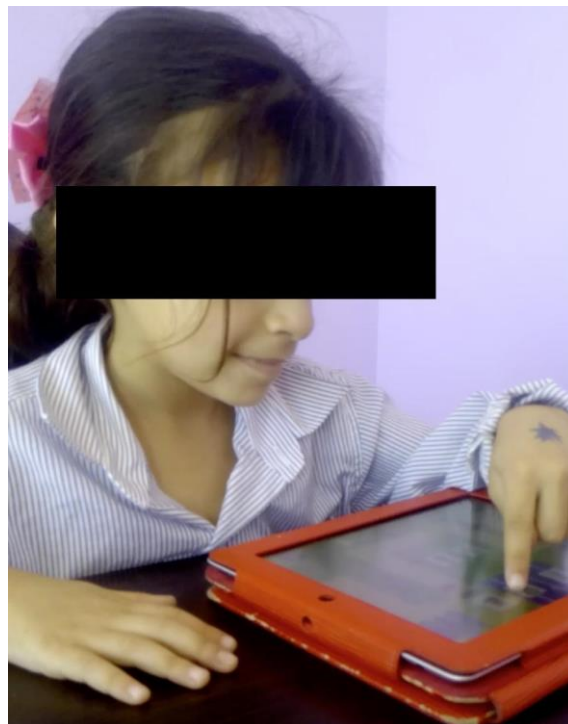


Figure 5.18: Player D is using UI.

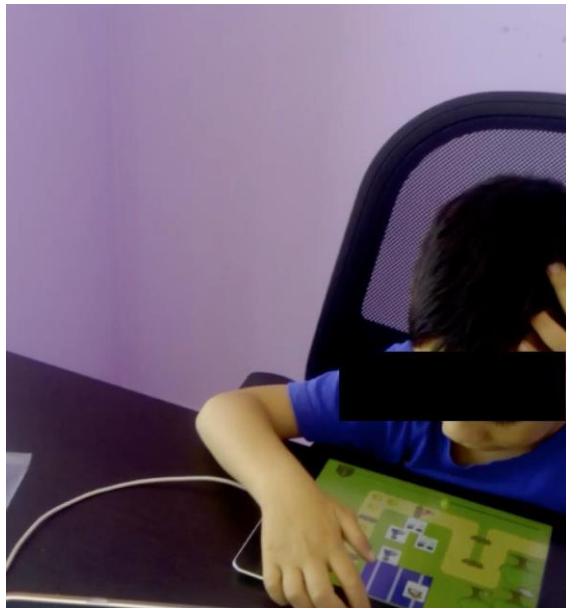


Figure 5.19: Player D is playing level3.



Figure 5.20: Player B is looking to the therapist.



Figure 5.21: Player D is clapping when he won.



Figure 5.22: Player A and B during play cooperative level.



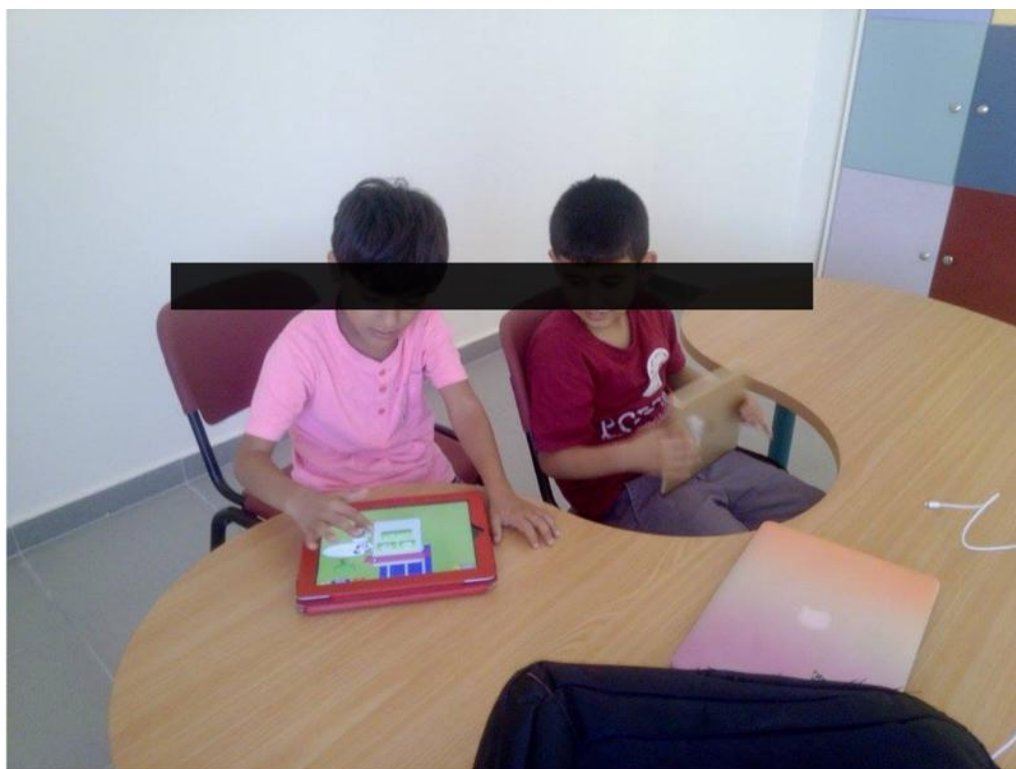


Figure 5.23: Player A is looking at player B.



Figure 5.24: Player A successfully created complete sentence to request edibles during post-test.



Figure 5.25: Player D during post-test session.

# Chapter 6

## Discussion

The results in chapter 4 display some interesting points. In this experiment, motivation parameters show a relation between serious game approach and increasing engagement on activities. Smiling and laughing and duration of playing indicate how much enjoyable the game is, it's considered by therapist both A and B often exhibit low tolerance time in doing any activity to be their tolerance on average 5-8 min, so with playing the game they reordered over than their ordinary tolerance time in sessions 4 and 5 to be more than 12 min, see tables 5.1 to 5.4. However, losing ability on controlling when playing leads to losing engagement. For example, A registered bad record of no response, focusing and smiling on first four sessions this have been changed on the last three sessions as see in table 5.1 because the procedure of moving object is changed from drag and drop to be on click. Also, facing difficulties on understanding the core of the game can lead to lose the motivation of playing, such as player B in the beginning sessions gave less motivation in playing the game comparing with other players, with time went by the focus and enjoyment parameters improved this might related to the core of the game in the first three sessions. On the other hand, Both C and D players demonstrated a good degree of interest in the game and the technology. Out of the specialists' answers to the questionnaire about if the child really has enjoyed the game, the majority of them confirmed the ability of the game in enjoying children with autism and attracting them, which support our observations and collected data about the motivational variables.

While the game design was enjoyable for the most of children, others showed their inability to adapt with it see tables 5.5 to 5.8, whereas A faced difficulties on dragging and dropping and player B annoyed from the game sound. Moreover, most specialists also advised that the game environment (characters / sounds / colors ) could be improved which make the child feel more comfortable with game. Also, when we asked about the suitability of the game in matching the abilities of children

with autism the answers' division between agree and disagree it almost equal.

Game design helps to learn by and builds a good experience for the players by contributing using different elements such as gradual on level difficulties, using of time, instructional methods and the feedback, these elements contribute in judging how difficult on building a good experience and understanding the core of the game. Figure 5.10 illustrates how the success rate for all players is exponentially increasing.

The analysis results of pretest and post-test indicated that that there is a significant difference between post-test and pretest of ten language skill parameters. Where the developed game successes in promoting participants' language skills. The results indicated higher difference in requesting. For example, the  $t(\text{request-edibles}) = -39.000$ ,  $p < 0.0001$ ,  $t(\text{Request-item based on its characteristics}) = -7.00$ ,  $p < 0.006$ . Related to the results of pre-test and during the game, the game has proved good ability to output some language skills that players don't used to use in their daily life. Tables 5.9 to 5.12 represent this improvement where most of players have successfully passing sub-levels that aim to form complete sentences to request edibles, activities and toys. The developed game cant promote request-help/assistant and request the item based on its characteristics of player A, but the post-test quantitative data showed ability of the game in long-term. Tables 5.9 to 5.12 represent this improvement. About the process of decision making by players both players C and D had high response rate with low wrong triggers; which backed that they need more time to scan the objects followed by dragging the objects within minimum number of triggers. Whereas player B had good response rate with low wrong triggers. See Figure 5.11

The game collaboration levels succeed on encouraging social behaviors (intentions of communications); While the most frequent communication intention was looking/smiling to the partner, the less frequent one was talking with partner and complain as table illustrate 5.13. In the level2 although there was a significant decreasing on looking to the partner, there was remarkable increasing on using gestures and smiling, moreover, some non-existing intentions in level1 have appeared in later levels such as "talking to help" the partner and "commenting", which considered as advance communication skills. Related to Players C, D in level1 they have good intentions communication such as talking to encourage and help the partner especially from player D as shown in table 5.14.



# Chapter 7

## Conclusion

This chapter concludes the thesis. A summary of developed game is presented with focus on the main contributions, results, limitations and assumptions, and future work.

### 7.1 Contribution

The main contribution of this thesis is developing a serious game for children with autism to help them in developing their communication and social skills. The developed game consist of a set of steps summarized as below:

- The game developed based the official intervention system "PECS" to be the core of the game with the integration with the elements of serious game which play an important role in attracting and motivating the children.
- Understand the autism requirements and the valuable suggestions from the therapists and speech language pathologist were considered an important contribution in developing the game.
- Prepared a list of preferred items and activities of each participant in order to reinforce the child to play the game and to be sure the participant is familiar for the game items. Moreover, conducting assessment activities to know the resources, strategies and sensory disorders for building robust serious game and to empower children with autism through instructional methods, animation and sounds.
- Employed serious game elements such as feedback and ability to choose the game's character added attractive factors to the participant to play the game.
- Educational roles are given in a form of visual scanning, matching, ability to distinguish, build a complete sentence based on functional communication skills, ask and comments.

- The educational components which need to be delivered in the game is gradually embedded in order to introduce attractive environment for encouraging the participants to keep on playing and take benefits.

## 7.2 Results

We use three ways of collecting results to evaluate the effectiveness of developed game. The results summarized as bellow:

- **Observational results:** these results are used to observe the social behaviors that the participants have showed during the game, these results are collected on individual and cooperative levels. The observational results indicate that the developed game have been successfully stimulated some behaviors that children in normal situations have not showed before, such as exchange eye contact, ask for help, talk with a partner, etc. Also, using the serious game technology encourages children to join in activities and increase their attention. Related to cooperative levels nine intentions of communication were observed to indicate showing of socially responsible behaviors between two players.
- **Collected results:** these data results posted directly to server database for further analyzing process, we collected these results in the first four levels of the game (individual game stage) to measure the response time, number of no response, wrong triggers and reloading of level and playing duration values. Also, these results give indication of the participant's enjoying. The collected results showed a positive impact for our game in promoting autistic children motor skills, their interactive functionality. Pretest and post-test results showed a significant difference in the language skills of children before and after the game, which proved the effectiveness of the game in improving the language skills in requesting, rejecting, etc.
- **Questionnaire results** are collected to investigate the ability of the game on motivating children with autism by developing their social and communication skills, to what extent their feedback is close enough for our data results for long-term as well as short-term in the daily life of children with autism. Out of the specialists answers to the questionnaire about if the child really has enjoyed the game, the majority of them confirmed the ability of the game in enjoying children with autism and attracting them, which support our observations and collected data about the motivational variables. Also, the questionnaire results indicate the ability of the game to develop both social and communication skills.

Despite the inability to demonstrate the effect of the game on improving communication and social skills in real life for children with autism. The game is successfully stimulated the functional communication skills on request, ask, reject that the participants have not appeared in their life at all. Moreover, The questionnaire results show the ability of the game to improve communication and social skills of children with autism in their daily life and on long term period, whereas when we asked specialists of autism "The effectiveness of the game in helping children with autism in their daily life" 60% answered on average were 30% answered a lot.

### 7.3 Key findings in relation to the research questions

The five subsidiary research questions were addressed at the beginning of this research play an important role in determining the structure of this research and contribute on answering the main research question.

- Can serious game attract children with autism?

The collected and observational results indicate our developed serious game have encouraged children to join on activities and increased their attention and motivations. On the other hand, some children showed less attention especially when they didn't adapt well with the game design or environment.

- Can serious game elements be adopted to work well with autism?

We added the instructional methods as effective elements in our game to guide the player in learning. Most of learning models in education children with autism depend heavily in using instructional methods in learning[55]. In this game we used photos, animation and spoken words to help the participant in learning.

- How much can we benefit from previously reviewed papers that target children with autism?

It is difficult to draw customize the serious game ideas to be directly applied to children with autism. Whereas, we observed children with autism can be easily distracted. such that extraneous materials and don't highlighting essential materials gives negative feedback and don't deliver the learning message.

- Can we adopted the formal intervention system PECS to be the core of our developed game?

Actually, we successfully used one of popular intervention system "PECS", that is used to help children with autism to develop their communication and

social skills to be able to express their needs and feelings. Customizing this system to be a serious game by gradual in game difficulties across six phases of PECS

- Can we conclude from the output results the ability of the game in developing communication and social skills?

The results show the game's ability in developing language skills, comparing between post-test and pretest results, the game caused many improvements in the players' behaviors and noticeably motivate showing many language skills in requesting, rejecting, affirming and social skills that child with autism lack off and don't usually use it in his daily life.

## 7.4 Challenges

The main challenge in this study is limitation of space in autism centers, such that the case study is designed to be conducted in two autism centers applied in eight children, but due to space limitation in the second center we practiced the game in one center with only four players.

## 7.5 Future work

The study spotlight on using instructional methods in gaming to guide the player in learning. So the next step will be focused on using instructional method principles to develop an intelligent system depends on the player abilities and his/her performance in previous levels and making analysis and based on that display instructions to help them in learning and make more progress in their skills.

# Appendix A

## An Appendix

### A.1 Children with Autism and Assessment Activities

In table A.1 and A.2 we display all autistic children in two autism centers, we applied three activities to evaluate their abilities and determine their needs. This table demonstrates the abilities and interests of autistic children in two autism centers based on caregivers notes, speech and language pathologists. The important of these two tables is lie in; every child has their reinforces that increase their motivation in learning.

#### A.1.1 Assessment Activities

We try to correctly evaluate the abilities of autistic children in matching, compensation and auditory processing. So we do three assessment activities.

##### 1. Matching activity:

How to play this game Kids look at clips and decide which one is matching the color wheel and rectangle, and clip it into place. See Figure A.1 The purpose of this game:

- To measure their motor skills (use clips with sufficient speed and accuracy).
- Measure visual scanning of different colors.

Table A.1: The autistic children in the first autism center.

The child	Age	Caregiver notes	Speech and language pathologists notes
Bara'a	7 years	<ul style="list-style-type: none"> <li>• Excellent using tablet devices and he can search in different languages (Arabic and English).</li> <li>• Very good abilities in math subject only when the questions is displayed on tablet devices.</li> <li>• He is interesting in listening kids songs.</li> <li>• Very bad contact eyes.</li> <li>• High sensory disorder.</li> </ul>	<ul style="list-style-type: none"> <li>• He has Pronunciation problem with some of the letters.</li> <li>• He can speak some words in English.</li> <li>• He can't create a complete sentences.</li> </ul>

- To be sure that they don't have sensory disorder problem related to colors.
- Two shapes (circle and rectangle) are used, in order to be sure that they can deal with different model in displaying the items.
- To measure their abilities in matching activities.
- Instructional methods that is used to guide children during the activity.

## 2. Competition Activity

In this activity the child will use sets of eyes, mouths and noses to put in its correct place. See Figure A.2.

The purpose of this game:

- Are they can grasp cartoon drawing?
- How they deal with composition game?
- How they deal with sets of choices?
- Instructional methods that are used in this activity?

Ala'a	8 years	She can use the tablet devices.	<ul style="list-style-type: none"> <li>• Very good abilities in creating sentences, but she talks in standard Arabic accent.</li> <li>• She mumbles in unclear words.</li> </ul>
Mujahid	8 years	<ul style="list-style-type: none"> <li>• He can use the tablet devices.</li> <li>• He like to encourage him by using promoting words such as (good job, excellent, etc.).</li> <li>• Good contact eyes.</li> </ul>	<ul style="list-style-type: none"> <li>• He has Pronunciation problem with some of the letters.</li> <li>• He can't create a complete sentences.</li> </ul>
Wala'a	8 years	She can use the tablet devices	<ul style="list-style-type: none"> <li>• Very good abilities in creating sentences.</li> <li>• She speaking in standard Arabic accent.</li> <li>• She mumbles in unclear words.</li> </ul>
Mohammed	7 years	<ul style="list-style-type: none"> <li>• He can write any words.</li> <li>• He e↵ects on loud voices by closing his ears</li> <li>• Bad contact eyes.</li> </ul>	<ul style="list-style-type: none"> <li>• He can't speak very well.</li> <li>• He can't create a complete sentences.</li> </ul>

- Related to the Figure A.3, we test if the child can create a complete sentence to describes each face?

Note:

This type of activities are used in order to:

Table A.2: The autistic children in the second center.

The child	Age	Caregiver notes	Speech and language pathologists notes
Hamdi	10 years	<ul style="list-style-type: none"> <li>• Need loud voice to be attention.</li> <li>• He can use tablet devices.</li> <li>• He has inactive autism.</li> </ul>	<ul style="list-style-type: none"> <li>• He can't speak.</li> <li>• He mumbles with unclear words.</li> </ul>
Mohammed	8 years	<ul style="list-style-type: none"> <li>• He can use tablet devices.</li> <li>• Need loud voice to be attention.</li> </ul>	<ul style="list-style-type: none"> <li>• He speaks some words.</li> <li>• He can't create a complete sentences.</li> </ul>
Qusai	7 years	<ul style="list-style-type: none"> <li>• He can use tablet devices.</li> <li>• Very clever boy.</li> <li>• He has inactive autism.</li> </ul>	<ul style="list-style-type: none"> <li>• He speaks in standard accent.</li> <li>• He can't create a complete sentences.</li> </ul>
Laith	7 years	<ul style="list-style-type: none"> <li>• He can't use tablet devices.</li> <li>• Sometimes he has nervous Innings.</li> </ul>	<ul style="list-style-type: none"> <li>• He can't speak very well.</li> <li>• He spells some letters.</li> </ul>
Ahmed	6 years	<ul style="list-style-type: none"> <li>• He can use tablet devices.</li> <li>• He can learn fast.</li> </ul>	<ul style="list-style-type: none"> <li>• He can't speak.</li> </ul>

- Grasp children strength points, abilities and needs.
- Short-term goals are related objectives of communication skill goals in autism world.



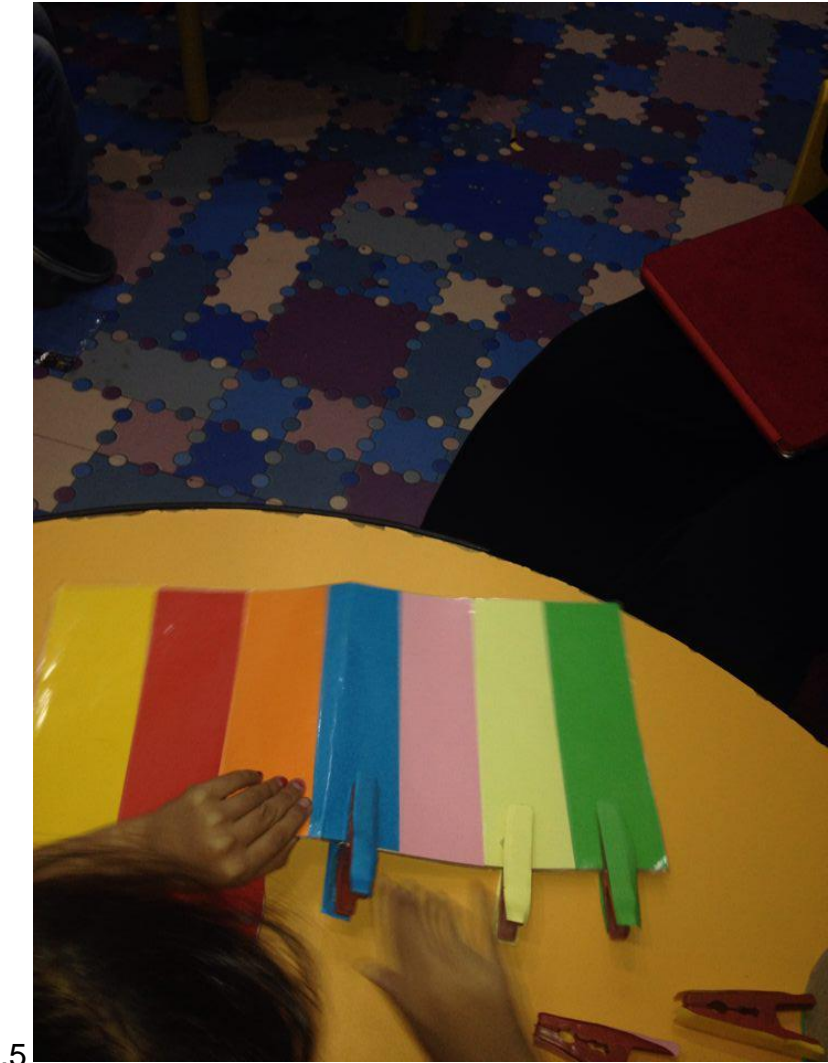
Salam	6 years	<ul style="list-style-type: none"> <li>• Good abilities.</li> <li>• She can use tablet devices.</li> <li>• She motivated in using promoting words.</li> </ul>	She can't speak.
Hmoudah	6 years	<ul style="list-style-type: none"> <li>• He can use tablet devices.</li> </ul>	<ul style="list-style-type: none"> <li>• He can speak.</li> <li>• He can't create a complete sentences.</li> </ul>

- Resources and strategies that will be used to build robust serious game to empower autistic children to depend on themselves.
- Auditory Processing Activity: In this activity animal and transport sounds will be used along beside card system to choose the correct answer. The purpose of this activity:
  - Can the child interprets and recognizes the sounds?. item How they deal with audio cues?
  - Check their matching skills when using audio cues.

Note:

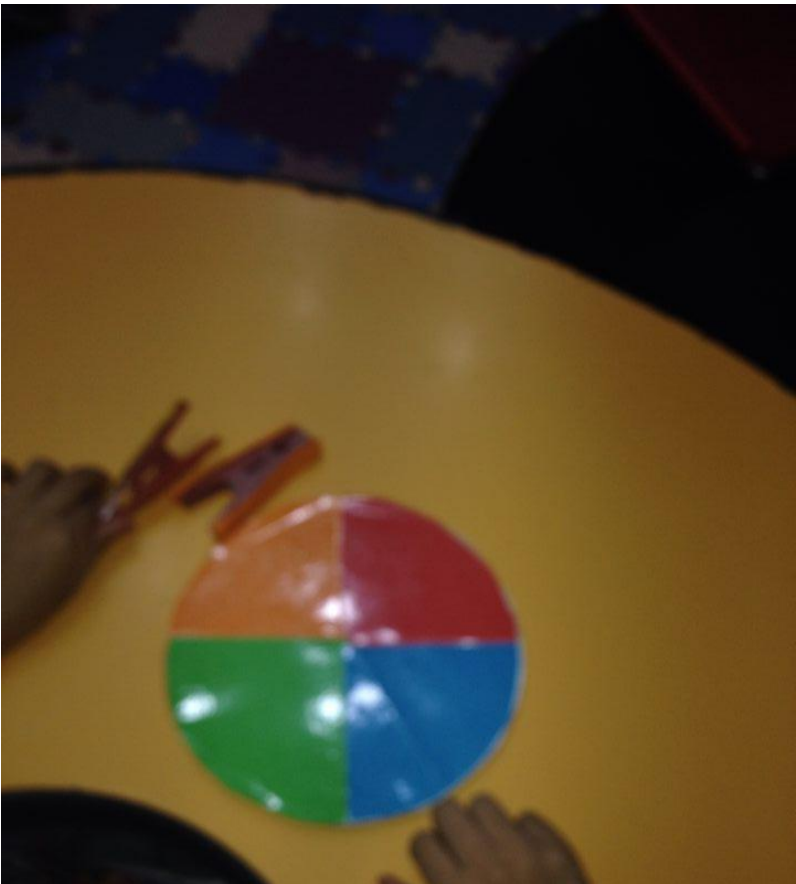
This activity are used in order to:

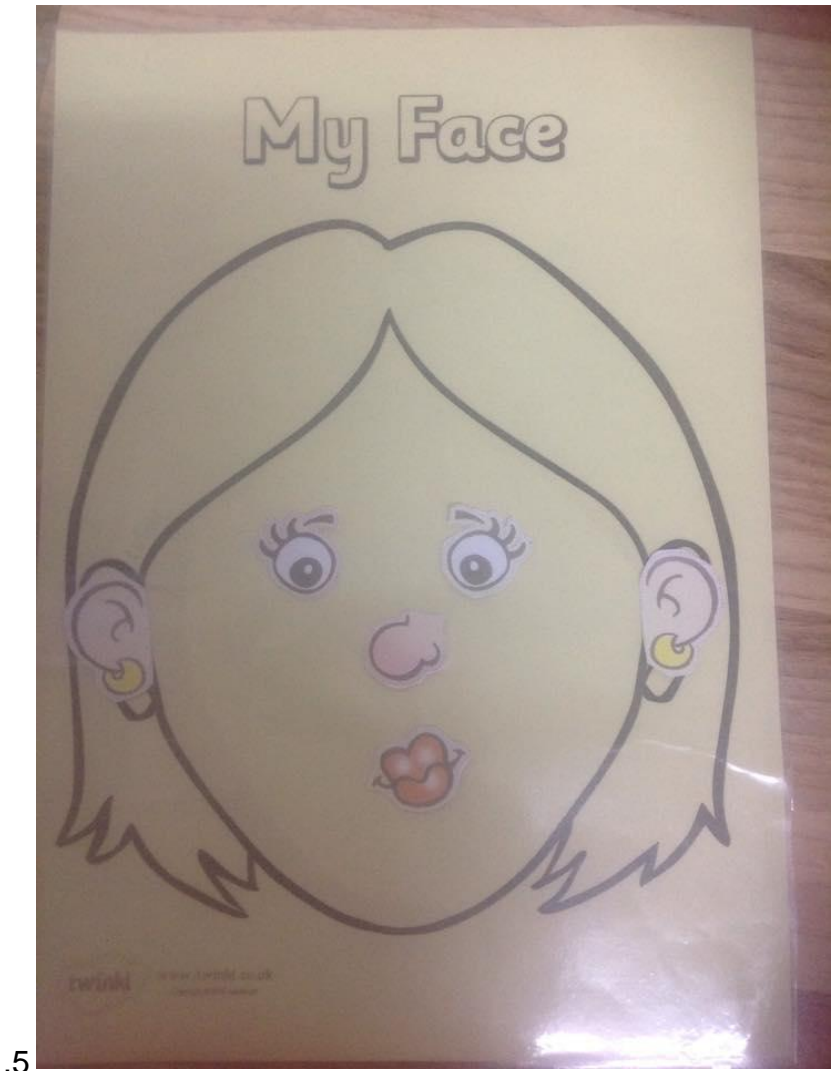
- Audio cues is important procedure to instruction child in different game levels and do the steps in correct way.
- Audio is essential to child language development.
- The game will depend heavily in this term to guide the child.



.5

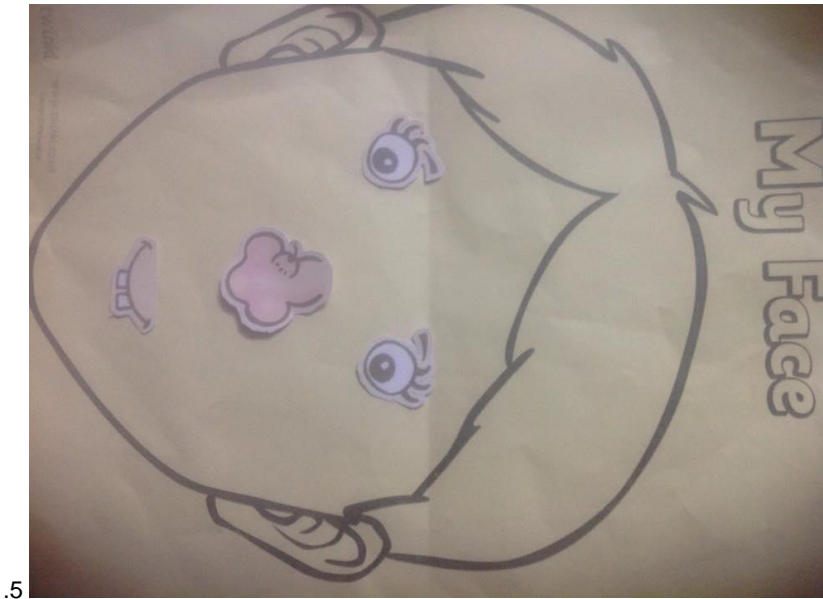
Figure A.1: 1a





.5

Figure A.4: 1a



.5

Figure A.5: 1b

Figure A.6: Composition activity in autism center.

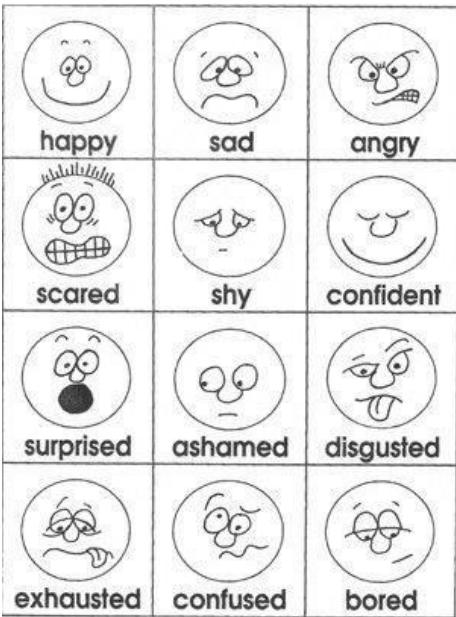


Figure A.7: Description the face activity.



Figure A.8: Auditory processing activity.

Table A.3: The child performance in the three activities.

The child	Match activity	Composition activity	Audio processings
Bara'a	1- High motor skills. 2-High speed in matching. 3-No sensory problem related to colors. 4-Can deal with two shapes. 5-Good matching skills. 6-Loud voices, claps encourage him to do the activity.	1-He can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 2, he can't deal with a large number of sets. 4-He can't create a complete sentence to describe the face.	Good
Ala'a	1-Need instructional methods to start the activity. 2-High motor skills. 3-High speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Good matching skills. 7-Loud voices, claps encourage her to do the activity.	1-Can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-She can't create a complete sentence to describe the face. .	Good
Wala'a	1-Need instructional methods to start the activity. 2-Accept motor skills. 3-Good speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6Good matching skills.	1-She can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-She can't create a complete sentence to describe the face.	Good.
Mujahid	1-Need instructional methods to start the activity. 2-Good motor skills. 3-Good speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Good matching skills. 7-Loud voices, claps and promoting words encourage him to do the activity.	1-He can deal with cartoon drawing. 2-Good composition skill, but he can do it after the caregivers do it. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-He can't create a complete sentence to describe the face.	Good.

Mohammed	1-Need instructional methods to start the activity. 2-Weak motor skills. 3-Accept speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Good matching skills. 7-claps encourage him to do the activity.	1-Can deal with cartoon drawing. 2-Good composition skill, but he can do it after the caregivers do it. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-He can't create a complete sentence to describe the face.	Bad
Hamdi	1-Need instructional methods to start the activity. 2-Weak motor skills. 3-Accept speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Good matching skills. 7-Loud voices, claps encourage him to do the activity.	1-Can deal with cartoon drawing. 2-Good composition skill, but he can do it after the caregivers do it. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-He can't match it with correct answer, that describe the face (He can't speak).	Good
Qusai	1-High motor skills. 2-High speed in matching. 3-No sensory problem related to colors. 4-Can deal with two shapes. 5-Good matching skills. 6-Loud voices, claps encourage him to do the activity.	1-He can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 2, he can't deal with a large number of sets. 4-He can't create a complete sentence to describe the face.	Good.
Mohammed	1-Need instructional methods to start the activity. 2-Good motor skills. 3-Good speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Good matching skills. 7-Loud voices, claps encourage her to do the activity.	1-He can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-He can't create a complete sentence to describe the face.	Good.

Laith	1-Need instructional methods to start the activity. 2-Weak motor skills. 3-Weak speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Weak matching skills. 7-Loud voices, claps encourage her to do the activity.	1-He can deal with cartoon drawing. 2-He can't do the activity. 3-He can match the face after the caregiver do it with correct answer, (He can't speak).	Good
Ahmed	1-Need instructional methods to start the activity. 2-Good motor skills. 3-Good speed in matching. 4-No sensory problem related to colors. 5-Can deal with two shapes. 6-Good matching skills. 7-Loud voices, claps encourage her to do the activity.	1-Can deal with cartoon drawing. 2-Good composition skill, but he can do it after the caregivers do it. 3-Reduce the number of sets from 4 to be 1, he can't deal with a large number of sets. 4-He can't match it with correct answer, that describe the face (He can't speak).	Good
Salam	1-High motor skills. 2-High speed in matching. 3-No sensory problem related to colors. 4-Can deal with two shapes. 5-Good matching skills. 6-Loud voices, claps and promoting words encourage her to do the activity.	1-She can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 2, he can't deal with a large number of sets. 4-She can't create a complete sentence to describe the face.	Good
Hmoudah	1-High motor skills. 2-High speed in matching. 3-No sensory problem related to colors. 4-Can deal with two shapes. 5-Good matching skills. 6-Loud voices, claps and promoting words encourage him to do the activity.	1-He can deal with cartoon drawing. 2-Good composition skill. 3-Reduce the number of sets from 4 to be 2, he can't deal with a large number of sets. 4-He can't create a complete sentence to describe the face.	Good

# Appendix B

## An Appendix

### B.1 Questionnaire (English version)

Personal data      Name:      Age:      Gender: F      M

How many years do you have experience with dealing with children with autism?  
 Less than 1 year   (1 less than 5) years   (5 less than 8)years   more than 8 years

#	Question					
1	Do you think that the child can understand the rules of the game?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
2	Do you think that the child doesn't feel comfortable with the game environment?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
3	How close the game is in developing communication skills of child with autism?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
4	How close the game is in developing social skills of child with autism?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
5	Do you think that the child enjoys in playing the game ?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
6	Do you think the child's communication skills have been developed gradually through the game levels?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←



7	Do you think the child's social skills have been developed gradually through the game levels?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
8	How close the game is in applying the PECS phases and principles?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
9	Do you think the game is suitable for all children and match enough with their abilities?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←
10	Can the game helps the children with autism in their daily life?	A lot	Average	Natural	A bit	Not at all
		←	←	←	←	←

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