Implementing a Serious Game to Improve Communication and Social Skills for Children with Autism

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Abstract. In this research, we have developed a serious game app to help children with autism to overcome their social and communication problems. This game is implemented based on PECS system. The developed game is an educational game with educational target by containing educational roles based on PECS and other attractive factors. The 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 preliminary experiment results revealed a positive impact in promoting children with autism motor skills and their interactive functionality.

Keywords: Computer supported collaborative learning (CSCL) · Serious games · Autism

1 Introduction

Usually, a person who has good communication and social skills can effectively express his ideas and feeling 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 talking (listening skills) [1]. Limitations in communication and social skills for children with autism consider the main reason for not accepting them in the public in many countries. In term of intervention for children with autism, the more motivations in learning, the more positive effects they will get.

In this research, we employed the intervention system Picture Exchange Communication System (PECS)[1] to implement our serious game. Our game

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[1] https://pecsusa.com/pecs/.

is integrated 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 delivering 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 our game on improving communication and social skills in real life for children with autism. The game was 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 behaviors during the game.

2 Literature Review

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

– Weakness in communication and social interactions
– Language latency
– Unusual behaviors and delays in cognition
– Sensory processing disorder.

2.2 PECS Approach

PECS is developed in 1994 as one of augmentative and alternative communication (AAC) [3] strategies for solving language deficits of children with autism. 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) [4]. PECS technique has a notably developed with six phases:

– 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.
– Phase 3: Child is learned to distinguish between different pictures and learn to match the picture with preferred object.
– Phase 4: The child learns to build a sentence strip in order to obtain what he wants.
– Phase 5 and Phase 6: Expand the instruction to include helping, commenting and asking questions.

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 [5] 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 goals. Projecting game principles in learning or training environment dubbed as "Serious Game" or "Gamification" [6].

2.4   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 [7] 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 were identified in that research; 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.* found a positive impact of using serious game to teach autistic children new vocabulary by using computer virtual character dubbed as "Baldi" [8]. In meeting environment, Strickland *et al.* 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 [9]. In traveling, Mazurek and Engelhardt developed "Route Mate" a serious game is designed to promote traveling independently for individuals with intellectual disability [10]. In social life, Fernandes designed a Virtual character for helping autistic children to recognize others feeling [11]. They found effective role of context in improving the reaction of autistic children with games.

Serious game can be used as an assistive tool for people with autism, whereas games can lead to addict. Fernandes *et al.* mention of addiction problem of using video game for both individuals with ASD and individual with ADHD [12]. Autistic children are losing interaction with others, so they stick on tablet devices.

3   Game and Experimental Design

3.1   Game Design

This section describes the structure of the implemented serious game to be used to support social and communication skills of children with autism. Individuals

with autism took part in different sessions (fifteen sub-levels). The level of difficulty proportionally increases with the game level; the first thirteen sub-levels played as individual to gradually develop their communication and social skills, where the last two sub-levels is considered as a collaboration game between two players aiming to improve the social skills. The following game elements were employed in our game:

Fig. 1. The first level of game that covers the first level of PECS.

- Storytelling Coherent: We employed Storytelling in different levels. For instance, in Fig. 1, 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 does not fall down, the player must help her to rebuild the bridge by matching a series of hint objects to the objects in the top of screen.
- Goal: The goals of this game is to promote learning around both communication and social skills. Therefore, storytelling should support this and it is important to keep the leaner through flow channel. We employed the principle goals in the game as follow:
  • Levels that practice the first, second and third phases of PECS: the main goal in these levels is to achieve differentiation and recognition skills.
  • Levels that practice the fourth phase of PECS: the main goal of these levels is 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: The main goal here is to accomplish the progress in communication by giving comments and request a help.

- Levels of cooperative phase: The main goal here is to be more social, whereas the previous levels are lack of social activities, do partnership and have friends.
- 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 techniques 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 response was fast to do the correct action.
  - 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 a burnt rope.
  - In cooperative levels PECS, which practice the phase 5 and 6 of PECS: we used a timer. Figure 2 represents the structure of cooperative game.
- Rewards: the player will be reward by collecting 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.
- Behavior rules: the following rules are used in cooperative levels:
  - 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: these rules was covered by PECS concepts and phases.

3.2 Participants and Environment Selection

Participants: The participants in the preliminary experiment were selected based on the therapist notes and the experimental activities that we did in two autism centers. We picked up a small sample group consists of four participants taking in considerations the following aspects:

- Age.
- Gender.
- Diversity of participants' abilities (strong, weak).
- Have a communication problem.
- Have a social problem.
- He/She can use a tablet device.
- Does not use PECS before.

Fig. 2. Cooperative game.

Environment: The following is a list of the issues we considered for the individual game environment in the first four levels:

– The experiment was conducted in a classroom that equipped with table, chair, and tablet.
– Removed any distraction factors that maybe confuse and reducing the attention of the child.
– Removed any other applications exist on the tablet.
– Only the player, therapist and experimenter attended in the classroom.
– The therapist role was to help the child to react to changes and to guide him if he asked.
– The experimenter role was to deal with any technical issues and take notes.
– The following is the extra issues we considered for the cooperative game environment in the last two levels:
– Conducted the game on classroom that equipped with one table, two chairs, and two tablets.
– Only the two players, PECS game environment, therapist, and experimenter attended in the classroom.

3.3   Data Collection

The four participants took part in the preliminary experiment and the data observed and collected throughout different sessions, while the majority of data was digitally collected directly from the game itself and posted automatically to the server database. The notes and observations were recorded by the camera and

manually by both the experimenter and therapist. The following is the collected variables related to individual levels:

- Response time: this is 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 1 presents the assessment parameters of language.
- Stay focused and engagement time.
- Behavior functioning: these are the motor skills; such as asking for help or other interesting behavior that appear during the game.
- Ease of learning.

Table 1. Assessment of language skill parameters.

	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			

In the other hand, the following is the collected variables related to the 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.

In Table 1, the Pretest of functional communication skill values were filled after we interview the therapists to evaluate the player ability in creating complete sentences based on ten language skill parameters. The third column during the game were filled during the game and present the ability of the player to pass the game levels. Post-test was filled after the experiment and it 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.

We used a camera to record non predefined parameters to be analyzed along be-side observational parameters. Table 2 illustrate observational variables of individual levels. The final stage of the data collection, after the experiment procedure was per-formed a questionnaire was given to the therapists. The questionnaire goal was 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 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 autistic children.

Table 2. Level1 & 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.

4   Preliminary Results

We used three ways of collecting results to evaluate the effectiveness of developed game. The preliminary results are 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. In addition, 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. In addition, 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 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. 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. In addition, 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.

5   Conclusion

In this research, we developed a serious game for children with autism to help them in developing their communication and social skills. The game developed based on 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. In one hand, the 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. In the other hand, the educational roles were given in a form of visual scanning, matching, ability to distinguish, build a complete sentence based on functional communication skills, ask, and comments. In addition to that, the educational components, which needed 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.

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