Smart Therapy Environment: A Design Science Research Towards Innovative Artefact Design for Autistic Children's Social Interaction and Emotion Recognition

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Abstract

Autism is a lifelong pervasive developmental disorder that affects social, communication, and reasoning skills. Manual therapy merged with the latest artificial intelligence-based systems has shown promising results in developing social interaction and emotion recognition in Autistic children. Technological innovations for social interaction and emotion recognition in Autistic children are one of the most challenging and highly prioritized research objectives in today's world. In this study, the concept of a Smart therapy environment is introduced for children with Autism which aims to offer the following functionalities: (1) Simple and easy games projected on the sensor-based floor mat for social interaction and emotion recognition development in Autistic children. (2) Scientific therapy procedures, software applications, virtual reality basics, and robotic interventions inspire game designs. (3) Artificial Intelligence-based voice assistant as an avatar to guide and reinforce children during games. (4) Continuous monitoring of children's excitement, facial expressions, and stress through the smartwatch. Currently, no such system design concepts involve intelligent projected playgrounds with those technological aspects together for Autistic children's social interaction and emotion recognition development. So, the responsibility to develop the design of a Smart therapy environment cannot be underestimated and is something to focus on.

The study utilizes the framework and guidelines of design science research and assesses previous literature related to therapy for Autistic children's social interaction and emotion recognition development and how technology has been utilized in them. All of those studies help to identify factual perspectives of technological and manual establishments for Autistic children. At the same time, those concepts are the main tool to develop basic design principles that create a knowledge base for the artefact design of the study. Those design principles are used to develop the proposed Smart therapy environment including a few prototype designs of games. Those are further evaluated by interviewing professionals who were engaged in government project for Autistic children's identification, and early childhood learning in Bangladesh. The evaluation results encourage the future development and practical implementation of such a significant and feasible system as well as bring a few challenges to consider in reality. The entire study could be an inspirational concept in future research to combine smart and feasible technical aspects. The dynamic use of an artificial intelligence-based voice assistant in the form of a projected avatar and an interactive smart playground concept will inspire future researchers to think about new dimensions in Autism research.

Keywords

Artificial Intelligence, Social interaction, Emotional recognition, Autism spectrum disorder, Virtual reality, Robotic intervention, Applied Behavior Analysis, Artificial Intelligence-based voice recognition system, Smart therapy environment.

Supervisor

Responsible director of research, Netta Iivari.

Foreword

I am thankful to my supervisor, reviewers, examiner, tutor-teacher, and professors who supported me in achieving my goal in this study. Every day I learn to think, implement, and research. I am also grateful to the Autism Clinique in Chittagong, Bangladesh, and the wonderful Autistic children who are the main motivation for this study. I am also thankful to the participants who allocated their important time to participate in the interview. This study is a dream and emotion for me. Thanks to my wonderful parents and my children for inspiring me every day.

Again, special thanks to Netta Iivari for excellent support from the beginning. I am also very thankful to Helena Tokkonen for her nice cooperation.

Abbreviations

ASD	Autism Spectrum Disorder
AI	Artificial Intelligence
NDD	Neuro-Developmental disorder
PECS	Picture Exchange Communication System.
ABA	Applied Behavioral Analysis
SAR	Social Assistive Robots
VR	Virtual Reality
DTT	Discrete Trial Techniques
PRT	Pivotal Response Training
CDC	Centers for Disease Control and Prevention
TEACCH	Treatment and Education of Autistic and Communication-Handicapped Children
VVA	Virtual Voice Assistant
PDD	Pervasive Development Disorder

Contents

1. Introduction

People always communicated through language, physical movements, and emotions or feelings with each other in society, and thus social interaction developed. As a result, they experienced various sensory activities (Cristopher & Shakila, 2015; Charlton et al., 2020; Yin &Tung, 2013). Psychology and neurology findings suggested that emotions played a vital role in problem-solving, cognition, intelligence, and finally decision-making (Fabri et al., 2007). Thus, the expression of emotions through face and body was a part of natural human communication which also facilitated social life (Fabri et al., 2007). For average people, it was common to adopt such kind of interaction ability. Social interaction development is a normal and natural phenomenon for them because of their psychological advancement from childhood. However, there was a portion of people who had trouble interacting socially with others because they were born with different brain development for which their psychological behavior patterns were affected from childhood. (Goulart et al., 2018; Hirota & King, 2023). Sometimes, those behavioral problems and delayed learning abilities were so extreme that they suffered from language delays, hearing problems, social interactions, emotion recognition, and other vital issues (Volkmar & Pauls, 2003; Yin &Tung, 2013). The research categorized them as having Pervasive Development Disorder (PDD) which is also known as Autism (Volkmar & Pauls, 2003; Yin &Tung, 2013). This group failed to establish interpersonal relationships and integrated into society because of the limitations of interaction ability with others (Cristopher & Shakila, 2015; Volkmar & Pauls, 2023). It was not possible to fully cure this disability but therapeutic procedures and technological advancement helped to adapt them to society (Charlton et al., 2020). Researchers recommended the beginning of those interventions at the early stage of life with proper identification of the child's requirements as every Autistic child is unique in their perspective (Volkmar & Pauls, 2003) In 2022, one in 36 children was identified with Autism spectrum disorder (ASD) (Centers for Disease Control and Prevention,2022). For such a major proportion of people with Autism, the research of Autism is targeted as a highly prioritized area of research globally (Charlton et al., 2020; Yin & Tung, 2013).

The main motivation for this study came from personal work experience with Autistic children in a private Autism clinic, in Chittagong, Bangladesh during the pandemic time as a volunteer assistant nurse. It was possible to serve as an assistant nurse because the organization was a family-owned social service and there was a severe shortage of nurses due to the pandemic. The experience was about the handling of ASD children with care as suggested by therapists. During the engagement, I observed the specialist team's involvement in making ASD children socially interactive and joyful with small activities so that the child became confident and avoided self-injury. Moreover, children's interest in technology, such as digital tools and cartoon characters was also an important observation. All manual establishments such as organizing therapy environments with objects for specific procedures during therapies were interesting but they needed the time and patience of the therapist. During the entire working experience, I was inspired to think about supportive technological smart objects that can used practically to enhance the possibility of success in creating social interaction and emotion recognition in Autistic children. When the commencement of my Master's thesis approached, the chosen study focus centered around designing a Smart therapy environment aimed at fostering social interaction and enhancing emotional recognition development in children with Autism.

The study analyze previous literature based on applied behavior analysis (ABA), play-based therapies, and technically advanced implementation for social interaction and

emotion recognition in children with Autism. The literature review helps to identify gaps and at the same time to allocate effective and practical features. Initially, the focus is to study articles on Autism and behavioral changing therapies such as discrete trial techniques, picture exchange communication systems, and Pivotal Response training. Those therapies were known as Applied Behavior Analysis which was a scientific discipline that analyzed and focused on the overall behavior improvement of ASD children. (Yu et al., 2020). The study also analyzes play–based therapy. All of those research articles, books and websites explained those therapies as a very constructive and basic process for improving social communication, learning, and emotion recognition for ASD children. However, those usually required up to 40 hours of careful sessions each week. The successful implementations of those sessions were highly associated with professional skills, patience, timing, and cost. (ABA, 2020; Matson, 2009; Panceri et al., 2021).

To locate the technically advanced features, the selection involves studies on intelligent avatar-based software games, virtual reality-based environments, robotic implementation, smart environment concepts, virtual voice assistant systems, and smart stress monitoring systems. The study explored a collection of research articles on various software games especially for Autistic children's social interaction and emotion recognition development. For example, "ECHOES", "ALTRIRAS" and other interactive platform-oriented game-based learning environments such as "FaceSay", "ACALPA", "Edutainment system", and other applications. (Almeida et al.,2019; Bernardini et al.,2014; Hopkins et al., 2011; Konstantinidis et al., 2009; Moutaz et al.,2013). Most of those gaming environments had various humanoid or cartoon character avatars for teaching different social skills and emotion recognition to Autistic children as they were more attracted to the facial expressions of the avatar (Almeida et al., 2019). Thus, live animations using avatar pilots operated in a virtual game environment could be more dynamic as well as increasingly accessible technology for ASD children's social interaction and emotion recognition development (Almeida et al., 2019; Charlton et al., 2020; Fabri et al., 2007; Konstantinidis et al., 2009).

To assist children with Autism, robotic intervention was studied and published in a huge number of articles. Research showed high recommendations for the successful intervention of robots with Autistic children for social interaction and emotion recognition development. Articles presented social assistive robots as a well-functioning supportive system to generate interaction and cognitive skills among Autistic children. (Conti et al., 2015; Feil-Seifer & Mataric, 2005; Kim et al., 2013; Panceri et al., 2021). Children with Autism were very attracted to the robot and followed instructions compared to the therapist (Feil-Seifer & Mataric, 2005; Panceri et al., 2021). However, such a promising artificial intelligence-based field was occupied with feasibility issues related to Autism (Sharkey & Sharkey, 2010).

During the smart environment exploration for Autistic children's social interaction and emotion recognition development, the study also identifies the concept of a magic room and interactive floor-projected gym (Garzotto & Gelsomini, 2018; Takahashi et al., 2017). The study found the idea of interactive projection with the combination of smart objects and manual tools which enabled the establishment of a playground for children with Autism. Moreover, a few studies also presented the significant use of artificial intelligence-based voice assistance devices for guiding and motivating Autistic children for daily performance (Hoy & Pomputius, 2018; Parvin et al., 2022; Safi et al., 2021). Continuous stress monitoring was also found to be essential for Autistic children's safety (Hufnagel et al., 2017; Tomczak et al., 2020).

So, every specific environment was efficient with its specialization tools. However, research ideas, designs, and concepts did not explore a smart game environment that involved different advanced technologies together practically and effectively. In particular, the study was unable to find the idea of a projected avatar character with an artificial intelligence-based virtual voice assistant that guided and reinforced the child during physical participation in the floor-projected game. Continuous stress monitoring through a smartwatch was also not found with any interactive projected game concept. So, ultimately the study located a few gaps in the previous studies and formulates the research question as follows,

"What would be like a feasible and potent virtual intelligent environment for Autistic children where they can physically participate alone or with peers to develop social interactions and emotion recognition? "

In the following Figure 1, the overall process of the study is presented.

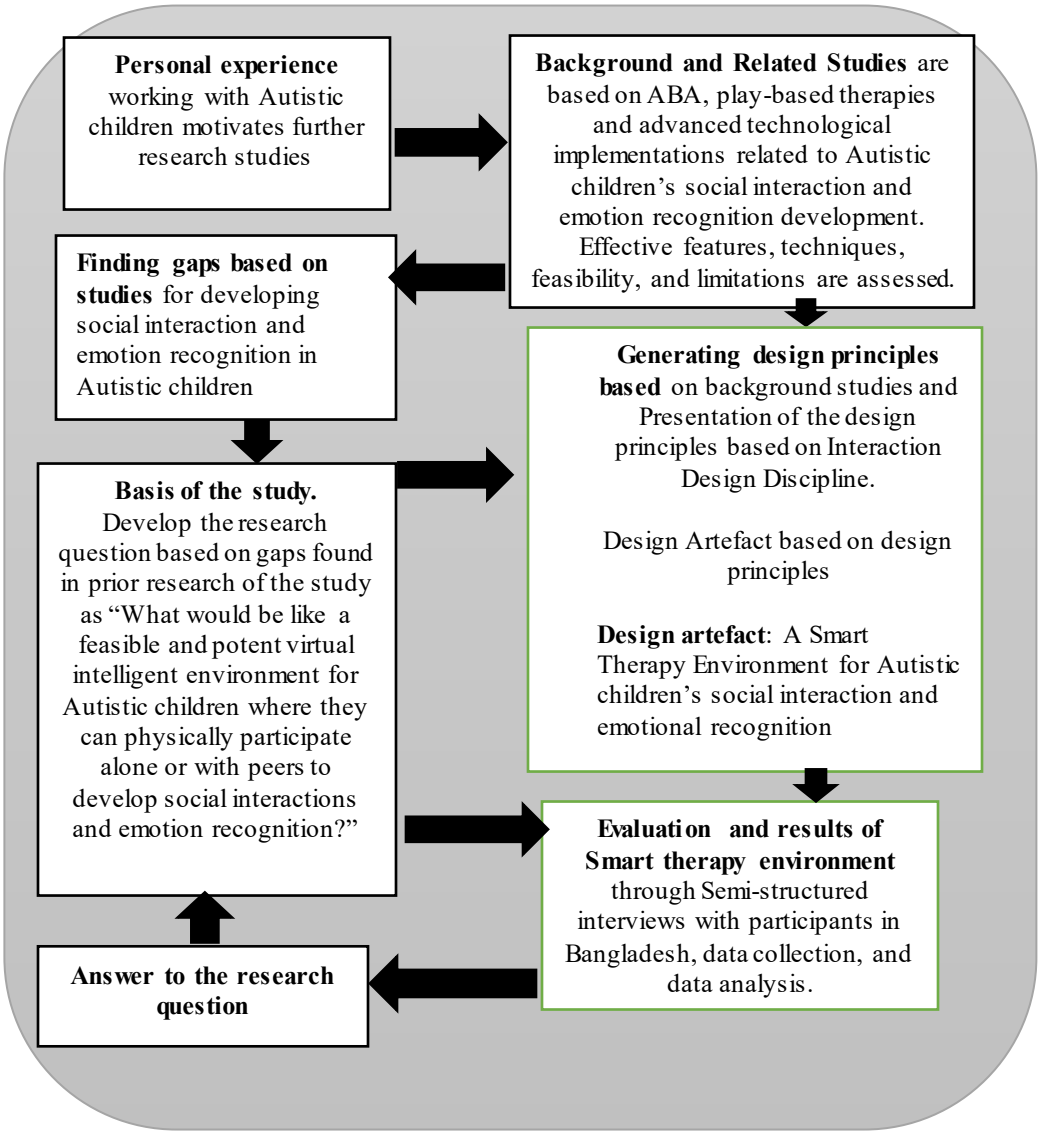

Figure 1. Overall process of the study that follows the design science research Method (Hevner et al., 2004)

Figure 1 shows the step-by-step process of the study from research motivation, finding of the research question, and answer to the research question. Personal experience motivates further research studies and the literature review helps to select and analyze background studies. That results in a combination of design principles and are presented by following the interaction design discipline. Those are used as a knowledge base for the artefact design of the study. Based on the design principles, the study proposed the artefact design of the Smart therapy environment. Currently, no such system design are available for Autistic children's social interaction and emotion recognition development. So, in this study design science research method is used to create and evaluate artefact of the proposed Smart therapy environment (Hevner et al., 2004). Design principles and artefact design of the proposed Smart therapy environment are described in detail in section 4. Further evaluation of the artefact design is done by interviewing expert people who were engaged in a government project for Autistic children's identification and early childhood learning in Bangladesh. The evaluation of the artefact will also act as an answer to our research question. The evaluation procedure and results are explained in section 5.

2. Background and related studies

In this section, the study explores previous research, books and websites based on applied behavior analysis (ABA), play-based therapy, and technical utilization that are successful in generating social interaction and emotional recognition among Autistic children. Those help to identify the feasible and efficient use of advanced technologies and manual therapies. Thus, the study finally separates those core findings that are practical and effective in developing social interaction and emotion recognition for Autistic children. Interaction design discipline is used to represent those core findings as design principles for the Smart therapy environment. With that regard, the interaction design discipline and its successful utilization are also demonstrated in this section. Those help to design the proposed Smart therapy environment.

2.1 Autism and Applied Behavior Analysis

Autism Spectrum Disorder(ASD) referred to a neurodevelopmental disorder(PDD) that affects behavior, movement, attention, or other mental conditions which results in a lack of social interaction, and repetitive or restricted patterns of behavior, interests, and activities (Association American Psychiatric, 2013; Cristopher & Shakila, 2015; Singh et al., 2022). ASD was diagnosed through the identification of persistent deficits in a few areas of social communication and interactions as follows (Association American Psychiatric, 2013):

- Atypical social approach and communication during conversation.
- Lack of response to social interaction
- Limited engagement in sharing interests and emotions.
- Challenges in integrating verbal and nonverbal communication.
- Irregularities in eye contact and body movement
- Deficiencies in establishing, comprehending, and cultivating relationships.
- Lack of interest in interacting with peers. (Association American Psychiatric, 2013).

Moreover, the severity level was also based on social communication impairment and selective monotonous behaviors (Association American Psychiatric, 2013; Cristopher & Shakila, 2015). ASD was combined with the term “Spectrum” which explored the most difficult side of the disability that means there were no similarities in the identification and treatment procedure for ASD children as every ASD child was unique from their behavioral disorder perspective (Cristopher & Shakila, 2015; Singh et al., 2022; Yu et al., 2020). There were lots of available effective therapies designed according to the specific needs of individual child requirement. Research showed that improvement in social interaction among Autistic children occurred if required analysis and scientific therapeutic procedures were applied at the early stage of their lives (Charlton et al., 2020; Cristopher & Shakila, 2015). Social interaction was the initiation of all activities and helped a child to adapt with changing behaviors (Cristopher & Shakila, 2015; Charlton et al., 2020).

Applied behavior analysis (ABA) is a scientific discipline that focuses on developing learning skills, social interaction, emotion recognition, and other behavior improvement and analysis of Autistic children (Yu et al.,2020). Based on the theory of operant conditioning by B.F Skinner’s principles, Ole Ivar Lovaas produced a method to help Autistic children alter their behavior in 1970 (Gitimoghaddam et al.,2022; Lovaas,2003).

The Young Autism Project Model was developed to evaluate that method by the University of Los Angeles in California. After two to three years of one-to-one, forty hours of intervention trials for each child, the results showed that forty-seven percent of Autistic children reached normal intellectual and educational functioning (Gitimoghaddam et al., 2022; Lovaas, 2003). ABA evolved from its core principles over the last 60 years and supported new forms of models, strategies, and practices (Lovaas, 2003). The most effective parts of this therapy involved the keen observations of the environment where the behavior occurred. It also analyzed and evaluated the factors associated with every behavior pattern of an ASD child. The process was coordinated with specific techniques that were suitable for specific situation. (ABA, 2020; Kearney, 2015; Matson, 2009).

The ABA technique involved different approaches and interaction methods between the therapist and the child. All those approaches were customized according to the behavior patterns, observations, and discussions with parents. During all the specific therapy sessions, the initial target was to monitor the attention and excitement of the child. Moreover, it was really important to observe the child's interaction with the therapist and the techniques involved. (ABA, 2020; Matson, 2009; Yu et al., 2020). During such sessions, therapists organized the environment of the intervention according to the child's interest and arranged tasks so that the child performed without fear or complications. Reinforcement is another interesting feature of ABA therapy that involved positive reinforcement and giving rewards. In case of failure, the reinforcing activity always appeared to be encouraging for the next attempt. Between all activities, there were time slots for relaxation, music, and storytelling activities. Specific games with balls, bubbles, or balloons according to children's preferences were also arranged to attract children's interest. Ultimately, this scientific method was effective in instructing, motivating, and reinforcing the child for activities that ultimately helped to adapt to new changes in behaviour. (ABA, 2020; Matson, 2009; Yu et al., 2020).

2.2 Common ABA Therapies

Applied behavior analysis (ABA) was a vast platform of research that provided parental interventions, social skill training, independent living skills, early intensive behavior interventions, functional assessments, etc. Discrete Trial Training (DTT), Picture exchange communication system (PECS), and Pivotal response training (PRT) were common ABA therapies that shared common features for developing social interactions. (Yu et al., 2020). PRT is not a pure ABA therapy but the concept of PRT is based on ABA principles (Brown, 2023).

Most of the time, Autistic children did not realize communicative efforts to make them familiar with certain things to learn. As a result, they tried to avoid the situation and were frustrated. This kind of situation was critical for the therapist to understand the way of introducing the learning materials to them. (Kamaruzaman et al., 2016; Lovaas, 2003). The discrete Trial technique was the most effective ABA therapy that supported Autistic children in acquiring new forms of behavior, knowledge, and action that they failed to utilize properly (ABA, 2020; Kamaruzaman et al., 2016). Discrete trial techniques (DTT) involved several trials according to the specific learning act and with few steps (cue, prompt, response, consequences, and intertrial intervals) (Kamaruzaman et al., 2016). The process was able to ensure the child's learning about the specific stimulus of any action and responding according to those acts. Ultimately the child's social interaction and communication skills were systematically developed through the application of DTT. This method involved structured steps for education, testing and reinforcing, ensuring the child could eventually engage with instructions independently or generate responses on

their own. Research indicated that the cultivation of nonverbal communication skills, including aspects like eye contact, imitation, comprehension of physical gestures, modulation of voice tone, attention, and facial expressions necessitated training grounded in the principles of DTT. (Kamaruzaman et al.,2016). Ultimately, children who had been interfered with such intensive intervention for at least three years, had achieved a high level of mental, physical, and academic skills that lasted for many years (Kearney, 2015; Lovaas, 2003).

PECS was also a unique augmentative therapy that involved pictures with icon settings (Angermeier et al., 2008; ABA, 2020). Those enabled Autistic children to understand different activities like "need", and "want", with different iconic images of objects. In such a kind of intervention, the role of the therapy environment was significant in achieving success. The therapy environment involved the picture setting of images and physical objects. An Autistic child was required to match the images and objects to present a need or a want for a specific object. It also helped the child to create different sentences for their requirements in a step-by-step scientific way through iconic images. (Angermeier et al., 2008).

2.3 Pivotal response training (PRT)

PRT was an evidence-based treatment for Autistic children that targeted pivotal skills and ultimately functional and learning skills were generated that lead to social interaction development. PRT was not an ABA therapy but the concept of PRT is based on ABA principles. Four pivotal areas were considered which resulted in more successful learning and social interaction development. (Koegel et al., 1989). Motivation was one of the pivotal areas focused by PRT which inspired the child to learn or to do any activities from their interest. During motivation, the child started their activities with their preferred toys or objects. Motivation also brought new opportunities such as engagement in pretend play and involvement with another person with a shared toy or objects. Both were important social skills. Another pivotal area was the initiation of social interaction which focuses on encouraging the child for social interaction development. The child was influenced to ask questions about activities or tried to capture other's attention through activities. The third pivotal area was responding with multiple cues that were enabled through proper training of the child so that they responded to multiple cues. The fourth pivotal area was self-management through which the child was taught to manage their behavior by themselves. (Brown, 2023; Koegel et al., 1989; Lei & Vintola, 2017). Research showed promising results regarding the improvement of social skills in children with Autism when PRT was implemented by peers (Koegel et al., 1989). Peers could be great motivational aspects during PRT-based intervention during the first school year for Autistic children. One study examined the efficacy of PRT treatment in Autistic children involving peer training. The before, immediate, and 6 to 9 weeks following an eight-session training session were carefully observed and evaluated. The results showed that the rate of peer engagement and social initiation increased and the overall intervention provided immediate positive results. Ultimately, Autistic children were involved more with classmates and peers. (Boudreau et al., 2019).

2.4 Play-based therapy

Another kind of therapy that was related to play also focused on social interaction development and learning skills for Autistic children. One web article showed that, during play therapy, most of the children experienced safety and were comfortable with the therapist. Thus, their skills and interaction at school or home were enhanced. Moreover, parents also participated actively during play therapy, and thus a stronger bond with

parents was achieved. Furthermore, play therapy provided a relaxed environment for the child to create their mood of engaging in their activities at their individual speed while simultaneously acquiring social skills. Such kind of intervention also brought more potentiality as the children tried to involve with peers. (Minot, 2023).

Another approach was the treatment and education of Autistic and communication-handicapped children (TEACCH) and important for providing structured teaching from a perceptual point of view by using visual aids. That ultimately supported Autistic children to become more independent with an understanding of reality. An appropriate environment with a visually attractive task schedule along with step-by-step properly structured learning materials were very useful in generating a better approach for TEACCH methods. (Andréas RB Deolinda, 2023; Mesibov & Shea, 2009). Besides, there was another interesting process called Aquatic therapy for children with Autism in which play-based intervention focused on the aquatic environment. Children showed more positive responses about acquiring knowledge of learning and thus, the social skill was developed with proper guidance. A study showed that Autistic children aged six to twelve achieved a satisfactory amount of knowledge about social facts and learning through three-month trials of such aquatic therapy. Parents also provided positive feedback as they noticed the encouragement of children while moving their bodies with excitement in the water games. (Güeita-Rodríguez et al., 2021).

All the above-mentioned therapies for Autistic children required a maximum of forty hours of interventions or commitment of the therapists per week (ABA, 2020; Kearney 2015; Panceri et al., 2021). At the same time, those demanded expert and authentic professional licensed therapists (ABA, 2020; Kearney 2015).

2.5 Avatar-Based Games

Research demonstrated the attachment of Autistic children to technology and as a result, they were attracted by digital devices such as Mobile, Tablet, or computer games (Bernardini et al., 2014). Children with Autism had difficulties with screening or understanding unnecessary sensory information so they needed a total of twenty-five to forty hours of ABA therapy per week from expert hands but most of the children did not get that recommended time slot for proper therapy (Hiniker et al., 2013). However, research showed that it was possible to narrow the disparity between the recommended and actual receipt of ABA therapy. That was possible through interesting gaming technology because most of the special children were heavy video game players which means they preferred playing video games most of the time. (Hiniker et al., 2013). Besides, creating visual stories to understand social skills and behavior patterns in a gaming platform with animated cartoons was possible through the latest interactive mobile or computer applications. Those were proved to be very advanced for Autistic children's social interaction development. (Bernardini et al., 2014).

Avatars are three dimensional virtual animated characters that inhabit in a virtual environment and have various animated behavioral abilities (Fabri et al., 2007). Research indicated that employing a computer-animated avatar resulted in increased motivation for children diagnosed with Autism to learn. This approach also lead to fewer disruptive behaviors compared to the more conventional method of personal instruction. The study revealed the effective utilization of computer-animated live agents for enhancing vocabulary and language acquisition for Autistic children. The study proved with experiments involving six Autistic children that the computer-animated instructor named “Baldi” was successful in teaching new words and sentences to the children which they further used in the natural environment. (Bosseler & Massaro, 2003). Avatar was also

able to produce emotions through body language which enhances the tutor-learner interaction. Therefore, Autistic children demonstrated a high level of distinction and clear comprehensions of emotions expressed by avatars. The study explored one research study on virtual messengers in which children of ASD had participated as humanoid avatars. (Fabri et al., 2007). The study analyzed that those virtual platforms were safe for Autistic youth to communicate with their avatars. They started mimicking the facial expressions of the avatars very effectively and also learned different social skills from them. The research also suggested an avatar-guided platform as it was able to present emotions through facial expressions and appropriate body language. It was also possible to slow down the communication ability of the avatar which enhanced a more adjustable environment to interact for Autistic children. (Fabri et al., 2007).

The research represented the design of the game "ECHOES" which included a 4-inch-display monitor and a three-dimensional virtual character that tutored the child to play the game and thus social interaction was developed. The study successfully proved that the humanoid virtual character ultimately became successful in capturing the children's attention and played a vital role in teaching social skills. (Bernardini et al., 2014). Also, there was other very lucrative game designs for Autistic children's mental development. For example, "ALTRIRAS" was a very attractive adventure game for ASD children that showed a cartoon environment and adventurous journey for the child where an avatar was acting as a friend. At the end of each journey, they found some chests with facial parts of emotional characters and needed to match them all to obtain a realistic emotional face at the end of the journey. (Almeida et al., 2019). That game was designed to teach students about social interactions and identification of emotional reactions on the human face such as anger, happiness, surprise, and sadness. The research showed that after a four-week trial with Autistic children, the team was successful in creating interest in the game or the virtual character in the children. Those children were also able to recognize facial expressions for emotions. (Almeida et al., 2019). However, body movement or peer activities were missing. Research suggested that physical movement and peer involvement were very important to enhance social interaction in children with Autism (Takahashi et al., 2017).

A study evaluated the effectiveness of FaceSay, a structured computer-based platform especially focused on social skill development and emotion recognition of Autistic children. Three games of different levels were designed to promote improved eye gaze, ability to discriminate facial expressions, and practicing social skill learning for Autistic children. The utilization of interactive and realistic avatar assistants enhanced their proficiency in employing social skills within natural environments. (Hopkins et al., 2011). The study revealed that Autistic children were interested in following the eye movement of the avatar to locate any specific objects. They tried to follow the eye gaze accurately and found the selected objects during the games. High-functioning Autistic children also tried to match the facial parts of the avatar to make different emotional expressions on its face. The less stress and easy instructions helped them to follow the avatar in learning emotions and other social skills. This study also encouraged the use of virtual avatars as a practical way to enhance children's participation in computer-based gaming environments. (Hopkins et al., 2011).

Another study illustrated that an interactive learning environment served as inspiration for modifying the educational approach for individuals with Autism. Affective Computer-Aided Learning Platform for children with Autism (ACALPA) was introduced as a learning platform that could be used by both teachers and students. The research study showed the trials of such an edutainment system operated by an avatar in the schools and found interesting feedback from teachers. (Konstantinidis et al., 2009). The entire

interactive platform provided multimedia content and avatar instruction to enhance therapeutic structured procedures such as the treatment and education of Autistic and communication-handicapped children (TEACCH). The avatar motivated the child to select content from a customized learning environment and also appropriately provided feedback. The avatar was also able to speak in the Autistic's native language which was the most interesting feature for the educator. The study revealed the educators' feedback on such educational platforms where they recommended the intelligent secured interface and avatar for learning social skills and emotion recognition for children with Autism. The study also evaluated that Autistic children did not lose their interest while learning in such an interactive interface. (Konstantinidis et al., 2009).

2.6 Virtual Reality (VR)

Virtual reality (VR) also emerged as a promising and cost-effective platform for assisting the social skill development and learning ability generation of children with Autism (Ke et al., 2020; Lu et al., 2017). VR was used in many forms such as computer rendering of a highly interactive virtual world or highly immersive multisensory environment established in laboratories. A VR-based learning platform enabled a controllable, motivating, non-threatening, diversifiable, and realistic environment for Autistic children. Research showed that VR was involved with an environment with authentic and plausible scenarios in which people performed real-life behavior in a virtual interface. (Ke et al., 2020). Research showed that with the construction of VR-based scenarios of daily life such as virtual schools, amusement parks, public facilities, and story scenes, it was possible to create a naturalistic learning environment for Autistic children. A study also showed that such kind of virtual schooling or virtual platform was interesting to Autistic children's and after one session, they wanted to participate again in the virtual world. (Ke et al., 2020).

Another study introduced the cost-effective WIVR (Wearable immersive virtual reality) that enabled Autistic users to experience three-dimensional virtual spaces of social stories. In this study, the WIVR (Wearable immersive virtual reality) was used to create a visual environment of social stories for children with neuro-developmental disorder (NDD) which was possible to customize according to children's preferences at any running time. It also provided feedback, and repetition of the stories, or any specific material to ensure better memory for children with neurodevelopmental disorders. (Gelsomini et al., 2017).

Virtual reality was also well known for its sensorial system. Children with Autism always suffered from sensory processing activities, so VR had a major role in treating Autistic children. (Lu et al., 2017). A study also explored the idea of a VR environment that involved pink dolphin Avatars. This VR game was designed to make Autistic children interested in training the Avatar dolphins for swimming actions. The child focused on giving the dolphin direction to move. Thus they were interested to learn skills. Eventually, the child started following the virtual elements more deeply and started using their hands during the interaction. Virtual games could be played in a simulated real-life scenerio multiple times without posing any physical risks. (Lu et al., 2017).

2.7 Robot-Assisted Therapies

Robotics played a vital role by using multimodal interactive functionalities through gesture, speech, or input devices. Those were customized for separate individual needs such as tutoring, physical therapy, personal assistance, and emotion recognition. The system could be a very good support for the therapist to generate more challenging

therapies. (Feil-Seifer & Mataric, 2005). Research also showed that during robot-assistive therapies, Autistic children's brain functionalities in those areas were activated more effectively which were responsible for creating attention along with social interaction development compared to normal situations (without a robot-assisted system) (Goulart et al.,2018). Social assistive robotics (SAR) was a well-implemented combination of social and assistive robotics to create a more generalized platform to help users through better interaction ideas for their specific needs. (Feil-Seifer & Mataric, 2005). For instance "Pleo", a socially expressive toy dinosaur robot measuring approximately 21 inches in lengh, 6 inches in width, and 8 inches in height was especially designed to convey emotions and attention through body movement and vocalizations (Kim et al., 2013). The study also showed that Autistic children tried to talk more with the robot compared to human tutors (Kim et al., 2013). Another example was the robot "Probo" which had an imaginary entity shape with 20 motors on its head that showed emotions as well as capable of verbal communication. The study showed that "Probo" helped the child to prepare fruit salad in a more interesting and inspiring way compared to a human tutor. (Simut et al., 2015). Another toy type robot is "Keepon" which was also very intimate with Autistic children. They tried to ask the robot several questions, introduced their toys to see the reactions of its face, and also soothed it by stroking its head. (Kozima et al., 2008).

There were also humanoid robots that looked like a human but were not that complex compared to humans. They delivered learning skills to Autistic children through models of imitating that were often quite difficult for them and thus human-robot interaction was developed. There were several types of successful humanoid robot implementation for example the robot "Nao" which was constructed to match the size of a two-year-old toddler. A research study proved that a well-designed and programmed remote-controlled "Nao" robot was capable of creating more eye gazing, imitations, and movements of the child during therapy sessions with pre-programmed dance or playful environment. Besides, when children came to learn about the remote controlling activity of the researcher to activate the robot, they showed more eye gaze as well as attention toward the researcher. (Conti et al., 2015).

Another interesting humanoid robot was "Kasper" which was a child-sized robot standing at 60cm. featuring a face made of a silicon rubber mask supported by a frame as well as 8-degree freedom of the head and neck movement but a fixed sitting place. It was able to sense the touch and according to that it moved its arms and could make different facial expressions of sadness, happiness, or excitement. (Robins & Dautenhahn, 2014). At the same time, it expressed feelings with verbal expressions. The study conducted an interaction with the robot "Kasper" with different aged school-going Autistic children and found that they were very interested in making the robot happy by touching it. However, few of them tried to touch it hard and wondered to see the sadness on the robot's faces when hiding the face with hands along with sounds. Those children asked the tutor about the facial expression of sadness of the robot and tried to realize that sadness. After a few sessions, they focused on making the robot happy with a soft touch and also gave a big smile to the robot. (Robins & Dautenhahn, 2014).

Moreover, in 2021, the latest research article introduced the "MARIA T21" robot which was portable and had a height that was also adjustable from 1.10m to 1.40m. The most innovative feature of the robot was the ability to project serious games onto the floor or on the table to support the therapists. Those games were performed with different movements or bar code identification cards. The robot had arms with 2-degree freedom and it reinforced the child in a very attractive way. It also presented facial expressions on

its face digitally. The robot had a touchscreen monitor on its chest along with a camera to record the movement or attention of the child during activities. (Panceri et al., 2021).

Thus, Robots were created to ensure a completely specialized therapeutic environment but the question was raised about the ethical issues for human-robot intervention especially for the treatment of Autistic children. So, ultimately such a promising field of artificial intelligence was occupied with so many barriers regarding the use of socially assistive robots. (Coeckelbergh et al., 2015). As we can see, the Euro barometer study presented the idea of public attitude towards social robot usage, and many European people were concerned about the implementation of human-robot interaction. As a result, they rejected the use of robots for caregiving. (Coeckelbergh et al., 2015; European Commission, 2012). Sixty percent of the EU citizens supported the ban on social robots for handling elder people and children with disability (Coeckelbergh et al., 2015; European Commission, 2012). Respondents showed more interest in robots as assistance or support for the therapist but not as a replacement (Coeckelbergh et al., 2015). Moreover, research showed that children or elderly people might have isolation issues and a robot-based system ultimately made them more isolated from human attachment (Sharkey & Sharkey, 2010). The long-term involvement of the robot with children would create a certain effect on their minds to think about the existence of the robot differently. Ultimately, they started thinking the robot had mental states and emotion recognition capabilities. Also, the researcher suggested more codes of conduct to limit the use of robots. (Sharkey & Sharkey, 2010). In 2022, a research paper outlined four key considerations that should be considered when implementing a social robotic system in the education sector. Those were barriers of language along with accent in pedagogy, system breakdown effects along with accidental harms, confidence, betrayal, and energy-efficient sustainable innovation. (Singh et al., 2022).

2.8 Virtual Voice-Assistant (VVA)

Another interactive technology was a virtual voice assistant (VVA) system that can understand human speech and respond accordingly. The widely adopted voice assistants are Apple's Siri, Amazon's Alexa, Microsoft's Cortana, and Google's Assistant. Those were typically integrated into smartphones or dedicated home speakers. Users asked questions or commanded the device to perform several tasks. It helped the user to learn and update daily to-do lists, and to manage smart homes, as well as older people also benefited through the use of such assistance. The interactions with humans were also done through actions such as jokes and stories, singing, performing mathematical solutions, or basic answering of questions. (Hoy & Pomputius, 2018; Safi et al., 2021).

A research study was arranged for three months of trials of three Autistic participants and their mothers with the use of a virtual voice-assisted system. The results showed improvements in expressing verbal vocabulary, learning of short phrases, and social interactions with the VVA application during the intervention trials. (Safi et al., 2021). The study compared Autistic children's learning or interacting interests using the VVA applications with traditional language stimulation activities involving the use of toys, picture cards, and storybooks. The VVA system was activated on the iPad named "Siri" and provided the children's mother with proper sessions with the researcher. The entire procedure involved trials with the children in the presence of their mother at home. It showed that children tried to learn some short phrases more quickly from the voice assistance application and felt an interest in learning more about the VVA system. Children also tried to follow the words they heard from the VVA and tried to use them with their siblings. As a result, the participating children successfully engaged with the VVA platform, generating new expressive vocabulary. They also try to interact more with

their siblings which was further reported by their mother. The data from the intervention phase demonstrated advancements in both social interactions and pronunciation of a greater number of words in fewer attempts. (Safi et al., 2021).

Another study revealed the progress of Autistic children's dental care at home through the use of Amazon Alexa. They used the personalized version of Alexa which could persuade the Autistic child for timely dental care and also helped the child to follow the routine guidelines for proper brushing. (Parvin et al., 2022). The study organized trials on three Autistic children under the supervision of their parents at home. It recorded the interest of the child in performing dental activities and also they tried to communicate with Alexa. Such intelligent home assistance with the voice recognition system helped the different levels of children with Autism to follow instructions in different ways. For example, some children frequently asked questions to Alexa about oral issues and others asked fewer questions. But overall the feedback from the parents was quite positive. However, some parents recommended Alexa as friendlier with the child in answering or communicating. The research article showed the good possibility of intelligent vocal assistants to motivate Autistic children with personal dental care at home. (Parvin et al., 2022).

2.9 Stress Levels Monitoring

Stressful situations were necessary to assess for individuals with Autism (Hufnagel et al., 2017; Tomczak et al., 2020). People with Autism often experienced high perceived stress levels and faced difficulties coping with the stressful situation. They also had difficulties in the accurate detection of stress and responded faster to fear. (Tomczak et al., 2020). As a result, monitoring stress and managing stress levels were very important for people with Autism (Hufnagel et al., 2017; Tomczak et al., 2020). A study successfully used an embedded sensor-based system in the shape of a manageable wristband to record the stress levels of Autistic children in an educational institution. The system also included software to analyze different stress levels and an algorithm to successfully monitor the data collection from the wristband to the software system. (Tomczak et al., 2020). The caregivers and teachers also provided positive feedback regarding the stress monitoring system data collected from the software application. They also recommended the user-friendly customization of the wrist band which was easily acceptable to wear by children with Autism. Research also recommended such stress monitoring wristbands with the software environment to monitor and manage stress for children with Autism. Customization options with color, shape, and elasticity to wear the wristband according to the preference of children with Autism was also possible. (Tomczak et al., 2020).

Another research study also showed that recording human psychological signals to measure different stress levels was possible through a process called vital sign monitoring. The paper proposed a prototype design of an embedded system that non-invasively measured heart rate and galvanic skin response. Those data could be analyzed by the intelligent approach that employed fuzzy logic to determine the high to low stress levels. The paper also proposed that such kind of device was possible to attach to a smartwatch or a smart wristband. (Gul Airij et al., 2016). So, stress level monitoring was a vital issue for any therapeutic environment for Autistic children, and a wristband or smartwatch was an effective option for monitoring and further management of data.

2.10 Smart Interactive Environment

Previous research introduced the concept of an interactive multisensory environment that involved interactive installations in a room where embedded systems merged with

physical objects to generate images, sounds, bubbles, and other smart influencing aspects that can motivate Autistic children's learning and social interaction development. The interactive environment with the effective utilization of smart technologies generated ambient projections, toys, ambient lights, mobile lights, aromas, and soap bubbles. Research showed that the use of games and colorful bubbles, sounds, and images created a magical room to motivate Autistic children in peer activities, relaxation, and social communication development. (Garzotto & Gelsomini, 2018). Different kinetics were used to detect body gestures, movements, and other children's activities. The magic environment started with the relaxation procedure by emitting lights, bubbles, aromas, and stuffed toys. Children were involved to check the shapes on the projection wall and match them on the interactive mats. There were also animated storytelling features of the room and that also encouraged the child for certain activities alone or in pairs. Music, learning, fun, and relaxation enabled the children to develop social skills, and caregivers were facilitated with smart equipment to maintain therapeutic procedures. The experiment of such a magic room was conducted successfully and researchers observed increasing interest of Autistic children in play-based activities compared to manual therapy procedure. (Garzotto & Gelsomini, 2018).

Another study revealed the concept of a floor-projected gym concept "FUTUREGYM" in which Autistic children played together to ensure better body movement, and peer attention, along with learning social skills. The research also proved that such kind of concept was very beneficial for developing social interaction in children. The researcher designed a floor-projected platform where children played with peers around specific projected shapes on the floor and followed each other. Those activities ensured physical fitness too. The research explored that such kind of peer-based activities initialized the motivation of the child to play and they started to interact with others' activities. During the running around the shapes, the child tried to give space or cooperate with others. (Takahashi et al., 2017).

All of those high-tech games, intelligent systems, and devices were helpful and stunning concepts for developing social interaction and emotional recognition for Autistic children. However, all of them had their design to highlight specialization features in a specific field and did not make a therapeutic smart environment with the combination of a few specializations together. However, some research proposed a smart environment with games, smart projected options, and smart tools to create ambient, encouraging, and soothing effects to support Autistic children's learning therapies. But playing with an avatar in a projected playground with intelligent voice communication is a new design concept for social interaction and emotion recognition development in children with Autism. Furthermore, the smartwatch stress monitoring option also added as a new dimension to the proposed system of the study. In the following section, the thesis explains the interaction design discipline based on which the thesis proposes the design principles for the Smart therapy environment for social interaction and emotion recognition development for children with Autism.

2.11 Interaction Design Discipline

Interaction design was the discipline that focused on designing interactive products, environments, or systems based on user experience to ensure the best quality products with accessibility. The discipline supported people in their everyday lives (Cooper et al., 2007; Preece et al., 2004). It defined system interactions with the user and was concerned with form content, system behavior, and user input. So, interaction design embodied three dimensions- form, content, and behaviors. A form encompassed the visual appearance and design aesthetics. It contained features such as colors, fonts, buttons, labels, and figures.

Contents defined the presentation materials those were visible to the user with the collaboration of form features. Form attributes supported the contents to generate a better user experience with the system design. Finally, behavior was contingent on both the content and forms, indicating how the contents are presented to the user. It pertained to the user experience and the emotions felt after accessing the presented content. Thus, Forms, contents, and behavior were closely related to each other. Interaction design aimed to produce good use qualities, efficiencies, and accessibility. The interaction design not only explored the idea of existing systems but also produced the design concept of imaginary contents and behaviors. The study of the design domain is significant for that perspective. (Preece et al., 2004).

Research articles found the interaction design discipline as effective in exploring important design factors, especially for children with disabilities (Anuar et al., 2013; Hussain et al., 2016). Those core findings of the effective design factors were proved practically important to improve the existing system design or introduce a new digital system design. Based on the successful research on practical technological implementations and user study, one research successfully utilized the interaction design guidelines to create a working prototype of a reading application for dyslexic children in Bahasa Melayu. In this research article, the analysis of the successful studies regarding dyslexic children's reading applications was done. After that, the research also involved the careful interview of dyslexic children to understand their difficulties and experience in reading through applications. The article presented the three dimensions of design principles based on those core findings and the interaction design discipline. Those dimensions helped to design more goal-oriented design prototypes of the reading application to ensure user satisfaction. (Anuar et al., 2013).

The study found another successful contribution of interaction design discipline in designing an edutainment system for children with Autism. After studying similar applications and recommendations, one study used the interaction design discipline to propose the design of the prototype of a new innovative application of an edutainment system. For creating the elements for form, content, and behavior, the study analyzed the features and contributions of five applications designed to ensure quality learning and communication skills for Autistic children. Those applications were CommApp, iCanLearn, Proloquo2Go App, TapToTalk, and AC Speech Communicator. The article suggested that three dimensions of presentation enhanced the design of a better edutainment system to facilitate communication skills for Autistic children. Better user satisfaction and learning outcomes were also achieved. Thus, interaction design proved to be significant in analyzing different important factors of the design or proposing a new system through the three-dimensional systematic procedure. (Hussain et al., 2016).

In this study, practical perspectives and effective utilization of ABA, Play-based therapy, and technical implementations from previous related literature were identified in a systematic way. Based on that the study introduces some design principles for the Smart therapy environment that can be an innovative support for therapy procedure of Autistic children. Interaction design discipline used to present those design principles of the Smart therapy environment. Those design principles introduce the concept of the avatar with an artificial intelligence voice assistant system that will act as a live animated character on the projected interactive floor games. Different ABA therapies and their step-by-step formulations also motivate the game design ideas. Moreover, projected interactive games on sensor-based floor mats, smart stress monitoring, content customization, and other feasible design principles support group interactions and ensure the safety of every participant in the Smart therapy environment. The study accommodates those design principles in more detail in section 4.

3. Research Methods

Research methods involve literature research in a systematic way, and design science research to create an artefact. The Literature review involved the utilization of search engines, including Google Scholar and Scopus to identify related research papers. The literature also involve a few websites based on Autism, applied behavior analysis (ABA) and play-based therapies although they are not scientific source to consider. This literature review is the knowledge base for designing the design artefact of the proposed system. That means the background analysis provides the assessment of the effective techniques, overall benefits, practical perspective and limitations of the ABA, play-based therapy and latest technological advancements. Those play a vital role in the design of the proposed Smart therapy environment.

3.1 Literature review

The literature for this study involves research articles, books and different websites for social interaction and emotion recognition development for Autistic children. Different informative website articles are chosen by examining the reference. In this study, all website articles has reference of research articles. Initially, applied behaviour analysis (ABA) and play-based therapy are selected. Because those were effective, scientific and successful intervention for the social interaction and emotion recognition of Autistic children (Angermeier et al., 2008; ABA, 2020; Boudreau et al., 2019; Matson, 2009). Research articles, books and websites are examined to locate gaps, effective aspects, techniques or procedures, limitations, and special features as well as overall benefits. Firstly, the study searched research papers from Google Scholar and Scopus. Search terms include, “Applied Behavioral Analysis for Autism”, “Play-based intervention for autistic children”, “Discrete trial technique”, ”Pivotal response training”, and” Picture exchange communication system” etc. The study also search webpages for the same purpose with the similar search words mentioned above.

The study also assesses technological implementation for Autistic children social interaction and emotion recognition development. For that purpose, the study select the latest successful technical features to analyse. Those are listed as follow,

- Robotic intervention (Both humanoid and non-humanoid robots , social assistive robotics (SAR))
- Avatar-based games
- Virtual Reality (VR)
- Virtual voice assistant system (VVR)
- Stress monitoring smart system
- Smart interactive room
- Projected interactive environment

The main focus is to identify gaps, effective aspects, techniques or procedures, limitations, and special features as well as overall benefits for Autistic children social interaction and emotion recognition development. The search terms involve “AI implementations for social interaction development on Children with Autism”, ”Virtual Reality-based games for Autistic children communication skill development”, ”How effective avatar-based communication system for Autistic child”, “Effectiveness of the robotic system for mental disable child development” and “AI voice recognition application for Autistic children”, “Ethical issues of AI for mentally disable child”, ”

Smart room for Autistic children",” Feasibility of robotics",” smart application for Autistic children stress monitoring ", "avatar-based software games for autistic children" , "Social assistive robotics for Autistic children" etc.

After finding the appropriate article, the study used Forward Snowballing (Wohlin, 2014). This paper outlined several crucial steps in the Snowballing method. The initial step involves examining the title of the paper, followed by reading through the abstract. Subsequently, attention is directed to the citation's location, and finally the full paper is considered. At each stage of snowballing process, exclusion may occur; for instance, if the full article does not align with the study's focus despite a relevant title and abstract, it is excluded. (Wohlin, 2014). Moreover, the study examines a few webpages and exclusion occurs if it does not have related good information along with reference of research studies. Web articles and web pages are mainly chosen to study Autism, ABA and play-based therapies. Research articles also examine for the same purpose. For the technological implementation, the study focus only on research articles published in journal and conferences.

The study examines the effectiveness, complete procedure, special features, Practical aspects, limitations, and overall benefits of all selected research articles, webpages and books. All of those high-tech games, intelligent systems, and devices are helpful and stunning concepts for developing social interaction and emotional recognition for Autistic children. However, all of them had their design to highlight specialization features in a specific field and did not make a therapeutic smart environment with the combination of a few specializations together. ABA and play-based therapies have also issues related to cost, time, therapist's expertise and patience. Thus, the study locates a few gaps in the previous literature and formulate the research question as follows,

"What would be like a feasible and potent virtual intelligent environment for Autistic children where they can physically participate alone or with peers to develop social interactions and emotion recognition? "

The core findings from the literature review are presented through the interaction design discipline as design principles for the Smart therapy environment (Preece et al., 2004). Those are described in more detail in section 4.

3.2 Design Science Research Methods

After finding the core effective and feasible features, the study also located a gap in research studies. There is no current research on proposing any smart therapy environment with all those located features together. So the study finds the Smart therapy environment as a completely new dimension of research in Autistic children's social interaction and emotion recognition development. The design science research method is utilized for designing and developing artefacts. The study also follows the structure that is defined by Hevner et al. (2004) as seven guidelines for creating artefacts in design Science Research. As the artefact of designing a Smart therapy environment with effective smart features of game designs is unique, design Science as a research method was suitable to do the research. Design Science can be defined as follows:

"[Design Science] seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished." (Hevner et al., 2004, p. 76)

The design framework of the design science research for this study is discussed below following the information system design framework mentioned by Hevner et al. (2004).

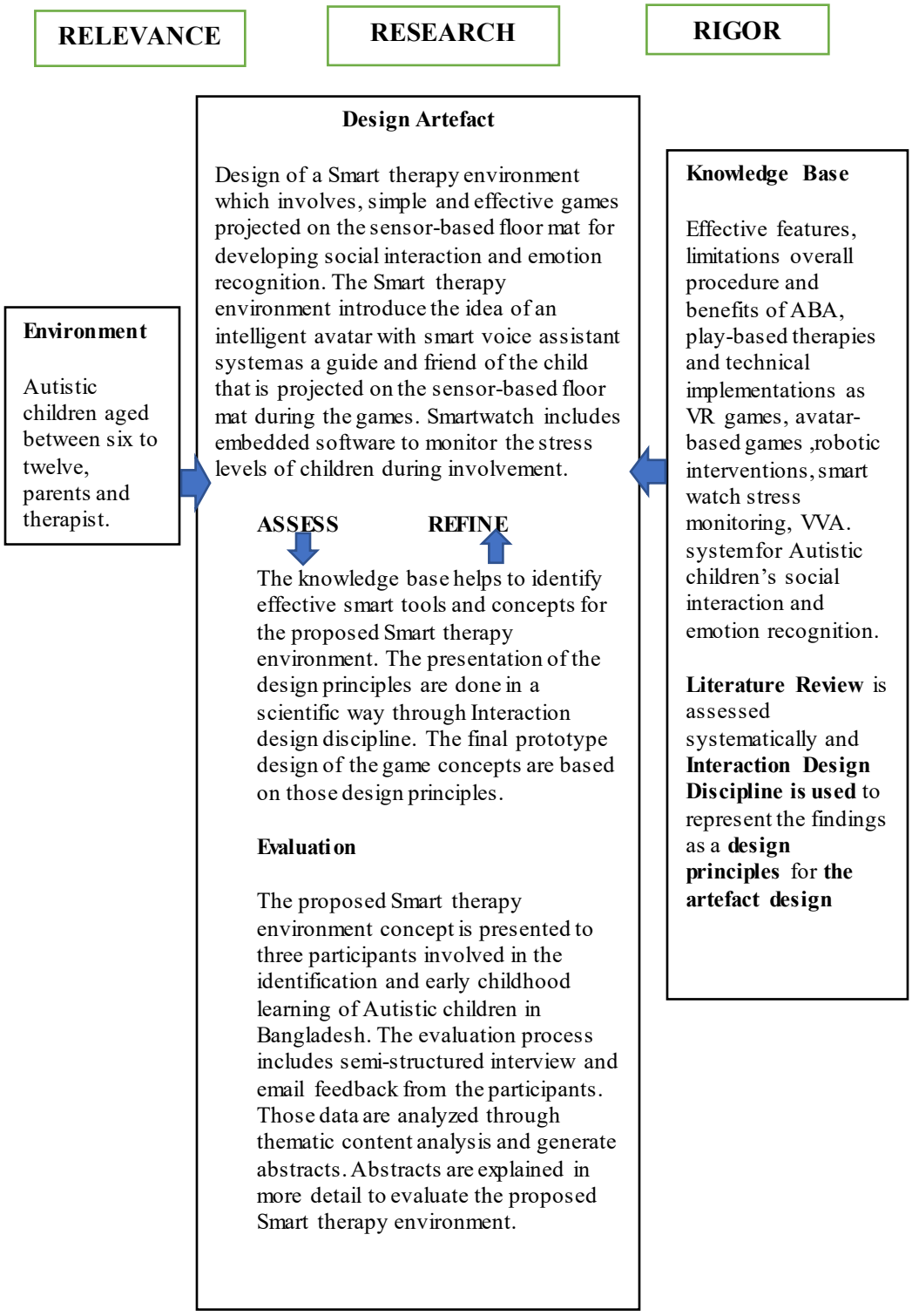

Figure 2. Design Science Research Framework for the proposed Smart therapy environment (Hevner et al., 2004).

Figure 2, demonstrates the design science research framework for the proposed Smart therapy environment. The environment involves Autistic children aged between six to twelve years, parents, and therapists. The artefact design involves designing a Smart therapy environment to develop social interaction and emotional recognition for Autistic

children. The Smart therapy environment proposed special features such as an artificial intelligence(AI)-based voice assistant system in the form of an avatar, a smartwatch stress monitoring, and communication, projected games on interactive sensor-based floor mats, game content customization, peer involvement, and an overall combination of all feasible aspects to ensure the safety of the child. Through the evaluation of the artefact, the study answers the research question. The knowledge base of the study involves articles, books, and online materials for Autistic children's social interaction and emotion recognition development. Those articles are related to behavioral and play-based therapies, software games based on avatars, virtual reality-based games, VVA systems, robotic intervention, smart stress monitoring, interactive smart environments, or playground concepts. The literature review is assessed systematically to locate important aspects together and the interaction design discipline represents the collection of design principles for artifact design. Those design principles are allocated in three dimensions such as form, content, and behavior as well as one extra dimension related to ensuring the safety of Autistic children. Moreover, the evaluation of the Smart therapy environment including game prototype designs is done through the interview of a few professionals who were involved with the government-organized project for Autistic children identification and early childhood learning. The participants are living in Bangladesh and working as a Govt. Trained teaching professional in Public colleges in Bangladesh. The participants are selected as they have two years of experience in Autistic children identification and early childhood learning projects organized by the government. During the project on Autistic children identification and learning, they experienced the identification of Autistic children aged between 8 and 11 and also learned about their behavior and activities. Besides, as they are from Bangladesh, it is easy to request and connect with them. In the beginning, six participants were chosen for the interview. Three of them have personal problems so they do not attend the interview.

All of the participants' information is listed in Table 1.

Table 1. Information about interview participant

Participant	Country	Occupation	Experience on Autism	Interview duration	Presentation
Participant 1	Bangladesh	Govt. trained College lecturer	Involved in Government training in Bangladesh for Autistic children's identification and early childhood learning (2 years)	15 minutes	
Participant 2	Bangladesh	Govt. trained College lecturer	Involved in Government training in Bangladesh for Autistic children's identification and early childhood learning (2 years)	15 minutes	
Participant 3	Bangladesh	Govt. trained College lecturer	Involved in Government training in Bangladesh for Autistic children's identification and early childhood learning (2 years)	15 minutes	
3 participant				45 minutes	15 minutes
Second Cycle of Data collection All participants sent combined feedback through email after three months of interview.					

At the beginning, three consent letters are sent to them regarding the permission for data analysis, data recording, and data use for the study. The basic format of the consent form is added in Appendix 2. They are contacted through email and WhatsApp. The video interview was conducted via Zoom for sixty minutes. In the beginning, the entire Smart therapy environment concept, game designs, and interview questions were presented to them for a total of 15 minutes. After that, all participants were interviewed separately for 15 minutes each. It was decided to conduct a semi-structured interview with open-ended questions because it was one of the best options for conducting an interview when the participant's unique view of the system was required (Adeoye-Olatunde & Olenik, 2021). The interview questions were selected in such a way that the important aspects of the system were focused on (George, 2022). Initially, the important aspects of the system were identified and considered inside a few themes (George, 2022). The questions are also based on important aspects within specific themes such as "first impressions"," feedback on design", "feedback on design goals" and "recommendation". All the

questions are listed in Appendix 1. The interview language was English but at the end of the interview, it was observed that the participants were not fully confident in speaking English. As a result, the collected data was not sufficient for the evaluation. Moreover, due to a shortage of available time, they failed to provide sufficient information about the whole smart therapy environment. As it was a broad concept to understand, they requested some time to discuss and further evaluate the procedure by themselves. They requested to send them the presentation slides and game concept design details through email. All details of the game design and presentation slides were sent to them via email. After three months, the participants sent the combined feedback via email. They didn't mention why they took three months to send the feedback. That is listed in Table 1 as the second round of data collection.

The interview was recorded and further analyzed for evaluation. For the analysis, the study utilized the thematic content analysis method (Damayanthi, 2019). From the recordings, the codes are generated through the reduction of the interview data. Clustering helps to identify positive and negative records and thus, finally themes are generated. Those themes help to summarize findings in a coherent and meaningful way (Adeoye-Olatunde & Olenik, 2021). The evaluation procedure is discussed in more detail in section 4. Thus, the study involves a well-executed scientific method to evaluate the utility, efficiency, and quality of the artefact. The study also follows the seven guidelines of the design science research (Hevner et al., 2004). Seven guidelines for creating artefacts in design science research are listed in Table 2.

Table 2. Seven Guidelines for creating the design of an artifact (Hevner et al., 2004).

Guidelines	Explanations
1. Design as an Artefact	Research must produce an applicable or practical artefact
2. Problem relevance	Artefacts must be important and relevant to resolve a problem.
3. Design Evaluations.	A well-executed scientific method will be involved to evaluate the utility, efficiency and quality of the artifact.
4. Research contribution.	The research should have a special contribution to the related research field.
5. Research Rigor.	Rigorous methods are needed to construct and evaluate the artifact.
6. Design as a search process.	Current knowledge within the research area must be sufficient.
7. Communication of research.	Research must communicate well both inside and outside with the scientific community.

The guidelines of numbers 1 and 2 from Table 1 are followed by the study as the artefact design of the Smart therapy environment is important and can solve one of the most important research issues involving Autistic children's social interaction and emotional recognition development. Research articles on Autism research proved that the development of social interaction and emotion recognition in Autistic children is a highly prioritized area of research globally (Charlton et al., 2020; Yin & Tung, 2013). Furthermore, during the entire study, the concept of live animated avatars with AI voice assistant systems in the projected game environment for Autistic children's social interaction and emotion recognition development was not found. The concept of stress monitoring through a smartwatch is also a unique concept of the Smart therapy environment. All of those concepts are separately very effective for Autistic children's social interaction and emotion recognition development. The study also identifies the

factual perspectives of robotic interventions (Sharkey & Sharkey, 2010; Singh et al., 2022). Moreover, the study locates the avatar concept as practical and safe for Autistic children's social interaction development and learning (Hopkins et al., 2011). Thus the study considers the AI-based Avatar-guided smart therapy environment as a significant and feasible contribution to future research. Besides, the study analyze the previous literature and accommodate the effective as well as practical aspects together as design principles for the artefact design. The study utilizes the interaction design discipline to present the design principles of the artefact design. Moreover, further evaluation of the artefact is done through the interview of expert participants. The interview data is also analyzed by thematic content analysis. So, the study follows guidelines 3 and 4 of Table 2. Furthermore, all assessment methods are also relevant and rigorous to the research. Again, it is worth mentioning that, the study contains the written documents of game prototype designs and all other research essentials. The study is planned to publish as a research paper in conferences and journals in the future. Thus, the study will act as a very effective written communication tool to support future research. Thus, the study follows the seven guidelines of design science research.

In the following section, the design principles, and game prototype designs are discussed in more detail.

4. Design Principles and Design Concept

4.1 Design Principles

The study uses the interaction design discipline to accommodate and represent the design principles. The design principles are the knowledge base for the design artefact of this study. Based on these design principles, the study proposed the Smart therapy environment. Those are discussed in the following Table 3, Table 4, Table 5, and Table 6.

Table 3. Design principles demonstrate the form dimension for the Smart therapy environment

Dimension	Design principle	Suitable design
Form	An interactive multisensory environment	Therapies such as applied behavior analysis (ABA) and technical implementations such as software games, virtual reality-based games, and robotic interventions for Autistic children involved attractive and entertaining environments or digital interfaces. An interactive multisensory environment involved interactive installations in a room where embedded systems merge with physical objects to generate images, sounds, bubbles, and other smart influencing aspects that motivate Autistic children's learning and social interaction development (Garzotto & Gelsomini, 2018). In the proposed Smart therapy environment, the thesis follows the idea of an Interactive multisensory environment that includes the following, **Sensor-based interactive projection mat** The Sensor-based projection mat includes embedded systems that will enhance the motivation of Autistic children as the contents of the games will change according to the movement of the child on the sensor-based mat. For example, when the children will jump on every object, it will disappear or move to a certain other point. The projected size on the mat will depend on the appropriate projection game environment where a single child or group of children will participate. The intensity of the light is also important to ensure the better projection quality of the game in an accurate-sized projection environment (Takahashi et al., 2017). **Sounds, colors, and visual effects** The interactive mat also generate sounds and change colors according to different game design and participants' movement. The research found that a multi-sensory environment was very effective for Autistic children's social interaction and learning development (Garzotto & Gelsomini, 2018). Enhanced graphical interface with audio-visual effects can stimulate the nervous system of Autistic children in such a way that they can imitate the virtual agents more accurately (Ghanouni et al., 2021). **Scientific Therapy based game environment** During ABA interventions, the therapist added more objects or images of the objects according to the advanced activity of the child. An appropriate environment is chosen to make the activities realistic, attractive, and fun for the child. (ABA, 2020; Kearney, 2015). In the Smart therapy environment realistic forest, car racing, or other learning environment is chosen with appropriate sound, images, and other visual tools. The therapist can add or change the contents of the environment as required.

Table 4. Design principles demonstrate the content dimensions of the Smart therapy environment

Dimension	Design principle	Suitable design
Content	Smartwatch	In a few ABA therapies for the social interaction development of Autistic children, it was a very effective and common procedure that involved the matching of objects. Children needed to select objects and match them with the same color objects. There was another process of matching objects based on hearing sound and other matching options (ABA, 2020; Kearney, 2015). In the proposed Smart therapy environment the smartwatch plays important roles. The smartwatch will generate certain emoji and according to that the child have to match the emoji on the projected game mat. The smartwatch will also measure the excitement of the child through blood pressure and record the overall activities of the child during the entire physical participation in the game. The embedded software device in the smartwatch will also be able to measure the stress level of the child during the game (Tomczak et al., 2020). The smartwatch is also involved in the transmission of data with the embedded system in the sensor-based projection floor mat.
	Avatar assistant	The avatar or virtual assistant was a very attractive and effective feature for social interaction development and emotion recognition for Autism in children (Fabri et al., 2007). Children enjoyed following the instructions of avatars and also tried to mimic them. Thus, avatar-based games had an effective success rate in enhancing social interaction development and understanding emotions. In the proposed Smart therapy games, the main character is the Cartoon dinosaur figure avatar which will guide and stay with children on the projected playground.
	Content customization for individual or peer-involvement	The content customization according to the preference of Autistic children was able to increase their interest in the game. Research showed that the graphical interface design and content selection varied among Autistic children. If the web-based design of the activity was according to their content preference, then they showed more interest in it (Lucas et al., 2014). According to the preference of objects and colors, the game contents will be customized. For example, if the child likes to play with cars, dolls, or fruits, the games will be customized. Also, the music or audio sound can be adjusted. This is one of the important aspects of the contents utilized in the proposed smart therapy environment.
	Artificial intelligence(AI)-based voice assistant system	AI voice assistance system was also effective in increasing social interaction in children with Autism. It has also proved to be very effective in generating learning daily activities for Autistic children as they are very influenced by the AI-based voice assistance system. (Safi et al., 2021). The proposed Smart therapy environment introduces the avatar guidance based on the artificial intelligence-based voice assistant system. The avatar will motivate, reinforce, and guide the child with the AI voice assistant system.

Table 5. Design principles demonstrate the behavior dimension for the Smart therapy environment

Dimension	Design Principles	Suitable design
Behavior	Reinforcement	Various ABA therapies for Autistic children showed that reinforcements during therapeutic procedures played an important role in motivating Autistic children to different activities. Rewarding, encouraging words, encouraging body gestures, and positive reinforcement while failing, all have a vital influence on a successful therapeutic procedure (Yu et al., 2020). The avatar will reinforce the child while playing. In case of failure, the avatar will restart the game again for the successful movement of the child. Different encouraging sounds will be generated to celebrate the success of the children for each trial. During failure, the avatar also produces inspiring songs and words.
	Social interaction	Developing social interaction among Autistic children is one of the most important research in Autism (Hirota & King, 2023; Volkmar & Pauls, 2003). Social interaction development will help them achieve sensory activities and thus ensure adjustment in society. During the game, Autistic children will follow the avatar's instructions. Games have group playing options. So, it will increase social communication between peers. Group activities encouraged interpersonal interactions among children with Autism (Takahashi et al., 2017). Cooperation and helping behavior can be achieved through peer-involved activities (Takahashi et al., 2017). Besides, the game will ensure the physical movements of the children. In a usability testing study, parents of Autistic children preferred the physical movement of the children during play as it ensured that the child was following the instructions. So, ultimately the game caught their interest (Ghanouni et al., 2021).
	Emotion recognition	The expression of emotions through face and body was a part of natural human communication which also facilitated social life (Fabri et al., 2007). In the game, the projected screen on the mat will produce different emoji with different facial perceptions. Those also generate sounds to guide the child to pick the right emotions. The gestures, appearances, and expressions of the avatar also play a vital role in understanding emotional expression (Fabri et al., 2007).
	Step-by-step guidance	According to ABA therapies, all tasks were modified into easy steps so that the child easily participated and interacted with the therapist (Kearney, 2015). In all behavioral therapies, it was necessary to organize the engagement of the child with the task and for that purpose, a set of proper instructions were needed. In the Smart therapy environment design, the avatar performs all specific tasks and the child can monitor the avatar's movement at the beginning. During the game, the avatar also instructs and motivates the child.

Table 6. Design principles demonstrate the other dimension of the Smart therapy environment

Dimension	Design principle	Suitable design
Others	Ensuring the safety of the child	Robotic intervention for Autism in children involved ethical issues (Sharkey & Sharkey, 2010; Singh et al., 2022). Research also stated that avatar-based virtual reality games were safe for Autistic children as they had control over the stimuli along with working at their own ability label (Ghanouni et al., 2021). The Smart therapy games involve virtual assistance and there is no pressure for the child to perform accurately. The child can move by their ability and interest. Moreover, the smartwatch will continuously measure the child's stress level to ensure a safe game environment.

4.2 Game Concept Design

The proposed Smart therapy games are "Animal Hide and Seek"," Jumping on the Car"," Blend with Emojis", and "Match and Jump". All of their projected graphical interfaces are shown in Figure 3 – 13. The study accommodates effective design principles and utilizes those design principles in game designs. For example, it will be possible to control and organize all the game activities when the therapist or researchers will use them in reality. The game designs are projected and controlled by software so, it will be easy support for the therapist to change the game environment, objects, or other important aspects very fast compared to the manual setting of the therapy environment. It is also important to note that all of the game designs are inspired by the techniques used in applied behavior analysis and play-based therapies for Autistic children's social interaction and emotion recognition development. So, it could be a good support for the therapist to ensure a better, faster, and more effective therapy procedure in reality. Moreover, all of those game designs are presented during the evaluation of the study.

Previous literature helps to identify smart, innovative, and effective technological aspects for game designs. In all the games, a dinosaur character is used as an avatar that will communicate with the child through a virtual voice assistance (VVA) system. The projected live animation of this avatar will guide and reinforce the child during the whole game activities. However, it is possible to change the avatar character according to the child's preference or parents' suggestions. Moreover, it is important to note that, all contents, colors, and music of the game can be customized according to the recommendation of the therapist and parents. Also, in case of a high level of stress recording, the therapist can stop the participation of the children at any time. Furthermore, all of the activities will be recorded through the camera for further analysis.

The study does not find a smart therapy environment with the combination of all those mentioned effective and practical features. The study also identifies the importance of such a Smart therapy environment after finding gaps in therapy procedures and technological utilization for Autistic children's social interaction and emotion recognition development. The games are presented as prototype designs and also express the overall concept of the proposed system. All the mentioned features of the games are selected with the assessment of a rich collection of previous related literature. Applied behavior analysis techniques, play-based therapy procedure, practical and effective smart features, and most importantly the sensor-based projected customized game environment will ensure peer involvement, physical participation, and safety. Which ultimately targets the most important development of social interaction and emotional recognition of Autistic children. Currently, there is no such system available with the above-mentioned features

together in projected games for Autistic children's social interaction and emotion recognition. So the Smart therapy environment with game designs is the biggest contribution of the study.

All the game ideas and expected goals are explained below with images of the game environment design.

4.2.1 Animal hide-and-seek

Listen to the sound and recognize the animals that hide in the bush

Expected goals of the game

- Interaction development by following the instructions of the avatar.
- Involvement and attention to the game environment
- To make the children realize different animals' sounds, and names.
- Group interaction development.
- Learning numbers
- Physical movement

Game Idea

In the beginning, the dinosaur-shaped avatar will participate in the game and provide basic training about the game to the Autistic children. The training session will occur several times at the preference of the therapist. The children will go to each numbered rock and on the specific rock, they will hear animal sounds. The child has to identify the animal by hearing the sound and tell the name to the avatar. After the answer, the animal will be visible from the bush. After every turn, the animal will be changed and the game interface will be updated. Through the embedded software in the smartwatch, is it possible to measure the stress level of the children during the entire game activities. It will ensure a safe game environment for children with Autism. During their activity of moving to different stones, the child will watch other children also moving with them on the stones. In that situation, sometimes, the avatar will guide them by "Move slowly" or "Give side to your friend" etc. This kind of situation will explore a new way of learning peer engagement and group interaction development will be initialized. Moreover, all the games will be customized in such a way that the avatar can create small competition activities between children. However, those will be conducted after several individual or group training and therapist recommendations. All the stones have numbers and during the game, the avatar will count the numbers and inspire the child to count them too. Figure 3 to Figure 6 presents the game environment where different game activities and avatar involvement are visible. The avatar also inspires the children during the game and uses rewarding words for success. During failure, it will generate positive reinforcement to influence the child to try again. Different music and positive reinforcement of the avatar will make the game environment attractive and children will be influenced to interact with the avatar. Moreover, the avatar will communicate with the child through an AI-based voice assistant system. For example, the avatar will call the child with their names and also respond to their questions. Thus, the child-avatar interaction will develop. It is also important to note that the whole game environment can be controlled by the therapist. For example, the therapist can slow down the appearance of the contents, change the color of the contents, or quit the game if required.

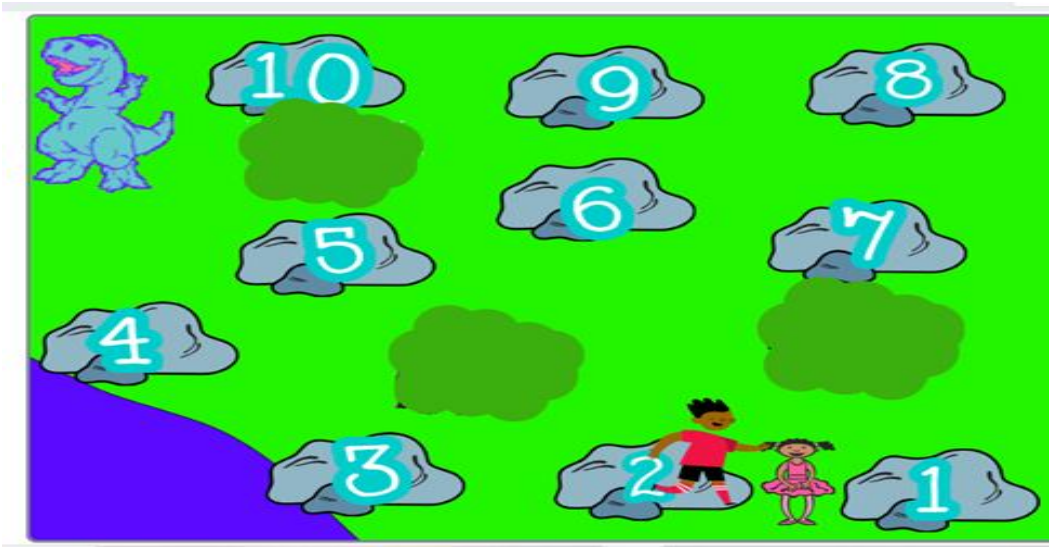

Figure 3. Game environment where the game design where two children listen to the avatar.

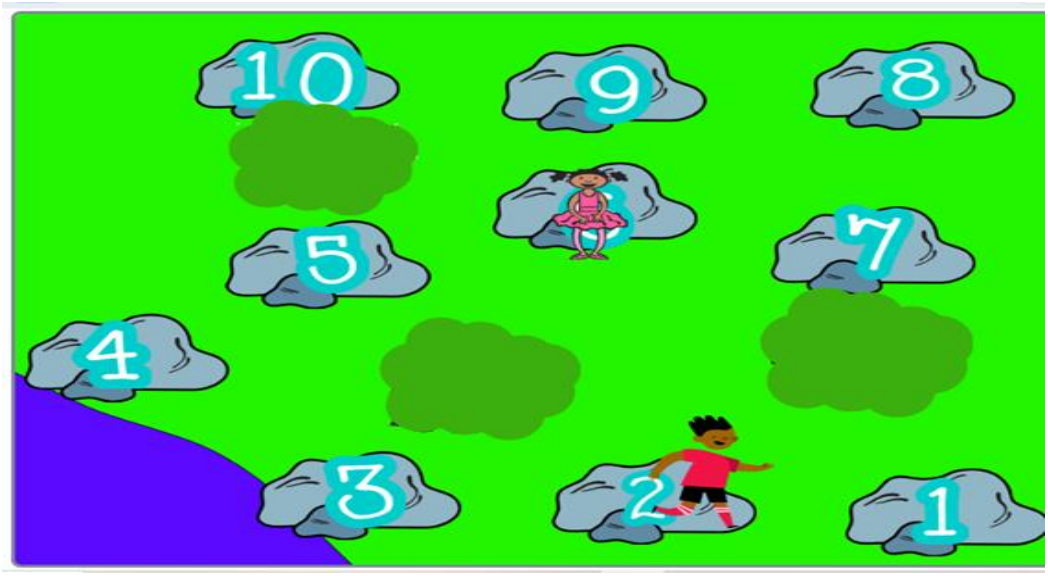

Figure 4. Game environment where children start playing.

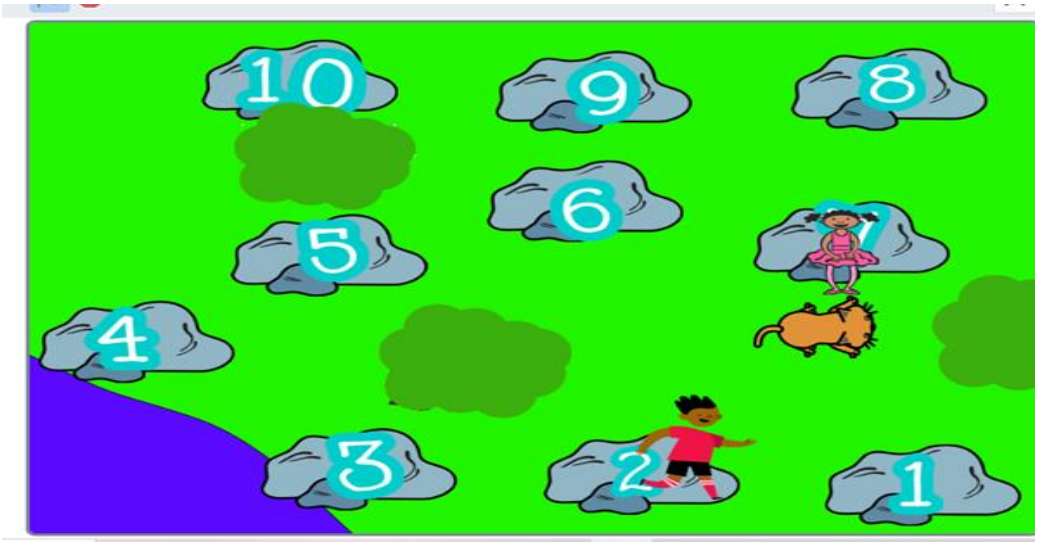

Figure 5. After the girl identify the sound, the cat is visible from the bush.

Figure 6. Game environment where when the girl identify the cow's sound, the cow is visible from the bush

4.2.2 Match and Jump

Follow the image on the watch and instructions of the avatar. Then go to the matching image.

Expected benefits from the game

- Interaction development with the smartwatch contents.
- Interaction development by following the instructions of the avatar.
- Involvement and attention to the game environment
- Understanding different shapes, and objects, and learning their names
- Group interaction development.
- Matching the image on the smartwatch with the visual projected surface.
- Physical movement.

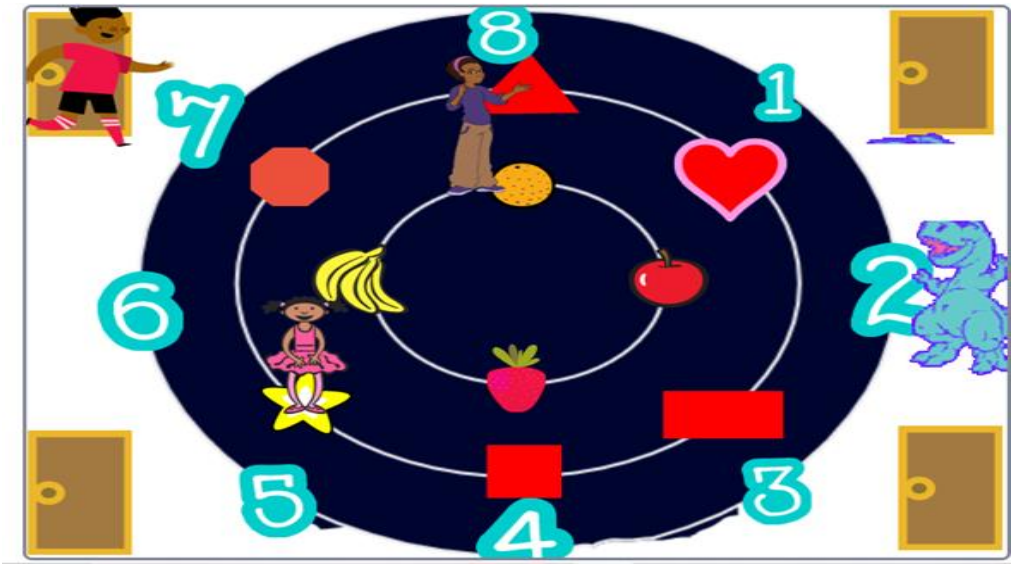

Figure 7. Game environment where children follow the sound and image on their smartwatches and jump on the object image.

At the beginning, the dinosaur-shaped avatar will play the game and instruct the children about the game activities. During the training, the avatar will follow the displayed shapes or object images of its virtual watch and show that image to the child in an attractive and entertaining way. It will then step-by-step jump on displayed images of the projected mat following the images visible on the smartwatch. In the end, it will enter inside the open door near the last visited image on the projected mat. The avatar will perform the game several times with the child to make the child confident and inspired. During the initial performance with the child, the avatar will guide the child to observe the visible shape on the smartwatch and follow the matching on the mat. The whole procedure is controlled by the therapist who can initialize the training session several times as required

Children will start from the center of the projected surface. On the smartwatch, specific images of objects such as fruits, numbers, and different shapes will be visible. They have to follow the image and match the image by stepping on the specific image on the projected floor. Avatar will also instruct the child with the names of the objects and guide the child to find the object on the projected sensor-based floor mat. When the child arrives at the content, data transmission from the smartwatch will occur and the right or wrong sign with sound will occur. The encouraging sound and visual effect on the sensor–based mat will be generated for both right and wrong choices. The avatar will also encourage the child by telling them about the correct choice. When they will successfully go to the last circle where they will match the numbers as visible on their smartwatch, they will be instructed to go to the nearest open door from their position. The game can be played by one child or a group of children. During the peer involvement, a competition will be designed in which the avatar will check which child successfully passes all the matching on each circle and reaches the specific door that is opened. Music and a colorful playground will make the game attractive. Constant monitoring of the stress level will be done through the embedded software inside the smartwatch. Figure 7 shows the game environment and children's participation during the game. Furthermore, in case of both success and failure, positive reinforcement will be generated by the avatar. Moreover, the avatar will communicate with the child through an AI-based voice assistant system. For example, the avatar will call the child with their names and also respond to their questions. Thus, the child-avatar interaction will develop. It is also important to note that the therapist can slow down the game's content appearance, change the color of the contents, or quit the game if required.

4.2.3 Blend with Emoji

Follow the story of the avatar, realize the avatar expressions, and check the emoji on the smartwatch. Go to the similar projected emoji.

Expected goals of the game

- Interaction development with the smartwatch contents.
- Interaction development by following the instructions of the avatar.
- Involvement and attention to the game environment
- Understanding basic emotions.
- Understanding stop and start signals.
- Group interaction development.
- Realization of the avatar’s expressions.
- Physical movement

Game Idea

In the beginning, the avatar will participate in the game and provide basic training about the game to the children. The training session will occur several times at the preference of the therapist as the therapist is responsible for controlling the games. During the training, the avatar will tell a short story and show emotional expression based on the story. After that, it will follow the emoji that appeared on its virtual smartwatch and move to the correct projected emoji on the mat. After the required sessions of training, the avatar will start telling new stories and expressing emotions on its face and appearance. The children will get images of emoji on their smartwatch. For example, for the happy emoji, the avatar will make a sound like "Hello, it is my birthday today and I am happy". It will also generate sounds of laughing. Then, the smartwatch will display a happy emoji. The children will be instructed by the avatar to match the emoji with the emojis projected on the mat. They have to go near the specific matching emojis.

The whole smart system will be linked together. For example, when the emoji appears on the smartwatch interface, the embedded system on the sensor-based mat will be notified about the correct or wrong emojis on the mat's projected emoji points. The embedded system will generate the correct and wrong signs on the projected mat based on the data transmission from the smartwatch during the children's appearance. Software and embedded systems will be merged to create such a game environment. The avatar will generate positive reinforcement for every right or wrong selection and encourage the child to try again. Thus for every emotion on each emoji, the child will get interesting introductions and sounds which will motivate them to go near the specific emojis on the projected game environment. The game will continue until the green light is on. The red light will indicate the end of the game. During peer involvement, a competition will be declared by the avatar, and within a time frame, the result will be measured by observing who will select more correct emojis. Stress levels will also be measured during every activity. After the competition, the avatar will generate rewarding words for the children. Moreover, the avatar will communicate with the child through an AI-based voice assistant system. For example, the avatar will call the child with their names and also respond to their questions. Thus, the child-Avatar interaction will develop. In Figure 8 and Figure 9, the game environment and children's involvement are visible.

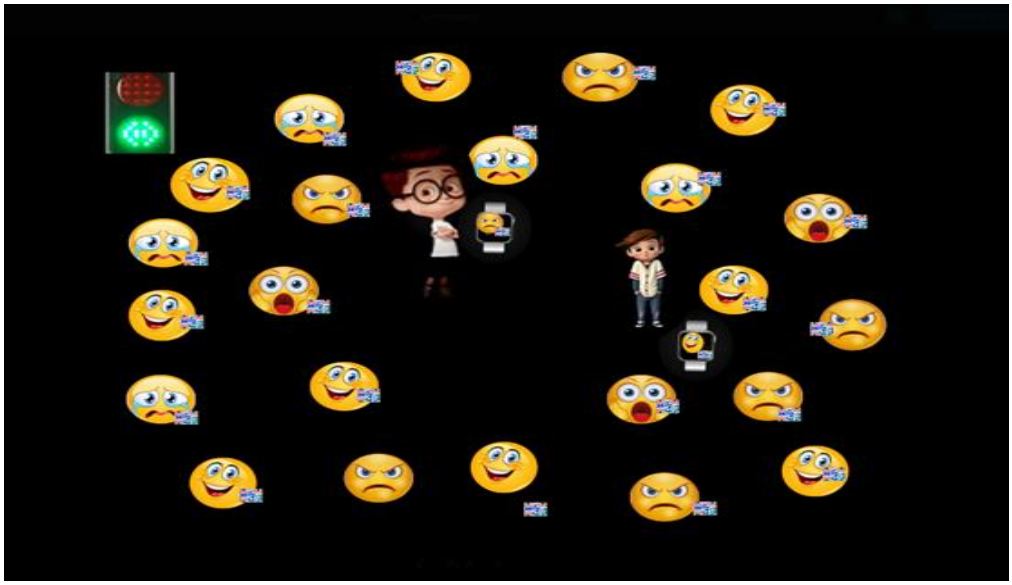

Figure 8. Game environment where children with Autism are checking their smartwatch emoji's and hearing the sound which help them to identify the correct emoji's on the projected floor mat.

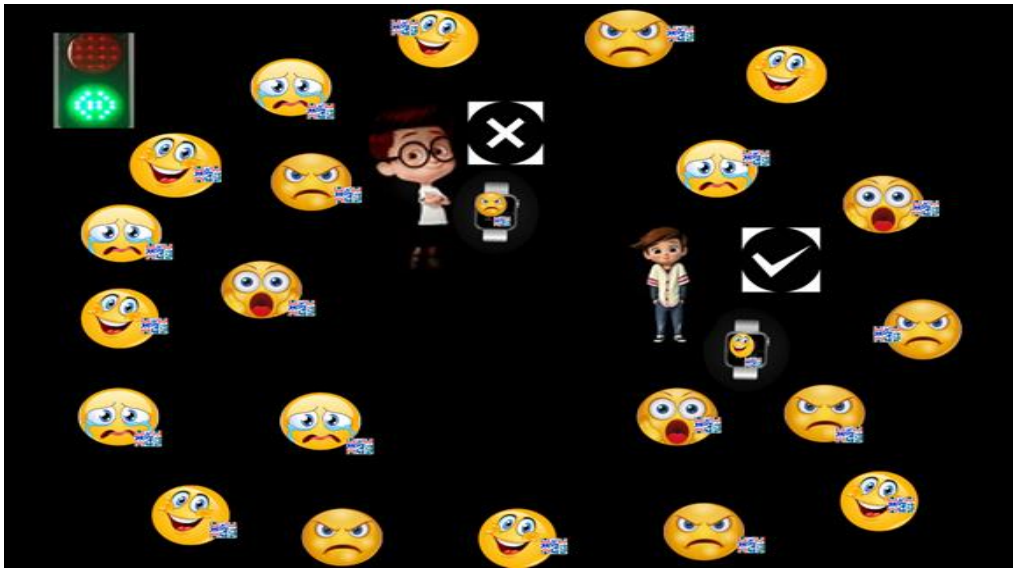

Figure 9. Game environment where selection of right or wrong emojis on the projected floor mat.

4.2.4 Jumping on the car

Follow the avatar's instructions and jump on the selected colored car.

Expected goals of the game:

- Interaction development by following the instructions of the avatar.
- Involvement and attention to the game environment
- Identification of colored objects.
- Understanding different colors' names.
- Understanding the stop-and-start signal.
- Physical movement.
- Group interaction development

Game Idea

In the beginning, the avatar will participate in the game and provide basic training about the game to the Autistic children. The training session will occur several times as the preference of the therapist. The game has two parts that involve individual or peer involvement of the child. The game interface is designed to motivate the child to play in an exciting environment with colorful car images, realistic sounds, and start-stop traffic signals. The avatar will call each child by their name. For individual involvement, the child will be instructed to jump on any colored car. The child will enjoy watching how the jumping will make the car move to a similar colored garage. During the start signal, the game will continue. When the stop red signal activates, the game will stop and the avatar will count how many cars are going to the garage through the jumping of each child. The success and failure will be reinforced by the avatar positively. The game interface is simple and easy in order to make the environment less stressful and safe. The sensor-based floor mat will identify the Child's appearance on specific colored car locations and the animation will help to show that the car will go to the specific colored garage. The whole system will be controlled by the embedded system and software gaming platform.

Figure 10 to Figure 12 demonstrate the game environment where the avatar instructs the child to play the game by itself.

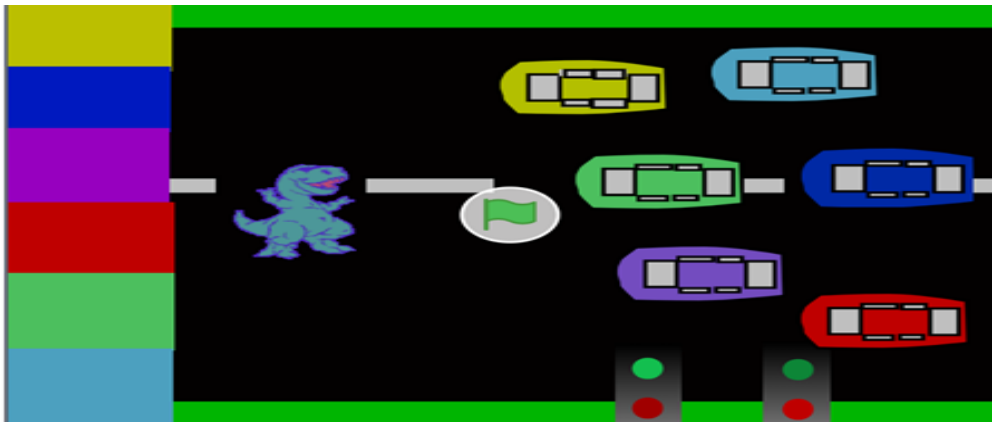

Figure 10. Game environment where the avatar instruct the child to jump on the specific colored car and those will go to the specific colored garage (One player gaming environment).

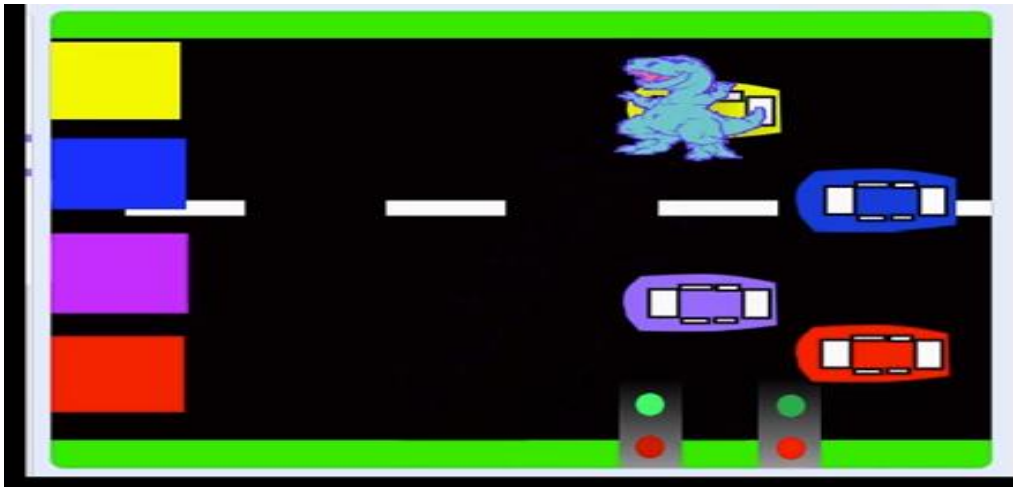

Figure 11. Game environment where the avatar instruct the child and jump on the yellow car.

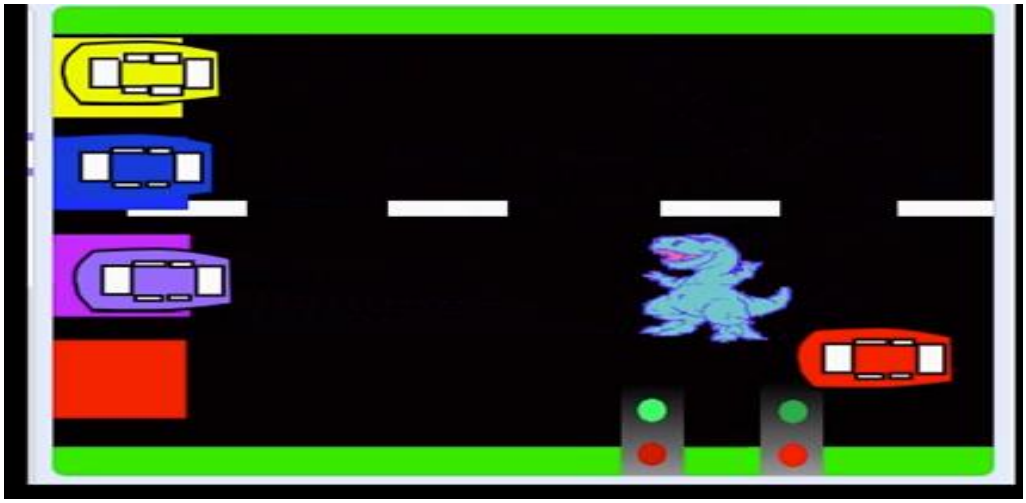

Figure 12. Game environment where the avatar jumps on specific colored cars and the car moves to a similar colored garage.

In case of peer involvement, the game interface will be transformed into a competition level. In that game, two kids will be involved. The avatar will select the specific colors

for each child and also provide them with instructions about the game. Both the kids have to jump on their selected colored cars to make the maximum cars in the accurately colored garage. All the steps will be done in between selected time slots. Thus, when the red light turns on, the game will be stopped. The avatar will count the maximum number of cars in the garage and reward the child with positive reinforcement. Another child will also get positive reinforcement to continue further. Continuous stress monitoring will be done through the smartwatch. Figure 13 to Figure 15, shows the peer-involved game environment. Moreover, it is possible to customize the contents of the game according to the child's preference. For example, if the children like to play with colorful dolls then the game's graphical interface will be changed. In the case of dolls, the child will jump on a specific colored doll and the doll will go to a similar colored doll house. The therapist can also customize the colors of the contects according to the child's preference or parents suggestions. Moreover, the avatar will communicate with the child through an AI-based voice assistant system. For example, the avatar will call the child with their names and also respond to their questions. Thus, the child-avatar interaction will develop.

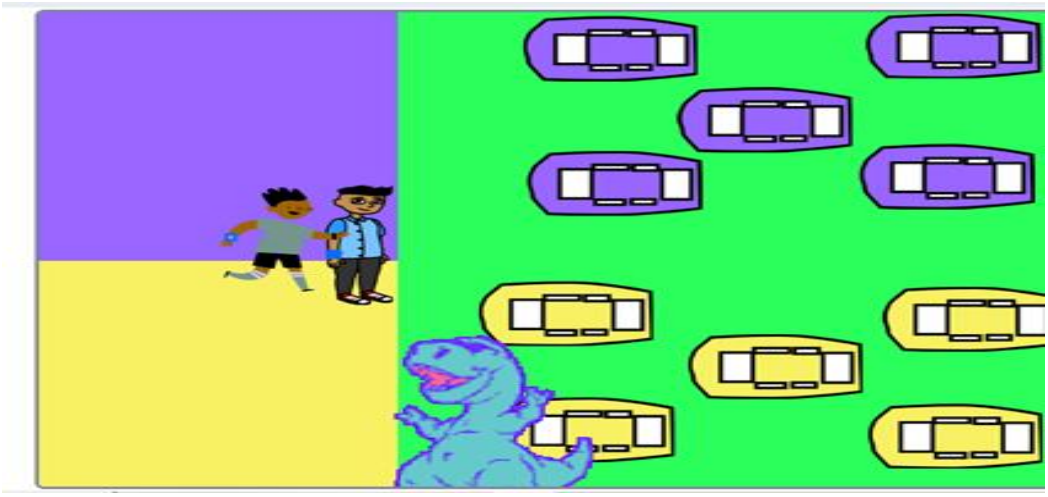

Figure 13. Two-player car jumping game starting phase.

Figure 14. Children start jumping on the specific car and cars going to garage. (Peer gaming platform)

Figure 15. The Avatar reinforces the child who wins (Peer gaming platform).

5. Game Design Evaluation

The study further focuses on the evaluation of the artefact design of the Smart therapy environment. The evaluation involves qualitative methods in the form of semi-structured interviews to collect research data for the study. The semi-structured interview is organized via Zoom video meetings with three participants who are involved with the identification of Autistic children and early childhood learning projects in Bangladesh. The interview is structured based on open-ended questions as those provide a broad view of user experience data for the research (Adeoye-Olatunde & Olenik, 2021). The interview takes about 60 minutes. The participants are very interested in the game design ideas and encourage the study. Moreover, all of the participants agree on some more details points about the proposed system and send their further opinions via email. They also hope to see those game designs in reality to support Autistic children's social interaction and emotion recognition development. The semi-structured interview data are analyzed using the thematic content analysis method (Damayanthi, 2019). In the beginning, all recordings are documented for each participant. Secondly, some codes are generated through reduction manually, and clustering allows positive and negative content to be visualized. Finally, themes are created and explained properly. It is important to note that, thematic content analysis results should be able to answer the research question (Damayanthi, 2019). In this study, the findings are related to the answer to the research question.

Table 7. Interview results table for Participant 1

Findings (participant 1)	**Reduction**
"All things will be good for different special children like autism. Our work was how to develop their social interaction and communication to another person. At first, the main thing is to diagnose their autism level by a registered doctor and then take suggestions from the parents." "This game idea is good for Autistic children. It will be helpful for them to understand color names, and identify different colors. Avatar guidance is also a nice feature." "All ideas of games for social interaction and understanding of basic emotions are quite understandable and attractive to me. Especially colorful games are really attractive to me." "All are good and effective to look at but it will be really effective when those will be fully applied to Autistic children in real life. "	**First impression** Nice and good game idea for Autistic children. **Feedback on the design** All designs seem effective to look at. All ideas for social interaction development and understanding of basic emotions are quite understandable. **Feedback on the goals of the design** Helpful Avatar guidance Helpful for learning colors' names. Helpful for the identification of colors **Recommendation** Need to diagnose their Autism level and take suggestions from the registered doctor. The effectiveness will be measured when applied in real life.

Table 8. Interview results table for participant 2

Findings (participant 02)	Reduction
"Design and idea are very good. Autistic children will benefit from your idea." "The idea of using different colors in the game is really nice as autistic children feel good with some colors. Alternative options for choosing other colors in the games are also very good. " I also like the stop and start signal understanding and basic emotions understanding of the games." "The tools, methods, and Avatar guidance all things should be very simple and the medium of instruction should be in different languages like Bengali, Hindi, or other." "The avatar is ethically better than a robot but it should also be recommended by a registered doctor or therapist before applying."	**First impression** Good idea, autistic children will benefit. **Feedback on the design** Different colors in the game will feel good to Autistic children. Alternative choosing options of colors based on children's preference. **Feedback on the goals of the design** Stop and start signal understanding. Basic emotions understanding. **Recommendations** Tools, methods, and Avatar guidance need to be simple. Medium of instructions in different languages. Recommendations of registered doctor or therapist before applying.

Table 9. Interview results table for participant 3

Findings (participant 03)	Reduction
"The game idea is good but the medium of instruction needs to be in a different language." "With the avatar, the expert therapist also needed to continue the game for special children. That may be best for your research proposal." "I think, the game will be interesting to the Autistic children to interact with each other. They will be interested more to play if their parents, siblings, and friends are involved" "This will help to develop social communication skills"	**First impression** The game idea is good. **Feedback on the design** The games will be more interesting if parents, siblings, and friends are involved. **Feedback on the goals of the design** Developing social communication. **Recommendations** The medium of instruction will be in different languages. An expert therapist is also needed besides Avatar guidance.

The interview is conducted via Zoom for one hour. As the study is a broad concept to understand, the participants request some time to discuss and further evaluate the procedure by themselves. With that regard, the presentation slides of the interview and game design documentation are sent to them via email. After three months, the participants sent the combined feedback via email. The combined feedback of the participants is also based on the presentation and questions from the previous Zoom

interview. So, the study generates an abstract from the content analysis of the combined feedback of three participants and adds them to the interview data analysis in Table 10.

Table 10. Interview and "Combined feedback of three participants" analysis

Clustering	Abstract
First impression **Positive** Nice and good Attractive Beneficial **Negative** Costly procedure Challenging procedure	1.First impression
Feedback on the Design **Positive** All ideas are quite understandable Different color options Colorful games interface A live talkative intelligent avatar seems to be very attractive The sounds and graphical interface of the game are interesting and quite entertaining Step-by-step guidance sounds very nice **Negative** Confused regarding the appropriate projection of the game due to light intensity. Difficulties in understanding the game activity by the ASD children. Not appropriate for Autistic children who has hearing or vision problem. Shadow effect of the child on the quality of projection. Missing relaxing activities by Avatar such as storytelling between the intervals of the games.	2.Strength and weakness of design features.
Feedback on the Goals **Positive** Stop and start signals understanding. Basic emotion understanding. Helpful avatar guidance Social communication development Learning and identifying colors Monitoring stress will enhance the feasibility of the game **Negative** Confused about the participation of Autistic children Difficulties during the training of the Autistic children before participation	3.Game Objectives
Recommendations Expert therapy involvement Need to identify the Autism level with a registered doctor before applying the game. Medium of instructions in other languages. Tools, design, and instructions should be simple. Options for Autistic children with hearing or vision problems. Design supports the participation of parents, siblings, and friends. Training options in an easy way by the Avatar before starting the game. Relaxing storytelling and introductory shows of the Avatar.	4.Game language for instructions. 5.Expert therapist involvement. 6.Preparing children before involvement in the proposed system. 7.More advanced design options.

First impression

Three participants appreciate the game design ideas as nice and good. Besides they also believe the game ideas will be beneficial for Autistic children. But in the written document, they also identify some important aspects. They highlight the procedure as costly because there are lots of intelligent features together in the Smart therapy environment. The Smart therapy environment will require a good amount of expert arrangements and practical implementations. Thus, the whole proposed system seems to be a challenging and broad concept to them.

Strengths and weakness of the design features

Participants appreciate the start-stop signal, features of basic emotion understanding, Avatar guidance, and the colorful game interface. They also prefer the color-choosing options according to the preferences of Autistic children. Ultimately, they are interested in the content customization feature. They also suggest an easy and simple game interface design and encourage the participation of parents, siblings, and friends in the games. So, all the game ideas should have separate options or features for extra participation. Furthermore, all three participants allocate some major weaknesses such as light and shadow effects on the projected mat during the game, and clear visibility of the projected contents. Participants were confused about the shadow of the child that would remove the projected game contents. Thus, it would create difficulties in performing activities smoothly. Again, the missing concept of relaxing sessions for the child after each activity is also mentioned by the participants through email feedback. The storytelling of the avatar can be a nice addition to make the games more meaningful and attractive to the child.

Game objectives

All participants agree on the main targets of the game which involves social interaction and emotion recognition development in Autistic children. Besides, they also appreciate a few goals of the games such as start and stop signal understanding, learning different colors, and interacting with avatars. They highly appreciate the stress monitoring feature of the proposed system. Besides, they are also confused regarding the participation of Autistic children during the activities. Because all Autistic children are not the same and some of them may be just jumping on the projected mat without understanding any activities. Finally, the participants are concerned about the difficulties of understanding the whole environment to Autistic children if it is not presented to them easily and appropriately. So, the initial training of the children with therapist and parent involvement is an essential aspect to consider. Moreover, the initial training duration can be difficult for the tutors to provide to every Autistic child. Those can be obstacles to achieving the aim of the proposed system.

Game language for instructions

Participants highly recommend the addition of various language instruction options during the games. They suggest different language instructions by avatars and also the effects of different languages on the game contents. They believe the avatar should be able to communicate with the child in their native language.

Expert therapist’s involvement

All of the participants encourage the expert therapist's participation and suggestions regarding the proposed Smart therapy environment. They also focused on the identification of Autism levels in children by expert registered doctors and after their recommendations, the games should be applied to the children.

More Advanced Design Options

The participants suggest additional features in the proposed Smart therapy environment for Autistic children who have hearing or vision problems. At the same time, they also recommend the storytelling features of the avatar after each activity session that will provide relaxation for the child and make them more interested in the avatar character. Overall the use of tools, instructions, and other features should be easy and simple.

6. Discussion

Initially, the study explored the idea of advanced behaviour analysis (ABA), play-based therapies and advanced technical implementations in Autistic children's social interaction and emotion recognition development. During the observations of all therapeutic procedures, the study found a few gaps. ABA and play-based therapy procedures were time-consuming and required the high patience of the therapists to generate the therapy environment and to guide Autistic children (ABA, 2020; Kearney 2015; Panceri et al., 2021). Also, research revealed that Autistic children showed more interest in robots and avatars compared to manual therapy procedures guided by humans (Fabri et al., 2007; Robins & Dautenhahn, 2014). A plethora of effective software games were identified on which avatar characters proved to be an efficient and attractive animation to motivate, guide, and inspire Autistic children to interact (Almeida et al., 2019; Charlton et al., 2020; Fabri et al., 2007; Konstantinidis et al., 2009). However, those games did not provide a smart interactive playground environment that ensure peer engagement, physical activities, and easy learning in virtual contexts together.

The study found the robotic intervention as a highly effective and motivating procedure that allowed Autistic children to move body parts, mimic robot words, and participate in various games (Feil-Seifer & Mataric, 2005; Panceri et al., 2021). Despite all successful interventions, the feasibility issues related to robots with Autistic children were also discussed in many research papers (Singh et al., 2022; Sharkey & Sharkey, 2010). So, there is no way to deny the ethical issues during the research of this study. Besides, most of the technical platforms did not provide continuous stress monitoring for Autistic children.

The study identifies an important gap regarding the research on a Smart therapy environment that involves the combined utilization of smart, potential, and safe methods for Autistic children's social interaction and emotion recognition development. The study formulates the research question, "What would be like a feasible and potent virtual intelligent environment for Autistic children where they can physically participate alone or with peers to develop social interactions and emotion recognition? " The study generates the answer to this research question based on a rich collection of related research articles and also the expert evaluation of participants who were involved in Autistic children's identification and early childhood learning projects for two years in Bangladesh. In the following paragraphs, the study demonstrates the successful implementation of the design principles in the proposed Smart therapy environment based on previous literature. And also answer the research question.

Environment played a vital role in the social interaction, emotional recognition, and learning aspects of Autistic children (ABA, 2020; Kearney, 2015). Research studies showed that both manual therapies and technical procedures required an appropriate environment that enhanced the therapy procedure. ABA and play-based therapies involved different picture or object models to create a basic learning environment for Autistic children. (Kearney, 2015; Lovaas, 2003; Mesibov & Shea, 2009). In most ABA, the therapist was needed to allocate different colored objects, or shapes in an appropriate environment to instruct the child to select the object and match it with the appropriate position (ABA, 2020). During such a manual procedure, it was important to allocate different environments for every child to participate in activities. Thus the child and therapist interaction developed and also enhanced the child's learning abilities. (ABA, 2020; Kamaruzaman et al., 2016). In software games, virtual reality-based games, and

robot-assisted games, the environment was also found to be very attractive, and easily adjustable with the games. To make the environment potent, there should be options for individual or peer involvement. Besides, the environment was needed to provide options for physical activities for Autistic children to ensure better social interaction and emotional development. (Takahashi et al., 2017). An interactive multisensory environment involved interactive installations in a room where embedded systems merged with physical objects to generate images, sounds, bubbles, and other smart influencing aspects that motivated Autistic children's learning and social interaction development (Garzotto & Gelsomini, 2018). The study also found positive outcomes with the utilization of the smart interactive projection environment and the interactive smart room concept very useful for Autistic children's social interaction and emotion recognition development (Garzotto & Gelsomini, 2018; Takahashi et al., 2017).

The proposed Smart therapy environment involves a sensor-based projected mat, and the projection of simple therapeutic games such as "Animal Hide and Seek", " Jumping on the Car"," Blend with Emojis" and " Match and Jump". The concepts of the games are based on manual therapies (ABA and play-based therapy) and provide easy and simple ways of choosing objects, colors, and shapes. Those shapes and colored objects are located in a playful environment so that children can feel interested in jumping in the objects. For example, in the game "Match and Jump, the children need to match objects, colors, and shapes with the visible image on the smartwatch and jump on the sensor-based projected floor mat. Another game is "Animal Hide and Seek" where the environment involves the identification of animals by listening to the animal sounds. In that game, the forest environment with numbered rocks appear. Another game "Jumping on the Car" provides a car racing environment and start-stop traffic lights. In the whole Smart therapy environment embedded system merged with software implementations and the use of a sensor-based mat will generate animations, sounds, and content visualization for creating excitement and motivation to learn and play. There are also options for group interaction development in all game environments. For example during the games the avatar will organize group competitions to determine who can pick the highest number of objects, or emojis, or who can jump on the maximum number of cars. During the group activities, children will observe others' activities, learn about engagements with peers, and follow others' steps on the same projected playground. It is worth mentioning that the entire game environment will provide attractive projected visual effects and music which will ensure a therapeutic playground for Autistic children to participate alone or with peers. That ultimately targets social interaction and emotional recognition development of Autistic children.

Content customization of the game environment ensured the group interaction development, the safety of children during the interaction, and a better understanding of the game activities. Previous studies showed that all contents of the environment needed to be customized according to each Autistic child's preference as well as to the requirements of the therapy procedure. (Lucas et al., 2014). In the manual procedure, the therapists needed to change the allocation of the contents frequently to develop social interaction, emotion recognition, and learning for Autistic children (ABA, 2020; Kamaruzaman et al., 2016). During play-based interventions, the main concept of the game design involved specific learning models and gaming platforms that helped to achieve successful intervention goals (Mesibov & Shea, 2009). It took lots of time, patience, and expertise of the therapist to arrange content in various therapy contexts (Kearney, 2015; Lovaas, 2003; Panceri et al., 2021). In the future Gym concept, the study found that the projected contents for physical activities were customized according to the group interaction development of Autistic children (Takahashi et al., 2017). Also, research showed how robot Maria allocated different customized, projected, and content-

based games so that children were highly influenced (Panceri et al., 2021). In software games, the study explored the idea of an avatar that frequently altered various contents in adventure games for Autistic children to learn basic emotions (Almeida et al., 2019).

The proposed Smart therapy environment can be customized according to the child's preference or safety. The colors, music, and objects can be modified according to the children's preferences. The game environment also can be customized according to individual or group involvement. For example, the therapist can change the allocation, numbers, or size of the object. They can also change the environment of the object to ensure children's motivation towards the game. The speed and timing of the games during individual or peer involvement can be controlled according to the situation.

The concept of step-by-step guidance was another important feature that was found in many research papers for both manual and technical procedures for developing social interaction and emotion recognition in Autistic. In ABA therapies, most of the procedures involved step-by-step guidance from the therapist children. (Kearney, 2015; Parvin et al., 2022). Regarding the guidance, the study explored the concepts of avatar and virtual voice assistant (VVA) separately. The study found the implementation of avatar guidance and VVA application effective and practical for the social interaction and emotion recognition of Autistic children. Firstly, the study locates the avatar concept as safe, and easily understandable by Autistic children. The study also found the avatar concept interactive for learning, social interaction development, and emotion recognition of Autistic children. (Almeida et al., 2019). The appropriate body gestures, speech, and motivations of the avatar character were safe, easy, and influential for Autistic children (Fabri et al., 2007). Secondly, the study identified the VVA system that ensured promising results in guiding and reinforcing Autistic children during their daily activities. Parents reported that children were more motivated and emotionally attached to follow the VVA device instructions and curious to understand the voice. Besides, reinforcement is also found valuable for encouraging Autistic children's participation in various learning activities. (Parvin et al., 2022). Rewarding, encouraging words, encouraging body gestures, and positive reinforcement were able to create a vital influence on a successful therapeutic procedure (Yu et al., 2020).

In the proposed Smart therapy environment, the study introduces the idea of a live animated avatar with a VVA system that appears as a live projected character. The guidance and motivation of the avatar to Autistic children during games are considered a safe and effective procedure after analyzing a rich collection of research papers. The avatar with VVA will perform the game on the projected game environment initially and present the activities to the child. The therapist can repeatedly generate the sequence of avatar performances for the child to make them realize the game activities. The avatar also participates as a friend with the child during each game. Positive reinforcement for both success and failure will performed by avatar. The avatar uses the children's names to instruct and reinforce them during the activities.

Moreover, continuous stress monitoring through an embedded system inside the smartwatch or wristband also proved to be effective during research studies. People with Autism often experienced high perceived stress levels and face difficulties coping with the stressful situation. They also faced challenges in the accurate detection of stress and responding faster to fear. As a result, monitoring stress and management of the stress level was very important for people with Autism. (Hufnagel et al., 2017; Tomczak et al., 2020). A study successfully used an embedded sensor-based system in the shape of a manageable wristband to record the stress levels of Autistic children in an educational institution. The device was utilized to monitor and report the stress levels of every Autistic

child during the game. (Tomczak et al., 2020). In the proposed Smart therapy environment, the smartwatch will contain embedded software for continuous monitoring of the stress levels of every child during participation. The data will be delivered to the therapist who will control the whole Smart therapy environment. If the therapist detects high stress in any child, they can cancel the game or customize the game environment as required.

Previous research, books, and websites are assessed to locate the potential design principles that are allocated in Tables 3, 4, 5, and 6 in section 4. All of those design principles are the basis of the artefact design of the Smart therapy environment. Following those design principles, the study proposed a potent and feasible Smart therapy environment for Autistic children's social interaction and emotion recognition development. Through the games, the children will interact with avatar instruction and also be able to learn colors, objects, shapes, numbers, emotional emojis, and animal names. The children also understand happy, sad, or exciting situations as the avatar will represent the sound and short story of feeling happy, sad, excited, etc during the game "Blend with Emojis". Emojis, shapes, or any content of the games will be identified by the sensor-based projected mat through the data transmission of the smartwatch during the game. The entire system will provide an entertaining playground where peer involvement and physical participation will be ensured. Such a system will reduce the child's attraction towards mobile or computer games randomly and allocate an indoor learning gaming environment. The entire Smart therapy environment focuses on making the interaction easy, effective, safe, and motivating. Thus, a Smart therapy environment involves maximum potential features in a practical way to develop social interaction and emotion recognition in Autistic children.

The study also interviewed three participants to collect their valuable opinions regarding the entire Smart therapy environment. The expert evaluation procedure will support the study to explore more research on the artefact design of the Smart therapy environment in the future and understand limitations. The participants highly appreciate the proposed concept and most importantly they support the concept of the live animated projected avatar with the VVA system. They also informed that the therapy environment is the most important part which can ensure better interaction development for Autistic children. Both contents and environments need to be influential, easy, safe, and attractive to the child so that they try to participate in that with their interest. They encourage stress monitoring and content customization options. However they raised questions about the following aspects,

- Practical implementations.
- Cost and effectiveness aspects
- Game concept understanding issues for blind or hearing-disabled Autistic children.

They also recommend a few extra features such as storytelling and introduction sessions of the avatar, family participation, and native language communication. The Smart therapy environment is an artefact design and requires further research and evaluation. It is also important to utilize the concept practically with Autistic children to understand their attractions and motivations. After the practical implementation, the aspects such as safety, cost, effectiveness, and arrangements of the environment will be more understandable for further research.

Moreover, the practical implementations will generate more limitations regarding the success of the proposed games' objectives in the Smart therapy environment. The

involvement of the therapist and parents during the children's participation, in reality, will uncover more challenging aspects to consider. The study identifies important limitations related to the light and shadow effects of the game during the projection. In that regard, the intensity of light in the projection mat and the shadow lengths of Autistic children need to be adjusted through the software. The allocation of the contents on the projected mat will be modified if it disrupts activities. The study considers this aspect for further research in the future. Cost and effectiveness are also important issues to consider in future research. Another vital limitation of this study involves a lack of data collection during the interview session in the evaluation. Because it is important to experience such a huge concept in reality to provide feedback or recommendations. It is not easy to generate comments or suggestions only by experiencing the virtual prototype design of the entire system which focuses on the major aspect of social interaction and emotion recognition in Autistic children. Besides, during the interview with the participants, the communication language was English so the participants were not comfortable answering all the interview questions. They preferred their native language. As a result, the one-hour interview data collection was not sufficient. However, they further sent their valuable feedback through email in a signed document. Those data are also analyzed with previous interview data in this study. Moreover, the study planned to interview six participants but unfortunately, three of them did not attend the interview due to personal issues. This also creates a limitation in the data collection process.

Further evaluation and development of such a promising system is essential in the future. Despite all the limitations, it is important to note that the participants do not raise questions about the feasibility issue of the entire system. The whole procedure seems attractive to them and they are interested in the real-life implementations of the system. Moreover, the study locate, search, and select related previous literature in a systematic way. It helps to identify gaps and accommodate the core effective and feasible aspects from the previous literature. Ultimately, it helps to formulate the research question. The presentation of core findings is also presented through the interaction design discipline (Preece et al., 2004). Ultimately, the Smart therapy environment is proved to be a completely new proposed system in this study. So, the design science research method is selected for creating and designing the artefact of the proposed system (Hevner et al., 2004). The study also follows the seven guidelines of design science research.

Finally, the proposed Smart therapy environment is a potent, feasible, and intelligent environment where Autistic children can participate alone or with peers to develop social interaction and emotional recognition.

7. Conclusions

Smart therapy environment is the artefact design of this study and design science research method is used to design and evaluate the artefact design. The live animated, projected, and smart avatar that communicates through the virtual voice assistant (VVA) system is one of the dynamic features that need to be explored more through research studies. The combined technological implementations are designed in a way that provides personalized options to bring more opportunities to learn and play. Moreover, it will bring the virtual world into the real playground and care about every participant as well as motivate researchers to think about new dimensional research for Autistic children's social interaction and emotion recognition development. It will be a great achievement for the study if future researchers are motivated by the study and consider innovative, and feasible technological aspects together to make Autistic children interact with the beautiful world. However, it is worth mentioning that the design of the Smart therapy environment needs more research and exploration as it initializes the involvement of potent, practical, and smart technologies together in one therapeutic environment.

Moreover, the expert evaluation of the participants has raised questions about the practical implementations of the artefact design. It is difficult to provide feedback and recommendations for the design of a system especially related to Autistic children without experience the practical implementations. It is important to develop those games in reality and monitor the participation of Autistic children with therapist supervision. The interview data are mostly positive because of the limitation of understanding the practical implementations of the artefact design to the participants. The participants only learned about the previous research aspects and prototype designs of the therapeutic games in the proposed Smart therapy environment. Besides, the participants are selected as they have training on Autistic children identification and early childhood education. However, for more data collection, it is required to conduct interviews with parents, trained therapists, and researchers related to Autistic children's social interaction and emotional recognition development.

Despite the limitations of cost, effectiveness, and practical implementations, the Smart therapy environment is the combination of feasible, smart technologies that are recommended in previous research studies. The design concept of the Smart therapy environment will motivate the researchers to invent a virtual projected playground for Autistic children that influences physical participation rather than dependency on robots, computers, or mobile games. The Smart therapy environment will bring a new research era for developing an environment for Autistic children where they can learn and play in their way. The psychology and brain development of Autistic children need to be researched more to generate the idea of their satisfaction during learning and interaction development.

Furthermore, it is worth mentioning that the Smart therapy environment could be a good support for the therapist or practitioners. They can conduct various therapies for Autistic children's social interaction and emotion recognition development by customizing the therapy environment as required. It will reduce their time and patience. The VVA-featured live avatar can be used in various procedures related to the therapy sessions as a guide, reinforcer, or a friend of the Autistic child. The stress monitoring data also help the practitioners to conduct more study on the children's safety or requirements issues.

Literature studies explore a plethora of concepts regarding manual and technologically advanced development for Autistic children's social interaction and emotion recognition

development. It is one of the biggest achievements of the study to learn about the feasible smart features and designing of the Smart therapy environment for Autistic children. The experience of interviews and data collection is also a great way to learn practical aspects. The study concludes that the practical implementation of such a noble, and challenging procedure is only possible if the government, the entire society, doctors, therapists, parents, and researchers of related studies cooperate and come forward.

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Appendix 1. Interview Questions

First impressions How do you feel about the idea How do you feel about the games` How do you feel about the game interface design? Please give both positive and negative feedback about the game.
Feedback on the design Which features of the game seem attractive to you? Which features of the game seem effective to you?
Feedback on the goals of the design Do you think, Autistic children between ages 6 to 12, will feel interest with the game? Does this game contribute to autistic children's social interaction and emotion recognition development?
Overall Feedback/Recommendation Please give both positive and negative feedback for the proposed Smart Therapy Environment and game concept design. Do you like the interactive projected floor games concept with Avatar involvement? If 'Yes ' or 'No' ,please explain why Do you think AI voice recognition through smart watch can be a good feature for such games, especially for Autistic children's social interaction and emotion recognition development? If 'Yes ' or 'No' ,please explain why "The games can generate social interactions among Autistic children" , What do you think about it?

Appendix 2. Consent Form

Informed consent form

"Smart Therapy Environment: A Design Science Research towards Innovative Artifact Design for Autistic Children's Social Interaction and Emotion Recognition " is the Master's thesis (Course id 813613S, 30 credit) work in the Faculty of Information Technology and Electrical Engineering (ITEE) of the University of Oulu. The thesis is supervised by,

Netta livari,

Responsible director of the research.

INTERACT Research Unit, University of Oulu

Description of the research project and research material

The thesis proposed the concept of a Smart therapy environment children with Autism which aims to offer the following functionalities: (1) Simple and easy games projected on the sensor-based floor mat for social interaction and emotion recognition in Autistic children. (2) Game designs are inspired by scientific therapy procedures, software applications, virtual reality basics, and robotic interventions. (3) Artificial Intelligence-based voice assistant in the form of an Avatar to guide and reinforce children during games. (4) Continuous monitoring of children's excitement, facial expressions, and stress through the smartwatch. Currently, there are no such system design concepts involving intelligent projected playgrounds with those technological aspects together for Autistic children's social interaction and emotion recognition development. So, the responsibility to develop the design of a Smart therapy environment cannot be underestimated and is something to focus on. The thesis carefully utilizes the framework and guidelines of Design Science Research. It assessed a plethora of articles on successful behavior-changing conventional therapies, Virtual Reality, Avatar-based software games, Robot-assisted interventions, projected game ideas, Artificial Intelligence voice assistance systems, and embedded software for stress monitoring in Autistic children's social interaction and emotion recognition development. All of those studies help to identify factual perspectives of technological and manual establishments for Autistic children.

Parties to research as a collaborative project and burden sharing

Thesis author: Samia Islam, Master's degree student, Faculty of Information Technology and Electrical Engineering (ITEE) of the University of Oulu.

Contact us if you would like to learn more about the survey or exercise your rights as a data subject. sislam21@student.oulu.fi.

Name, nature and duration of the investigation

Title of study: Smart Therapy Environment: A Design Science Research Towards Innovative Artifact Design for Autistic Children's Social Interaction and Emotion Recognition

Thesis work.

Duration of the study (how personal data are processed): The data will be collected during 2023. The research material is then processed and archived as such for longer-term use for thesis evaluation and research. Personal data is processed on the basis of the following criteria in accordance with Article 6(1) of the GDPR: the informed consent. Material that can be fully anonymised may also be opened after publication of the results in a national or international archive or storage service important to the research unit of the University of Oulu. More information about the processing and archiving of personal data can be found in the INTERACT research unit's data privacy notice: https://interact.oulu.fi/data-privacy-notice

Kindly note that, during the user experience study, all interviews with the participant will be recorded which help to further analysis of the user data for the result of the thesis evaluation. No personal data and information will be shared on other media. After the evaluation, all recorded materials will be deleted.

Regards

Samia Islam, Master's degree student, University of Oulu

Full name of the study participant:

Occupation of the participant:

Short professional profile of the participant (For example: name, aim and short description of the occupation or training related to Autism):

To participate in the above-mentioned study, I agree that the student can use my personal data and recordings for the evaluation of the thesis result. The data can be used for research work further.

Signature of the participant:

Date and place