

# ALTRUISTIC ASD (AUTISM SPECTRUM DISORDER) VIRTUAL REALITY GAME

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## **ABSTRACT**

*Autism spectrum disorder is a developmental disability that can cause significant social, communication and behavioural challenges. Parents of children on the spectrum find it difficult for their kids to communicate with them and other people, which makes it challenging for social interactions. Researchers have introduced different solutions such as Therapy Robot that Teaches Social Skills to Children with Autism. Additionally, Virtual reality was used to teach emotional and social skills to children with autism spectrum disorder. However, these solutions focus only on the person on the spectrum, neglecting the fact that the social challenges that people on the spectrum face are partly due to the lack of understanding on the neurotypicals' end. In this study, the solution introduced focuses on the neurotypical perspective; An advanced and interactive intelligent technology that can educate neurotypical people on how to communicate with people on the spectrum in different scenarios and environments. It also allows the learner to see the consequences of the different interactions from the point of view of a person on the spectrum, be aware of their actions, and fully engage in the scenarios through Virtual Reality (VR). Virtual Reality is a technology that simulates experiences that can be similar to the real world. The project aim was achieved by implementing a storyline game that is VR-based.*

## **KEYWORDS**

*Autism, Neurodivergent, Neurotypical, Virtual Reality, Communicating on the spectrum.*

## **1. INTRODUCTION**

Autism, or autism spectrum disorder (ASD), refers to a broad range of conditions characterized by challenges with social skills, repetitive behaviours, speech, and nonverbal communication [1]. autistic people find it hard communicating in general, and recent studies have shown that people on the spectrum prefer only contacting other autistic people [2], which may be due to the fact that neurotypical people do not have enough knowledge on how to communicate with people on the spectrum. The aim of this project is to make people with the least interaction with people on the spectrum experience situations from an autistic person's perspective to raise awareness about autism. This is achieved by allowing the learner to view how this neurological condition affects the integration of individuals living with it. This is done in an effort to make the learner understand the way people on the spectrum think by projecting the challenges they face daily, such as:

-social communication challenges, where adults and children with autism have difficulties with verbal and non-verbal communication for example they may not understand or appropriately use spoken language (around a third of people with autism are non-verbal), gestures, facial expressions and expressions not meant to be taken literally.

-additional social challenges: Including difficulty with recognizing emotions and intentions in others, expressing emotions, feeling overwhelmed in social situations, taking turns in conversations, and gauging personal space (appropriate distance between people).

lack of awareness and understanding of an autistic person's behaviour affects them in many ways psychologically and physically when a person misunderstands their behaviour, hence, Researchers have focused on solutions for ASD, and ignored the neurotypicals who interact with them. Therefore, there is a lack of studies that teaches neurotypicals on how to communicate and interact with people on the spectrum in our everyday life rather than the other way around. take on a futuristic look by incorporating innovative technology into an educational setting to address the complexity in interacting and communicating with people on the autism spectrum. The game was created with the assistance of specialists in that field to determine what would have been the best way for a neurotypical person to handle the different situations making an impact socially.

## **2. RELATED WORK**

There is no doubt that technology has completely changed our world. It has given us unlimited access to information and communication while removing the need for physical, social interaction. Technology has helped kids with Autism learn and develop skills like never before. However, this related work covers solutions that have used technology to enhance a life of people with autism.

### **2.1. Therapy Robot Teaches Social Skills to Children with Autism**

For some children with autism, interacting with other people can be an uncomfortable, mystifying experience. Feeling overwhelmed with face-to-face interaction, such children may find it difficult to focus their attention and learn social skills from their teachers and therapists—the very people charged with helping them learn to socially adapt.

What these children need, say some researchers, is a robot: a cute, tech-based intermediary, with a body, that can teach them how to interact with their fellow humans more comfortably [3].

It has so many positive impacts such as:

- Feeling at ease with a robot, these children are better able to focus their attention on a curriculum presented together by the robot and a human therapist.
- with a robot in the room, children tend to interact more with human therapists, according to feedback the company received during its research, says Nazari Khorram. "The robot has the ability to create a triangular interaction between the human therapist, the robot, and the child," she says. "Immediately, the child starts interacting with the educator or therapist to ask questions about the robot or give feedback about its behaviour."

We asked Nazari Khurram if it's possible that pairing robots with children with autism could move them further away from people, and closer to technology. "That's one of the fears that people have," she says. "But in practice, in our studies and based on the feedback of our users, the interaction between the children and the therapists improves.[3]

### **2.2. Upgraded Google Glass Helps Autistic Kids "see" Emotions**

When a face is recognized, the head-up display's boundary turns green, and the display identifies the facial emotion with an emoticon, emoji, or written text. Users can alternatively opt for an

auditory cue a voice defining the emotion from the bone-conducting speaker included into the glasses, which transmits sound waves through the skull to the inner ear. Happiness, anger, surprise, sadness, fear, disgust, and contempt are among the seven facial expressions recognized by the system, which we renamed "meh" to make them more child friendly. Children are supposed to quickly learn how to detect the feelings of their social partners and then stop wearing glasses once they have achieved social confidence [4].

### **2.3. Using Virtual Reality to Train Emotional and Social Skills in Children with Autism Spectrum Disorder**

In the beginning mentioned that training became popular with new emerging technology, focusing on virtual reality (VR) to help children with autism spectrum disorder (ASD) with social skills and developing communication with outside world by an environment that is managed and supervised to make them feel safe and practice skills repetitively. The Centre for innovative applications of internet and multimedia technologies (AIMTech Center) at university of Hong Kong developed a VR-enabled training program to examine efficacy on emotional and social skills with six VR scenarios with typical daily lives of children in Hong Kong, 94 children from mainstream primary schools in Hong Kong completed the study and 72 children were included in the analysis. Emerging modern technology offers solutions for different cases in our time, taking for example treating depression with computerized and internet-based treatment was found to be effective with therapist support, with the virtual reality (VR) technology increasing studies and application lately been increasing based on training and therapy, the environment of virtual reality (VR) provides a whole experience of situations [5].

Taking the actual definition of ASD being a developmental disorder characterized by persistent impairment in social communication and patterns of repetitive behaviours, it comes the part where using VR is useful to simulate different many social situations for autistic people to practice on and develop social skills easily better than social stories being presented on paper or in a recording or as visual representation where it just includes observing and not interacting.

For example, there is situations that cannot be presented in real life and practiced for how dangerous it is, like teaching children to cross a red light so by that it can be programmed into VRE, to provide a safe environment.[5]

The actual method performed on children with ASD and their teachers developed by the Centre for Innovative Applications of Internet and Multimedia Technologies (AIMTech Centre) at City University of Hong Kong has developed a VR training program to help children with ASD, called the (CAVE) cave automatic virtual environment that allows the interaction of different scenarios based on real life situations, the training include a group of children 3 to 4 to a briefing session covering to go back on previous skills taken to prepare for the actual VR training. Then, start every child individually on the CAVE technology and navigate through the VR technology supervised by the trainer, the session lasts one hour then followed by briefing discussion of learned skills to perform in real life, seasons are divided into six including a relaxation scenario, four training scenarios and one consolidation scenario.

All scenarios designed to match real life of typical primary school children in Hong Kong.[5]

Selected primary school children with ASD participated in the study, where parents and children were invited to an information session for the parents to consent over their children participating in the study voluntary and with the right to withdraw at any time.[5] At last, 94 children completed the study, and 72 children were included in the analysis after filtering for age. There

were 64 boys (88.9%) and 8 girls (11.1%) with a mean age of 106.3 months (SD = 13.53; Table 1). Children with documentation of intellectual disability were excluded from this study. The children have all received a diagnosis of ASD by Child Assessment Service in Hong Kong or via private practice. A waitlist control design was adopted.[5]

The feedback gathered from parent and teachers was positive as parents expressed that their children were more communicating with their surrounding environment of family and neighbours, while teachers reported that their students are making more friends and engaging in two-way conversations.[5]

In despite difficulties faced in beginning where children refused to wear goggles due to bad past experiences for example at the 3d movies or just being uncertain but with the support of the trainers after a couple of sessions children were able to wear it comfortably and went through the sessions with understand of the audio and visual information in the VR system, while the briefing sessions before the actual experience came in great help to the trainers facing the children emotional and behavioural issues that may arise during training.[5]

#### **2.4. Use of Telehealth for Facilitating the Diagnostic Assessment of Autism Spectrum Disorder (ASD)**

It can provide assistance and support to people who have specific health and well-being needs. Telehealth is defined as a "system that allows people to get professional services and support from a distance." [6]

Telehealth may have advantages over traditional face-to-face approaches, such as enhancing access to healthcare services, particularly for people and families living in rural and underserved areas.[6]

Several studies suggested that the use of telehealth programs, combining web-based instructional content with weekly video-conferencing coaching sessions may support parental learning and improve a child's social communication skills, Parents also indicated that such systems were effective, acceptable, and usable.[6]

The position of telehealth in the field of ASD is small but growing. Telehealth approaches have recently been explored as a way of supporting the delivery of a range of services for people with ASD and their families.

Telehealth might be used to improve individuals' access to behavioural intervention services. Several studies used telehealth to coach parents of children with ASD to conduct behavioural assessments such as functional analyses (FA), functional communication training (FCT) via the use of videoconferencing, either parents and their child located at a regional clinic, home, or school.

The findings suggested that parents can successfully conduct FA and FCT through telehealth when behaviour analysts offer consultation remotely. It has also been found reductions in problem behaviour of children. For example, Wacker et al. found the average reduction in problem behaviour was 93.5%. Similarly, Lindgren et al. revealed that problem behaviour was decreased by an average of 90%. It has also been demonstrated the preliminary efficacy of telehealth- delivered parent mediated interventions that are intended to increase parent knowledge and the use of ASD behavioural intervention strategies with the child in their daily life. Several studies suggested that use of telehealth programs, combining web-based instructional content with weekly video-conferencing coaching sessions may support parental learning and improve

child's social communication skills. Parents also indicated that such systems were effective, acceptable, and usable.[6]

### **3. RESEARCH APPROACH**

#### **Phase 1: Defining the Scenarios**

The game was created with the assistance of specialists in that field so that we can educate neurotypical people on how to interact properly with people on the spectrum. The scenarios will be based on real life told by people on the spectrum and how it affected them and how the situation could have been avoided if things were different.

Our advantage is that we take a scenario that occurred in real life with a person on the spectrum and present it to a specialist to determine what would have been the best way for a neurotypical person to handle the situation and educate people so that the social environment can be more accepting and welcoming of people on the spectrum. Our project will make an impact socially because it will raise awareness and help people deal with different situations connecting with people on the spectrum.

#### **Phase 2: Designing and Developing the Video Game**

We developed the game using the Unreal engine. The game is a storyline that teaches the users how to interact with a person on the spectrum as they go through scenarios and choose what action to make depending on their perception of what is the right way to act with a person with ASD's.

The main idea of this game is using the knowledge the average person has about people on the spectrum to help them choose the correct action to make and witness the consequences of it.

The game aims toward raising knowledge to those who are not aware of the right way to behave with an autistic person, where we saw the neglect on this area and the main focus and display of technology is on autistic people, employing VR technology to mimic a real life situation with an autistic person and from the point of view of an autistic person benefits both sides, where it will have a positive reflect on autistic people making them feel understood and ease the communication at the same time raise the level of knowledge and awareness in neurotypical people.

The game starts with the main menu, then the first level scenario will play. The first level is an introduction to the game play and structure. the level starts in a classroom, the teacher asks the students to take a seat and start working on the in-class assignment with their classmates.

The player walks to the classmate and faces with a question "The teacher asked us to pair up, do you want to work together?" The classmate is not responding; therefore, the player must choose between two choices. The first choice is "Ask to join by pointing to the computer", The second choice is "Shout Their name".

Each choice has its consequences if it is the correct choice the player will go to the next level, if it is the wrong choice the Player will see the point of view of the classmate. In the point of view in the first scenario the player sees the interaction from the classmate's perspective, it starts when the classmate was hyper focused on a green frog and did not hear the player shouting. The classmate gets triggered from the loud shouting and the interaction starts an episode, which the player sees.

The reason behind the first level is to instruct people on how a small gesture such as shouting can have an effect on someone who is on the spectrum and be more aware and understanding when it comes to interactions and how to leave a positive impact on other people's lives.

The second level has higher complexity to teach the player the different level of autism. The level starts with two classmates sitting next to each, the autistic student is doing schoolwork and the other student is playing music on the phone extremely loud. The interaction triggers an episode for the autistic student and causes a meltdown which contains screaming and rumbling. The player in this level is the teacher, after seeing the interaction the player is faced with two choices to resolve the argument between the two students.

The first choice is "Take the student out of class and clam him down" or the second choice is "Ignore the situation and let the classmates resolve the issue themselves". When making the right choice the player moves to next level, otherwise the player will see the perspective of the autistic student.

The point of view starts with the autistic student trying to work on their schoolwork and being distracted with the other student playing the loud music, the sound gets louder and it trigger a severe episode that starts a meltdown cause screaming and rumbling. The level displays the different perspectives of autism and how severe and episode can be. The third and last level has the highest complexity and another level for autism. The level starts in a school playground and the student is playing in the sandbox aggressively. The player is faced with two choices, the first one is "Calm the student down and show her how to play properly" or the second choice is "Scream at her for making a mess". Making the correct choice will take the player to the next level. Otherwise, the player will see the autistic student's prospective and how the screaming can trigger an episode and would make the situation even worse and might cause the student to cry, hit themselves or even others.

The scenarios are taken from real life events and set up as an open level where the player can have the freedom to make their own choices and see how it may affect other people's lives and try to make a positive impact on their lives.



Figure 1. Home screen



Figure 2. Loading game screen

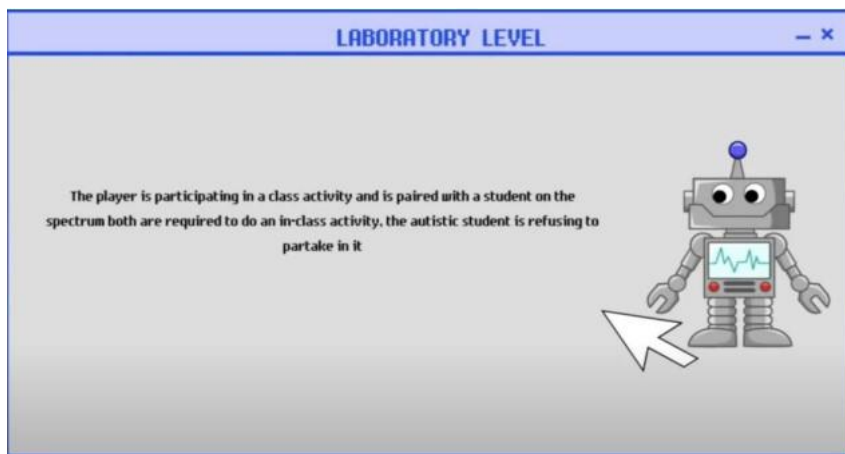


Figure 3. First scenario introduction screen



Figure 4. First scenario environment

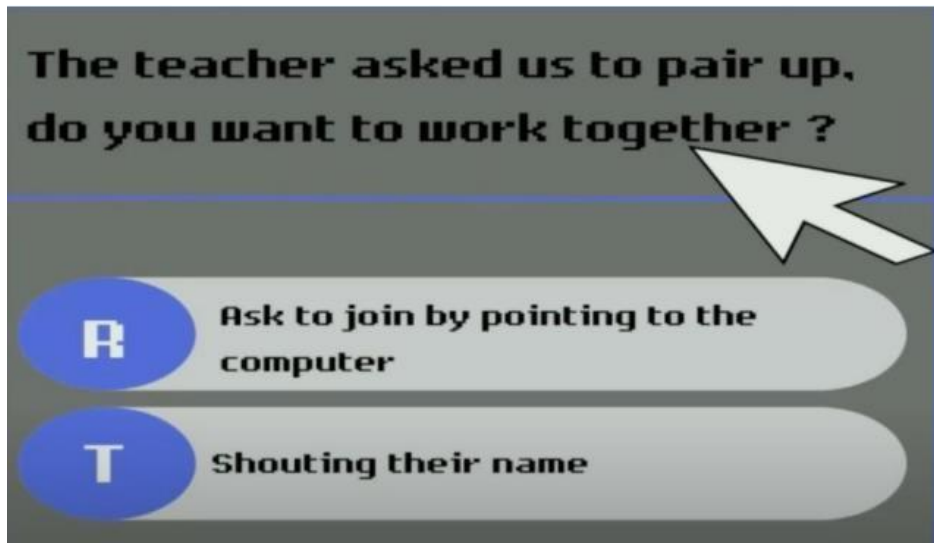


Figure 5. First scenario question

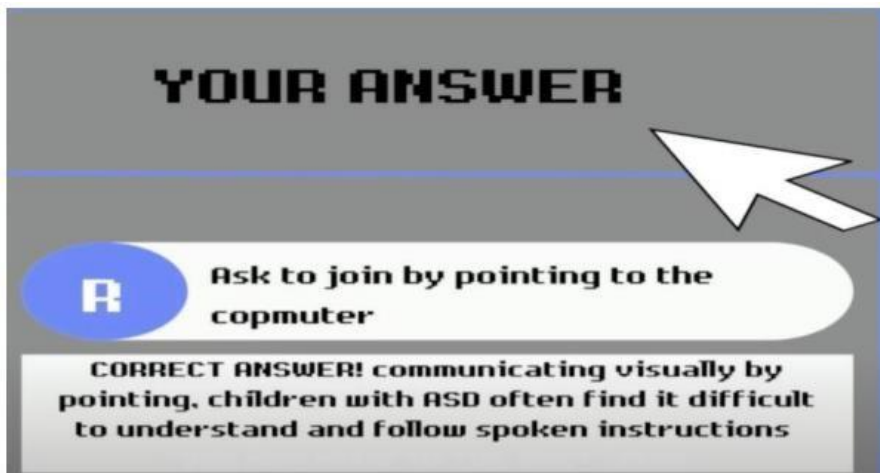


Figure 6. First scenario correct answer

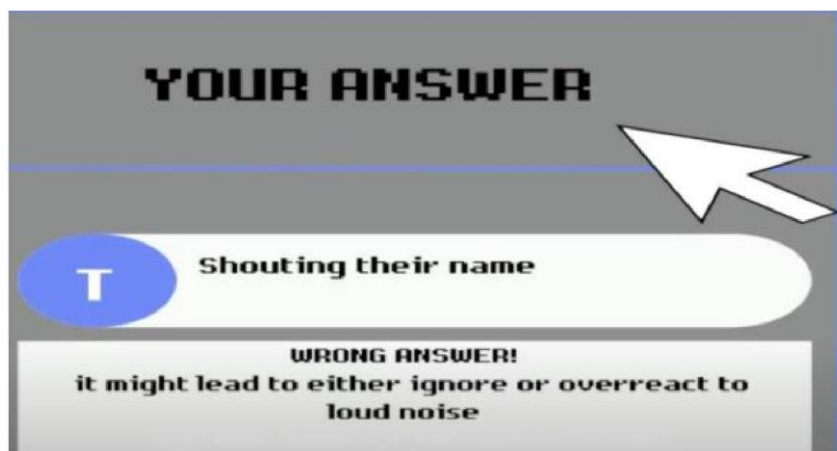


Figure 7. First scenario incorrect answer





Figure 8. ASD Point of View

### 3.1. Implementation

Our system is developed using unreal software which gives us the ability to develop our application providing the high-quality experience using virtual reality through the unreal software.

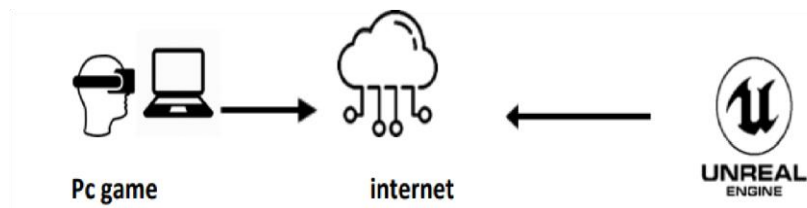


Figure 4. Application Architecture diagram

### 3.2. System Architecture Layers Description

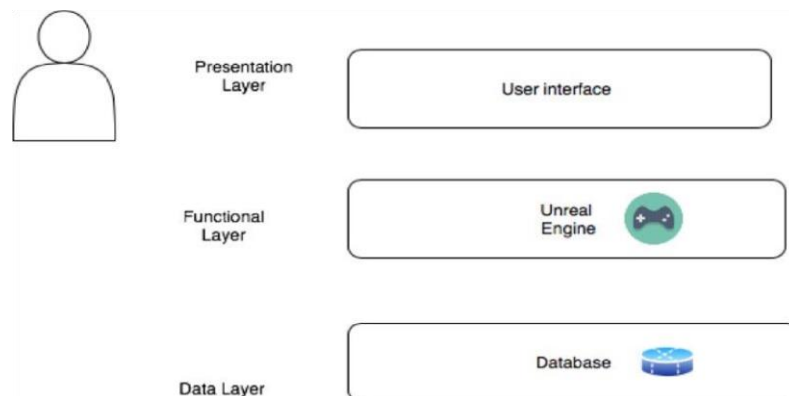


Figure 5. System Architecture layer description

The System Architecture Layer diagram shown above defines the main components in our Proposed System.

We chose a three-Layered Architecture in our design (see figure 5), and they all serve different purposes:

- Presentation Layer: this layer is responsible for the user interfaces /user interaction with the System, it consists of components within the application layer like game scenarios.
- Functional Layer: the main functionality of the system is in this layer which allows users to use/interact with the Game.
- Data Layer: Data will be stored in the Database to perform many functions like setting backup, recovery, updates, and tests.

#### **4. STUDY DESIGN PROCEDURES**

The participants took the usability test in a meeting room, we provided the game on a PC so that the users can try it. All the interactions were monitored by two of the team members after they gave a brief introduction about the game and the idea behind it.

A questionnaire and a consent form were filled by all the 10 participants to test their background information on the topic and if they ever used a VR headset before. We informed the participants that the time to complete the tasks will be measured and the team members will be observing their behaviours and interactions with the game. After completing the tasks all the participants will complete a post-task interview to give their honest feedback on the game. The questions were created using this model (TAM). The technology acceptance model (TAM) is a theory of information systems that describes how consumers accept and use technology.

When users are introduced with modern technology, the model argues that a few factors influence their decision about how and when to use it: (1) perceived usefulness, (2) perceived ease of use, and (3) satisfaction. The emphasis on the potential user's perceptions is a fundamental component of this strategy. That is, while the inventor of a technology product may believe it is valuable and user-friendly, potential users will not accept it until they share those thoughts.

##### **4.1. Test Results**

During the usability test our analyses were focused on the performance of the game and meeting the goal of educating neurotypicals on how to communicate with a person on the spectrum. We tested all 4 tasks in the game which are: Starting the game, Viewing the scenarios, making choices, Watching the POV.

The time taken to finish the game was shorter than we expected, and it was measured by calculating the mean times for completion to figure out the efficiency for the game

Table 1. Test cases

Number of participants	Start game	View 1st scenario	View 2nd scenario	Make a choice	Watch POV
Participant #1	x	x	x	x	x
Participant #2	x	x	x	x	x
Participant #3	x	x	x	x	x
Participant #4	x	x	x	x	x
Participant #5	x	x	x	x	x

Table 2. First scenario mean time

Task	Mean	Min	Max
1	1:58 s	1 min	2:30 s
2	38s	30 s	50 s
3	32 s	30 s	40 s
4	40 s	30 s	1 min

Table 3. First scenario mean time

Task	Mean	Min	Max
1	1:42 s	1 min	2:30 s
2	48 s	40 s	1 min
3	34 s	30 s	50 s
4	37 s	30 s	50 s

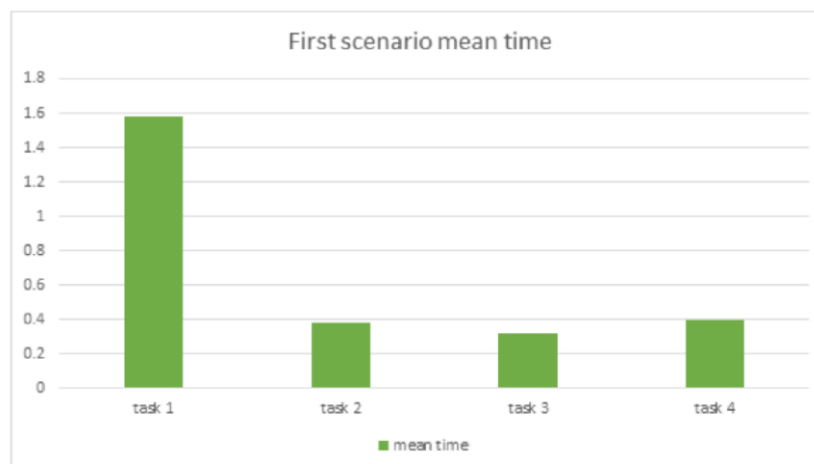


Figure 6. Mean time for the first scenario

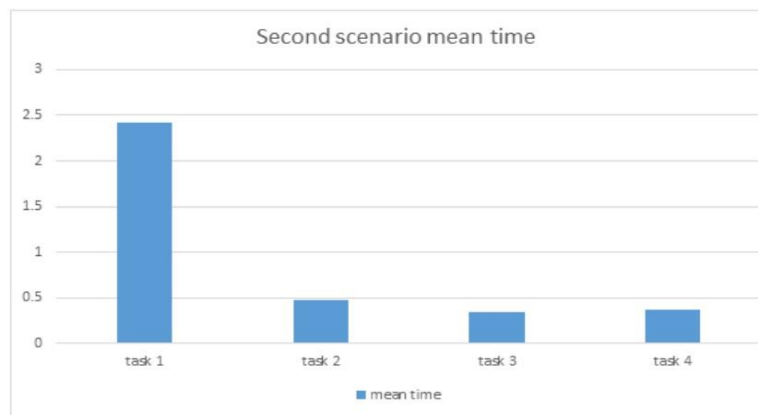


Figure 7. Mean time for the Second scenario

From the figure graphs shown above we can indicate that the mean time for the first task in both scenarios took longer than the rest. The first scenario took less time to play due to the simplicity of the interaction making the idea of the game understandable and easy to follow.

We also found that the users took a longer time playing the second scenario which was expected considering that the difficulty increases through the game showing how complex dealing with people on the spectrum can be. The users faced a harder time comprehending the reaction of the person on the spectrum during the second scenario which explains the increase in time it took to finish it.

For the rest of the tasks all the users took less than a minute to complete them since they were clear and easy to understand with no instructions needed.

We concluded based on the analyses we did that it took the specialists less time to complete the game compared to the other users without any experience in dealing with a person on the spectrum because they have had experienced similar interactions before.

## 5. FINDINGS

### 5.1. Efficiency

During the usability test our analyses were focused on the performance of the game and meeting the goal of educating neurotypicals on how to communicate with a person on the spectrum.

We tested all 4 tasks in the game which are: Starting the game, Viewing the scenarios, making choices, Watching the POV.

The time taken to finish the game was shorter than we expected, and it was measured by calculating the mean times for completion to figure out the efficiency for the game as shown above.

### 5.2. Usefulness

Based on the participants' feedback they all agreed that the game helped them understand people with autism better and the approach we chose to help raise awareness on this topic was unique and easy to understand.

The participants agreed that this game will have a significant impact on our society by teaching neurotypicals how to interact with people on the spectrum properly which will be a great step in achieving the kingdom's 2030 vision in making the society more vibrant and coherent.

### **5.3. Learnability**

All the participants agreed that the game was fast to learn although the second scenario was more intense and complex which resulted in requiring some instructions due to its difficulty and a longer time to complete by the players.

We noticed that the first scenario didn't need any instructions and took less time to finish considering that it was an introduction to the idea of the game.

### **5.4. Satisfaction**

By the end of the game the participants were pleased with the idea and the game play, they all agreed on recommending the game to others who would benefit most for example parents with kids who were recently diagnosed with autism, people who are interested in working in that field and the general public.

Some of the participants encouraged us to promote the game more during April which is autism awareness month to help raise awareness and educate the community in a fast, simple approach.

Overall, the participants were satisfied by the whole experience and were excited to see more of the game in future.

### **5.5. Ease of Use**

The participants stated that the game was clear and easy and the interactions of the game were understandable without needing any instructions.

None of the participants faced any issues interacting with different environments, making choices, watching the POV despite their differences on PC games experience in the past they all found it fun and exciting

### **5.6. Analysis Results**

Based on our research we found that all the participants enjoyed the idea of the game immensely and showed a great amount of support for the future of the project.

Additionally, participants who had no experience in dealing with people on the spectrum were significantly affected by the interactions and watching the POV considering their lack of experience in their day to day lives. Overall, our analyses showed that efficiency, ease of use, learnability, usefulness and satisfaction were the main strength points in the game. The interactions the participants had with the game showed how easy it was to learn with minimal instructions to guide them through it.

## **6. CONCLUSION AND FUTURE WORK**

In this project, we addressed the problem of the lack of recognition to the technology serving the autistic community but in Favor to neurotypicals who are not on the spectrum, one of our main

contributions is to highlight the need of spreading awareness and educating the community about autism and the right way to communicate with people on the spectrum.

Where we highlighted some topics concerning different areas in autism representing their behaviour in communication displaying different experiences with people on the spectrum from their point of view and from the neurotypicals point view, in the educational environment, actions and behaviours of the people on the spectrum in specific and lastly the technology field serving autism.

The focus of our project is to present an idea with a new approach in the technology field based on observing where the technology was aimed for in the autism field, introducing a concept filling the gap in that area and turning the focus about not being on the spectrum but dealing with the spectrum.

Developing a solution dedicated to help the world with the impact of the results and make a change.

The initial vision for the game was not fully achieved due to time constraints and some technical difficulties that are to be solved in the future. Adding the motion aspect to the characters was an integral part of programming the levels and was technically challenging. From the proposal of the idea, to digging into the system analysis identifying the system requirements and need then choosing the right application software to develop our game while it being a new challenging learning experience to us with programming and developing a game, moving to the designing process of the game and its levels, while considering a user-friendly interface.

Implementing the game into the software chosen facing difficulties and overcoming them, managing the results then testing its usability leading to an encouraging feedback and constructive criticism in the purpose of developing and enhancing our application. Throughout the process starting with little background about autism we gained valuable knowledge that every person must have, aiming for the purpose of awareness, new experience with developing games and learning through it In conclusion as we reach the end of this journey being the youth that aspire for a better future, we are proud to present this project dedicating the hard work achieved to a bigger cause serving a purpose and making a change.

Based on the point reached in the current work of the development of the game, the vision is not fully complete of the whole idea proposed as we faced some difficulties achieving it but came a long way through detection and hard work as seen in the development displaying the environments level based on the previous scenarios made while the autistic character being the same throughout the levels for it to be clear to the player, we managed to do all of the previous mentioned and programming the choices into the levels, as far as reached future work is needed

Therefore, in future work, more technical support will be utilized to accomplish programming goals in a timely manner. However, it must be stated that the progress made from the ideation stage to final execution was tremendous, due to continuous research and hard work.

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