St. Thomas' College of Engineering & Technology

Department of Computer Science & Engineering

Android Learning-Based Application for Kids

Prepared By

Student Name	University Registration No.
PRIYA ROY	161220110029 of 2016-17
RISHAB PRASAD	161220110100 of 2016-17
SANGITA POREY	171220120005 of 2017-18

Under The Guidance Of

Mr. DEBASHIS CHAKRABORTY

[Assistant Professor, Department of Computer Science & Engineering]

Project Report

Submitted in the partial fulfilment of the requirement for the degree of

B.Tech in Computer Science and Engineering

Affiliated To

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Utech

In Pursuit Of Knowledge And Excellence

Maulana Abul Kalam Azad University of Technology, West Bengal

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St. Thomas’ College of Engineering and Technology

Department of Computer Science and Engineering

This is to certify that the work in preparing the project entitled “Android Learning-Based Application for Kids” has been carried out by **SANGITA POREY (University Roll No.- 12200117002**), **RISHAB PRASAD (University Roll No.- 12200216027)** and **PRIYA ROY (University Roll No.- 12200116044)** under my guidance during the session 2019-20 and accepted in Partial fulfilment of the requirement for the degree of B.Tech in Computer Science & Engineering.

Project Supervisor	Head of the Department
Mr. Debashis Chakraborty	Dr. Mousumi Dutt
[Assistant Professor]	[Head of the Department]
Department of	Department of
Computer Science & Engineering	Computer Science & Engineering

St. Thomas' College of Engineering and Technology

Department of Computer Science and Engineering

ACKNOWLEDGMENT

Inspiration and motivation have always played a key role in the success of any venture. During the work we faced many challenges due to our lack of knowledge and experience but our Project Mentor, Mr. Debashis Chakraborty has helped us get over all those difficulties and in the final compilation of our idea to a shaped sculpture.

We express our sincere gratitude to Mr. Debashis Chakraborty, who has guided us throughout the project and has given us his valuable suggestions for the successful completion of the project. He has helped us understand the intricate issues involved with the objective of the project which would have been overlooked otherwise.

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Sangita Porey

[Roll No. – 12200117002]

Rishab Prasad

[Roll No.- 12200216027]

Priya Roy

[Roll No.- 12200116044]

INDEX

I. Pre-amble

I.I Vision and Mission of the Institute

Vision of the Institute

To evolve as an industry oriented, research-based Institution for creative solutions in various engineering domains, with an ultimate objective of meeting technological challenges faced by the Nation and the Society

Mission of the Institute

- To enhance the quality of engineering education and delivery through accessible, comprehensive and research-oriented teaching-learning-assessment processes in the state-of-art environment.
- To create opportunities for students and faculty members to acquire professional knowledge and develop managerial, entrepreneurial and social attitudes with highly ethical and moral values.
- To satisfy the ever-changing needs of the nation with respect to evolution and absorption of sustainable and environment friendly technologies for effective creation of knowledge-based society in the global era.

I.II Vision and Mission of the Department

Vision of Computer Science and Engineering Department

To continually improve upon its teaching-learning process and research with a goal to develop technical manpower with sound academic backgrounds, who will respond to challenges and changes faced by dynamic scenario of Computer Science and Engineering.

Mission of Computer Science and Engineering Department

- To inspire the students to work with latest tools and to make them industry ready.
- To impart research based technical knowledge
- To groom the department as a learning centre to inculcate advancement of technology in Computer Science and Engineering with social and environmental awareness.

I.III Program Outcome (PO)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering

problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

I.IV Program Educational Objective (PEO) of Computer Science and Engineering

Graduates of Computer Science and Engineering shall

1. Have skills to solve the problems by analysis, design, develop and implementation of algorithms leading to optimal solutions fulfilling the dynamic requirement of industry and society.
2. Have good understanding of Computer Science and Engineering concepts, making them practicing engineers with sound knowledge of logic and design, in Industries.
3. Undertake research in emerging fields in Computer Science and Engineering so as to face the challenges of global competitiveness.

I.V Program Specific Outcome (PSO) of Computer Science and Engineering

PSO1 : Programming skills : Apply fundamental knowledge and programming aptitude to identify, design and solve real life problems.

PSO2 : Professional skills : Students shall understand, analyze, and develop software solutions to meet the requirements of industry and society.

PSO3 : Competency : Students will be competent for competitive examinations for employment, higher studies and research.

I.VI PO and PSO mapping with justification

Project	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CS794	3	3	2	2	3	3	2	2	3	3	3	3	3	3	3

Justification:

- **PO1:** Applied the knowledge of engineering fundamentals and engineering specialization to the solution of problems in this Project.
- **PO2:** Identified and formulated a solution to problems using engineering science.
- **PO3:** Designed system components, analysis and interpretation of data for this Project.
- **PO4:** May arise during implementation of the Project.
- **PO5:** Android Studio will be used for creating the apps.
- **PO6:** Helps children with learning disabilities and suffering from ASD
- **PO7:** Not Applicable.
- **PO8:** We shall follow professional ethics and not submit a version of this app made by someone else.
- **PO9:** Discussion in group and contribution at an individual level has helped to develop solutions for problems.
- **PO10:** Communication has been an effective way for completing the pre-implementation stage.
- **PO11:** The project has been designed keeping financial expense in mind.
- **PO12:** Android is one of the most updated OS in modern times. So, continuous learning is required.

- **PSO1:** The project may be successful in solving a real world problem i.e helping kids with ASD.
- **PSO2:** The requirements have been analyzed and an application has been designed for the same.
- **PSO3:** This project will help broaden the knowledge in the field of a modern technology thus increasing chances for employment and research.

Chapter 1

Introduction

1.1 Objective of the Project

The basic objective is to create a mobile platform which can be used to share social skills and information in an individual with ASD (Autism Spectrum Disorder).

The app will focus on using social stories and visual schedules to improve socially appropriate behaviors in children with autism. It's a virtual visual support app to assist children with autism and communication challenges at home, school and the community. The app replaces the traditional visual supports that can be cumbersome, time consuming, costly to create and limited in function.

1.2 Brief Description of the Project

The project is an android application which aims to bring social stories to mobile platform. The app with its integrated view into requirements and interests of children, enables educators to provide comprehensive and modern approach.

The app implements social stories using text, images and audio. A Social Story is a story written to address various situations, concepts, or social skills that a person with Autistic Spectrum Disorder (ASD) might have difficulty in comprehending.

1.3 Tools & Platform

For Developers:

- Android Studio: It is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as the primary IDE for native Android application development.

- GitHub: It is a web-based hosting service for version control using Git. It is mostly used for computer code. It offers all of the distributed version control and source code management (SCM) functionality of Git as well as adding its own features.

  It provides access control and several collaboration features such as bug tracking, feature requests, task management, and wikis for every project.

- Android Mobile Device
- Android SDK framework
- Linux, MacOS, Windows with Java 8 installed

For users:

- An android device with android OS 5.0 (Lollipop) or above
- Android Device with at least 2 GB RAM

1.4 Project Organization

Project Development Approach:

To solve actual problems in an industry setting, a software engineering or a team of engineers must incorporate a development strategy that encompasses the process, methods, and tools. This strategy is often referred to as a process model or a software engineering paradigm.

A process model for software engineering is chosen based on the nature of the project and application, the methods and tools to be used, and the controls and deliverables that required.

We have used the Incremental Process Model for this project.

This model, as illustrated in the figure below derives its name from the way in which the software is built. More specifically, the model is designed, implemented and tested as a series of incremental builds until the product is finished. A build consists of pieces of code from various modules that interact together to provide a specific function.

At each stage of the Incremental Model a new build is coded and then integrated into the structure, which is tested as a whole. Note that the product is only defined as finished when it satisfies all of its requirements.

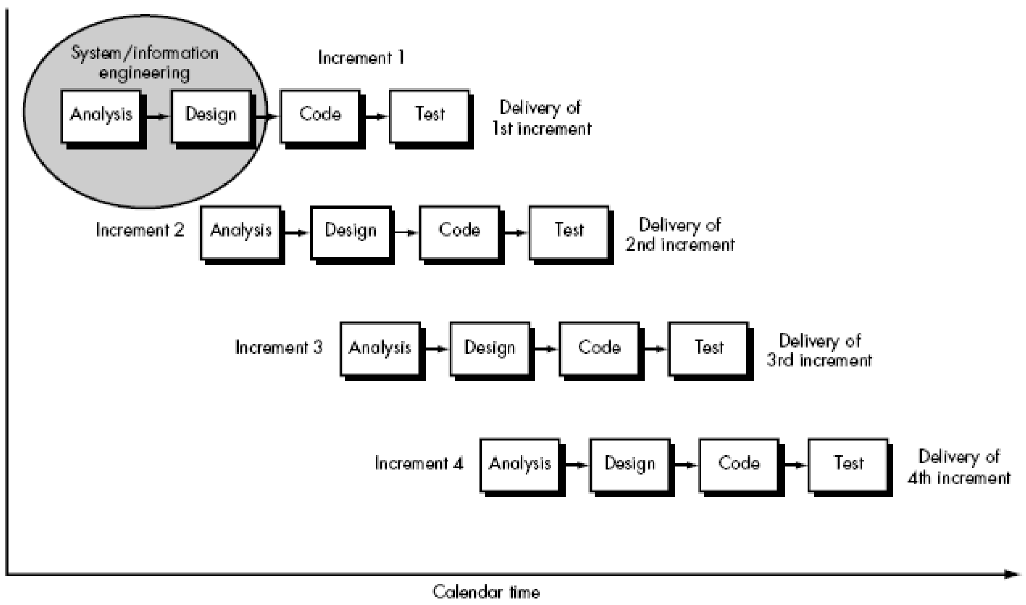

Figure 1: Illustration of the Incremental Model

Incremental Model

This model combines the elements of the waterfall model with the iterative philosophy of prototyping. However, unlike prototyping the IM focuses on the delivery of an operational product at the end of each increment.

An example of this incremental approach is observed in the development of word processing applications where the following services are provided on subsequent builds:

1. Basic file management, editing and document production function.

2. Advanced editing and document production functions.
3. Spell and grammar checking
4. Advance page layout

The first increment is usually the core product, which addresses the basic requirements of the system. This maybe either be used by the client or subjected to detailed review to develop a plan for the next increment. This plan addresses the modification of the core product to better meet the needs of the customer, and the delivery of additionally functionality.

Cost Estimation of App

Here, we are using the COCOMO (Constructive Cost Model) based on LOC, i.e. number of Lines of Code. It is a procedural cost estimate model for software projects and often used as a process of reliably predicting the various parameters associated with making a project such as size, effort, cost, time and quality.

The key parameters which define the quality of any software products, which are also an outcome of the COCOMO are primarily Effort & Schedule:

- **Effort:** Amount of labor that will be required to complete a task. It is measured in person-months units.
- **Schedule:** Simply means the amount of time required for the completion of the job, which is, of course, proportional to the effort put. It is measured in the units of time such as weeks, months.

Different models of COCOMO have been proposed to predict the cost estimation at different levels, based on the amount of accuracy and correctness required. All of these models can be applied to a variety of projects, whose characteristics determine the value of constant to be used in subsequent calculations. This is an **Organic Type** Project, since our team size is small, and the problem is well understood and this type of problem is solved in past but on a different platform so that was a sign of help for us.

We will be using the Basic Model of COCOMO since we do not have much external factors monitoring our project:

Calculating Effort based on Basic Model

E = a * [(KLOC)^b] (person-months)

Here **a, b** are constants

with value of a = 2.4 & b = 1.05

KLOC – Kilo Lines of Code

So, our project has near about 3500 Line of Code.

$E = 2.4 * [3.5^{1.05}]$

$E = 8.94 \sim 9$ (person-months)

1.5 Project Timeline

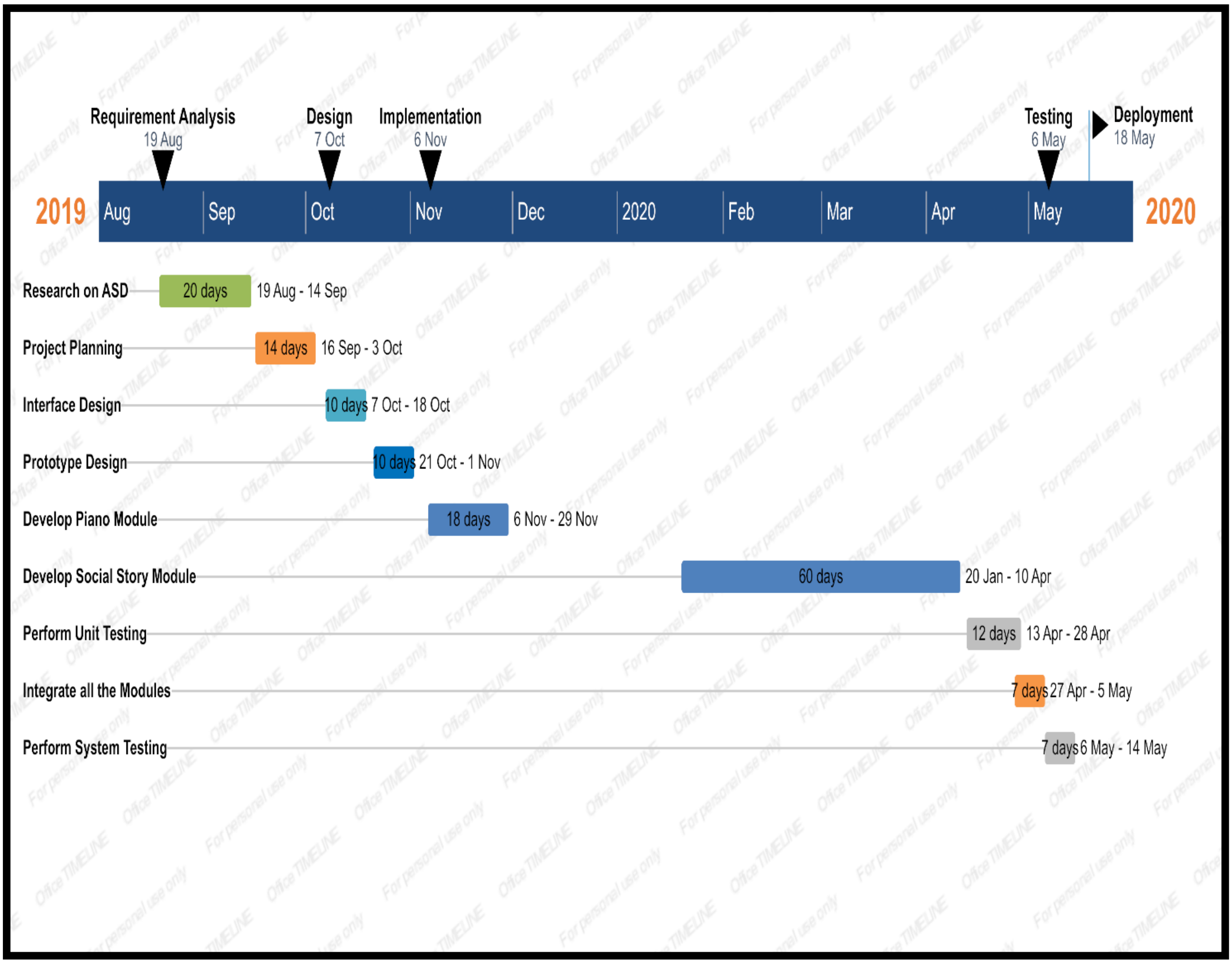

Figure 2: Project Gantt Chart from 19th August,2019 to 18th May, 2020

Chapter 2

Literature Survey

Many professionals and schools utilize computer technology as assistive technology to support children with ASD. Assistive technology is defined as "any item, piece of equipment, or product system, whether acquired commercially, off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of children with disabilities" [8]. In general, assistive technology can be any tool that is used daily to improve or increase the functional abilities, be it educational, social, behavioural or physical, of children with disabilities [9]. The idea of using mobile technology as assistive technology with children, including those with ASD, is not new. For example, Goldenberg [10] reviewed the uses of the

computer for communication for those with serious communication problems (e.g. deafness, autism or severe physical handicaps) and reported a pilot research work with 10 multiply handicapped children (5 – 16 years old). He viewed that computers are as prosthesis to these special children that can radically improve their quality of life, stating, "if you can control a computer, you have a powerful tool for communication and access to vast range of valuable educational, vocational and recreational activities".

Goldenberg also highlighted early research works of other researchers [e.g. 11; 12) that confirm the ability of the computer as a mediator to human communication as well as a stimulus for spontaneous and voluntary speech and communication among children with ASD.

A. Major Trends and Issues

There seems to be a sharp increase in the research articles published on the use of computer technology with children with ASD in the past ten years as compared to the 1990s and 1980s combined (see Figure 1). It is found that majority of the computer-based interventions address the core issues faced by children with ASD, such as communication skills, literacy and academic skills, social skills, and emotion recognition. Other skills include functional life skills e.g. using activity schedules, independent task completion, increased attention, understanding of virtual environments, symbolism and imagination, sense of presence, decreasing problem behaviors and pretend play.

1) Communication skills

One of the significant characteristics of children with ASD is the difficulty in communicating, be it verbal or non-verbal. It is not surprising that a notable amount of research focuses on developing interventions to address this core issue. Due to the fact that traditional communication interventions require highly complex procedures both in training and implementation as well as time consuming, computer technology has been utilized to provide intervention and instruction. Using computer-based intervention, the specific communication skills that were targeted are increasing vocal imitation learning and increasing new vocabulary words; increasing spoken utterances; and functional language. Most of these studies were carried out in a school classroom while the rest were either carried out at a computer room in the school or the university-based laboratory.

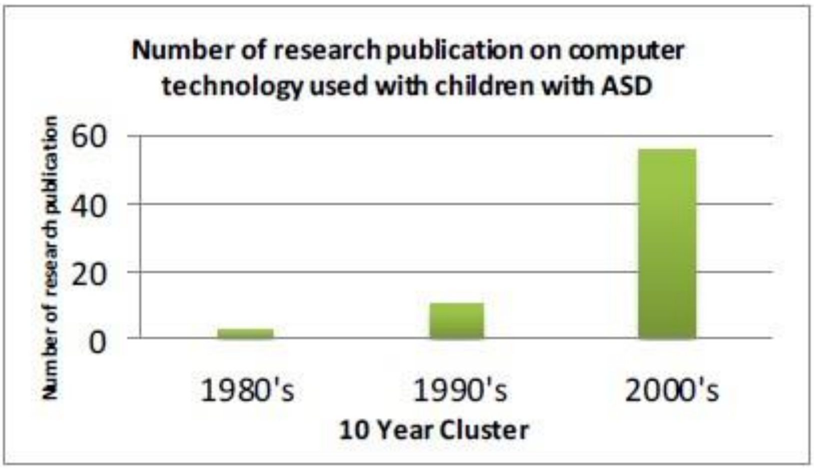

Figure 3: Bar Chart depicting the number of research publication on computer technology used with children with ASD

2) Social emotional skills

What heightens the impairment of communication skills in individuals with ASD is the inability to display appropriate social etiquette. Children with ASD often lack social understanding, awareness, empathy as well as failing to recognize others' emotions and facial expressions. These impairments ultimately lead to difficulties in creating and sustaining meaningful, positive relationships (Bellini,2006). Therefore, many computer-based programs have been designed and developed to train and teach social understanding
and awareness as well as emotion identification and recognition.

3) Functional life skills

One of the important goals for children with Autism is to attain functional life skills that would advance self-determination, greater independence and autonomy. Several researchers have used computer-based interventions to instill these functional like skills. For example, Kimball, Kinney, Taylor and Stromer developed and tested a computer mediated activity schedule with a young child with ASD and found that he was able to generalize the activities. Another group of researchers worked with several children, age 7-9, using a software program that simulated real-life activities such as setting the table, making soup and making a sandwich. The program required the student to manipulate images on the screen that stimulated the natural environment. The researchers found that each child mastered all the skills they were taught via the computer and generalized to the natural environment and the skills maintained after a two-week follow up. Teaching older children with ASD to complete a task independently via computer-based instruction such as cooking with recipes and pushing a 'request to stop bus signal' and exit a city bus in response to target landmarks also yield positive results.

Various computer technologies were used as the delivery system in the many research studies mentioned above. Among the most commonly used system is computer-assisted
instruction. Computer-assisted instruction usually utilizes a desktop computer or a laptop loaded with either commercial software (Microsoft Power Point and Hyperstudio), specialized software programs made specifically for children with ASD and other developmental disabilities (Keytalk, Alpha, Delta, Speech Viewer, Emotion Trainer, Baldi/Timo, I Can Word It Too, TeachTown: Basics, Mind Reading, Junior
Detective Program, I Can! -Daily Living and Community Skills, Book Builder, Let's Face It! FaceSay), and other programs developed by researchers. Other technology such as virtual environments and virtual tools are also gaining some popularity. Some researchers have also explored the use of robots as well as smart-board technology.

Chapter 3

Concepts and Problem Analysis

3.1 Concept Analysis

Autism

Autism spectrum disorder (ASD) is a neurobiological disorder that significantly impairs reciprocal social relations, verbal and nonverbal communication, and behavior of an individual. Children with ASD are more likely than others to respond to small, irrelevant cues, which significantly limit their ability to recognize and generalize more complex stimuli. The signs of autism can be observed in the early years of a child’s life. However, the causes of Autism Spectrum Disorders (ASDs) cannot be detected at that stage of a person’s life. Nowadays, behavioral therapies are normally the treatments for people who are autistic. The most recent development in the evolution of educational and therapeutic programming for children with ASD was an increased interest in technologies for facilitating access to general education core content. Technological interventions allow the user to work at different speeds and locations. The use of technology devices and multimedia increases the interest of participants with ASD, helping them to learn while playing with technology.

The current results indicate that nearly half the sample (41.4%) of youths with ASD spent most of their free time playing video games. It seems reasonable and helpful to use technology as the third party in therapy sessions. Previous researchers indicate that children with ASD do not respond to simultaneous cues from either a single modality or multiple modalities. Pivotal Response Treatment (PRT) is a naturalistic approach to behavioral intervention that is grounded in applied behavior analysis (ABA) method and developmental psychology [5]. This method is scientifically based on the practices of educating autistic children [6] in order to teach children with ASD. This paper looks at an existing mobile game that is readily available in the iOS platform, and observes ASD children's response to the game to understand their ability to respond to concurrent multiple cues by using touch screen device in therapy sessions.

Country	Autism Rate (Children)	Data source
China	1:909	Peking University Health Science Centre (2005 estimate) [8].
U.S.A.	1:68	U.S Centers for Disease Control and Prevention ADDM Study 2010 [7].
South Korea	1:38	The American journal of psychiatry [9].
Malaysia	1:625	Ministry of Health, Malaysia [10].
United Kingdom	1:263 (boys), 1:1250 (girls)	BMJ Open [11].
India	1:250	Autism Society of India [12]. The Times of India [13].
Brunei	1:150 to 1:1000	The Society for the Management of Autism-Related Issues - Training, Education and Resources (SMARTER), Brunei [14]. Child Development Center (CDC), Ministry of Education, Brunei Darussalam [15].

Figure 4: Tabular Representation of the data representing the autism rate in children in different countries

Social Stories

Social stories are a growing topic in the education field. They are a behavioral intervention to improve children's social skills through combination of visual and verbal cues. Children who are diagnosed with mild to severe disabilities are evaluated and assessed. Teachers then develop and implement an intervention they believe will be successful and effective in improving the child's social skills. The teacher uses task analyses to break down behavioral goals through language.

They teach children appropriate skills such as:

- Prompting
- Joining-in behavior
- Sportsmanship
- How to maintain conversation
- Skill Acquisition
- How to respond to cues
- How to describe settings

Why use Social Stories?

The overall purpose is to increase children's social competence. By improving their independence, children gain confidence communicating with their peers and engaging in play alongside peers. As a result, they learn to share materials in their classroom, learn turn taking and other choice making skills. Each social story intervention is geared specifically towards the child. Social stories emphasize on cognitive growth, social skills, emotional capacity and self-regulation.

Who needs social stories?

Social stories benefit children with mild to severe disabilities, specifically children with Autism or Asperger's. Teachers will evaluate and assess the child's behavior that needs to be addressed. Social stories are found in various education settings, but are most common in school classrooms. It is important for the intervention also to take place in a naturalistic setting, so they will also assess the child in their home environment.

Mobile technology

Mobile devices have gained popularity within the special need's community. These mobile devices are the "cool new" gadgets, unlike the previous, complex and "I-am not-normal-looking" assisting devices. These mobile devices are said to serve as a communication device in the pocket, a learning device on the go and even a lifesaver for some. Its features include flexible multimedia content and storage, portability, mobility and affordability. The touch screen interface makes it appealing and simple to use, particularly for those who have weak motor skills. It offers practical communication solutions for autistic people, so that they can interact with their families and others in the community. The flexibility and the advanced capabilities of mobile technology are opening new opportunities for further research in the area of computer-based intervention for children with ASD. Several anecdotal reports give an early indication of the immense possibilities of how these devices could play a significant role in enhancing the quality of life for children with ASD and their families. There is definitely a lack of published research studies on the use of mobile technology among children with ASD. Due to the growing popularity of adopting mobile devices as assisting devices, more in-depth research is warranted.

3.2 Problem Analysis

People with ASD, especially in their first years of life, present difficulties to identify, interpret and produce social behaviors, which are the basis for communication and social cognition, which makes it difficult to determine the intentions, thoughts and emotions from other people. Social cognition includes the ability to adequately interpret nonverbal social and emotional cues, such as speech, facial expressions, body movements, among others. In this way, social situations such as cooperative play and empathic attitudes to the reactions of others are minimal or non-existent, and in the future, they affect notably in adult life.

Within the various methods and tools of early intervention in people with ASD, information and communication technologies (ICT) have proven to be beneficial, and there have been great advances in research on ICT for education of people with special needs.

In general, mobile devices are adequate for the visual thinking of people with ASD; can help those who are not verbal; they constitute a convenient auditory material, provide multiple inputs of data suitable for different types of skills; they are adaptable to sensitivity (auditory, tactile, visual) and offer various communication channels.[1] Software intended for people with ASD, especially if they are infants, must respect the design for everyone, and of course adapt to their characteristics, according to their needs and abilities, pace of learning and interests. Additionally, its interface must be friendly and motivating, multiformat, with a progress evaluation system, easily configurable.[3] All the above will make the experience a positive process.

Within the ICT, given the accelerated growth, accessibility and commercialization of personal mobile devices (smartphones, tablets, ultra-books), the applications for these devices focused on supporting people with ASD proliferate, mainly in terms of the early development of imitation and joint attention, with diverse treatment objectives, highlighting: interactive environments, virtual environments, avatars, serious games and tele rehabilitation. The uses of these applications for ASD treatment can be classified according to their main objective: (1) support technologies that counteract the impact of sensory and cognitive alterations of life related to autism; (2) cognitive rehabilitation / remediation seeking to modify and improve the basic deficit in social cognition; (3) special education programs to counteract the difficulties of children with ASD in the acquisition of social and academic skills; (4) support tools and processes for parents, guardians, caregivers and / or professionals. All this, in addition, implies having an adequate induction by the users towards the available ICT to determine the right hardware and software according to each specific need.

Chapter 4

Design & Methodology

4.1 Android Architecture

The Android operating system composed of five main layers as shown in figure. These layers included Application, libraries of different nature, Kernel of Linux which is core of OS, framework of application and the last is runtime android. Top level layer is called android application layer in any android system. Here we can find some important feathers like short messaging service applications, electronic mail applications, calls, calendars, browsers, maps, contacts. Java is main language to develop these components.

Framework of application is the next and second layer of android architecture. This is outline or framework which uses by software application developers. Application programming interfaces are available for development purposes.it consist of basic tools and use to create more complex applications in android.

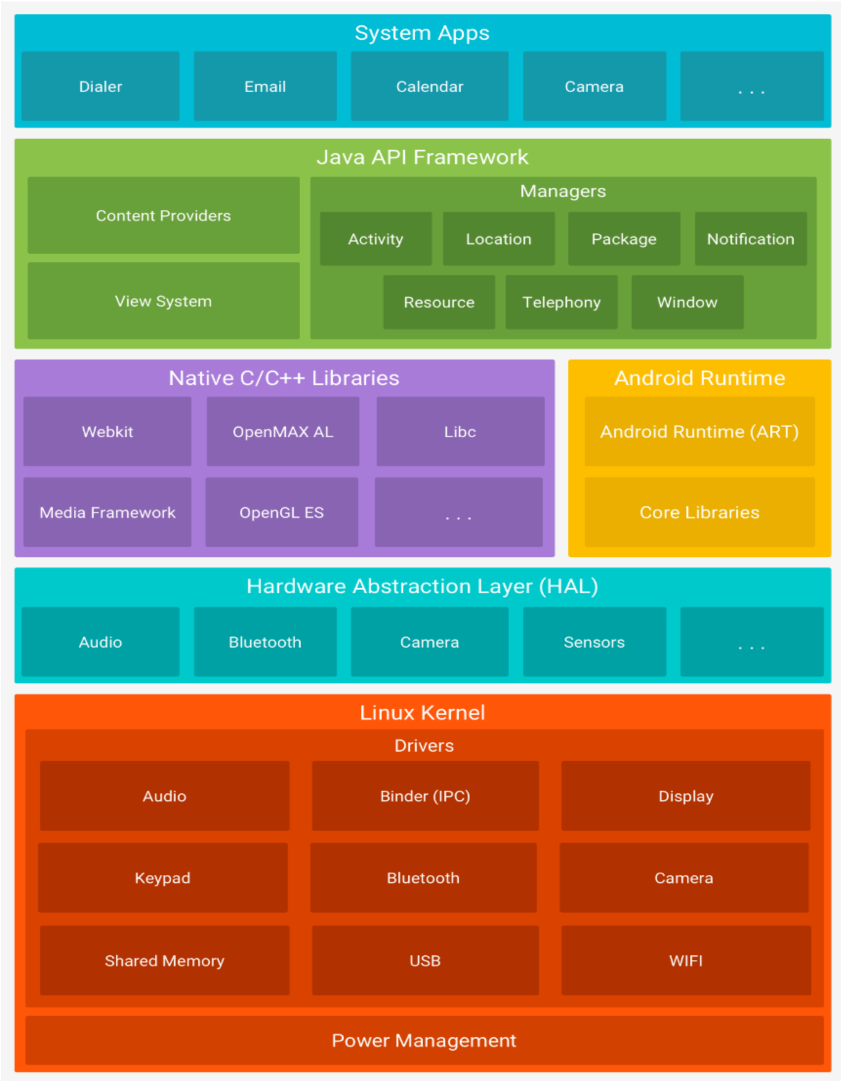

Figure 5: Android Architecture

The layer which is use by different Android system components. Developers fallow the available libraries in framework of Application. Developer use these libraries for common tasks or reuse system functions for their own purpose. The layer four of this architecture is the Android Runtime. Dalvik virtual machine is use by android as Java uses virtual machine to provide environment to application on runtime. It is a special software which create new processes independently for android application. Linux kernel is the last and fifth layer in android architecture. Linux kernel's Linux version 2.6 is use by the android.[8] It is used for memory management, power management software, file system access, networking, inter process communication, security settings and several drivers for hardware. The Kernel hides the hardware from the user of software.

Activities

Activities are one of the fundamental building blocks of apps on the Android platform. They serve as the entry point for a user's interaction with an app, and are also central to how a user navigates within an app (as with the Back button) or between apps (as with the Recents button).

Skillfully managing activities allows you to ensure that, for example:

- Orientation changes take place smoothly without disrupting the user experience.
- User data is not lost during activity transitions.
- The system kills processes when it's appropriate to do so.

Layouts

A layout defines the structure for a user interface in your app, such as in an activity. All elements in the layout are built using a hierarchy of View and ViewGroup objects. A View usually draws something the user can see and interact with. Whereas a ViewGroup is an invisible container that defines the layout structure for View and other ViewGroup objects, as shown in figure

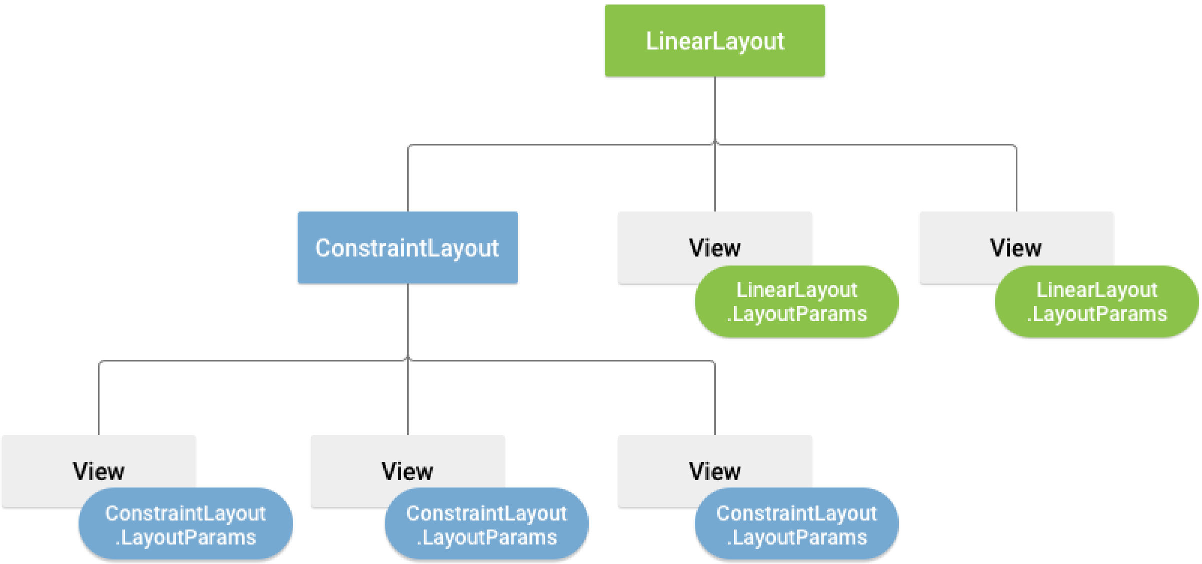

Figure 6. Visualization of a view hierarchy with layout parameters associated with each view

The View objects are usually called "widgets" and can be one of many subclasses, such as Button or TextView. The ViewGroup objects are usually called "layouts" can be one of many types that provide a different layout structure, such as LinearLayout or ConstraintLayout .

You can declare a layout in two ways:

- **Declare UI elements in XML**. Android provides a straightforward XML vocabulary that corresponds to the View classes and subclasses, such as those for widgets and layouts.

  You can also use Android Studio's Layout Editor to build your XML layout using a drag-and-drop interface.

- **Instantiate layout elements at runtime**. Your app can create View and ViewGroup objects (and manipulate their properties) programmatically.

Android lifecycle

To navigate transitions between stages of the activity lifecycle, the Activity class provides a core set of six callbacks: onCreate(), onStart(), onResume(), onPause(), onStop(), and onDestroy(). The system invokes each of these callbacks as an activity enters a new state.

Figure 1 presents a visual representation of this paradigm.

As the user begins to leave the activity, the system calls methods to dismantle the activity. In some cases, this dismantlement is only partial; the activity still resides in memory (such as when the user switches to another app), and can still come back to the foreground. If the user returns to that activity, the activity resumes from where the user left off. The system’s likelihood of killing a given process—along with the activities in it—depends on the state of the activity at the time. Activity state and ejection from memory provides more information on the relationship between state and vulnerability to ejection.

Depending on the complexity of your activity, you probably don't need to implement all the lifecycle methods. However, it's important that you understand each one and implement those that ensure your app behaves the way users expect.

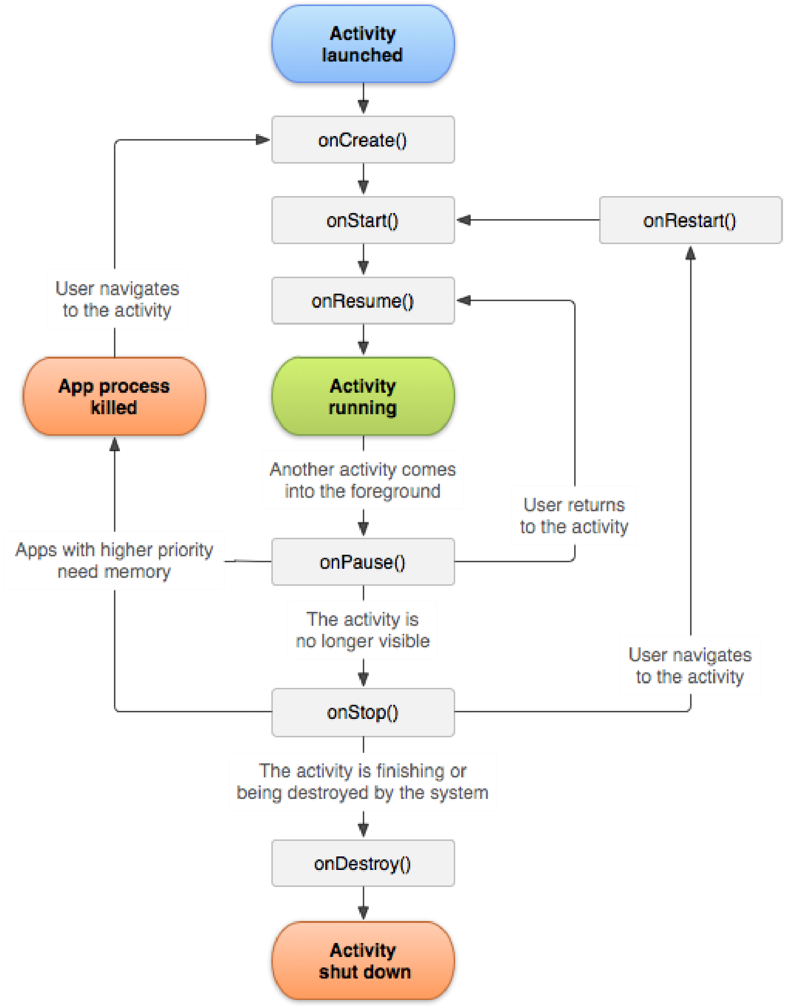

Figure 7: Illustration of Android Lifecycle

Common Layouts

Each subclass of the ViewGroup class provides a unique way to display the views you nest within it. Below are some of the more common layout types that are built into the Android platform.

Linear Layout: This layout organizes its children into a single horizontal or vertical row.

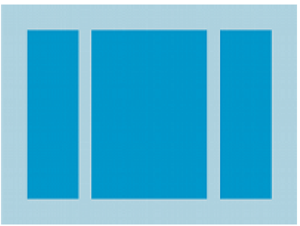

Figure 8: Linear Layout

Relative Layout: It enables to specify the location of child objects relative to each other.

Figure 9: Relative Layout

When the content for your layout is dynamic or not pre-determined, you can use a layout that subclasses AdapterView to populate the layout with views at runtime. A subclass of the AdapterView class uses an Adapter to bind data to its layout. The Adapter behaves as a middleman between the data source and the AdapterView layout—the Adapter retrieves the data (from a source such as an array or a database query) and converts each entry into a view that can be added into the AdapterView layout.

Common layouts backed by an adapter include:

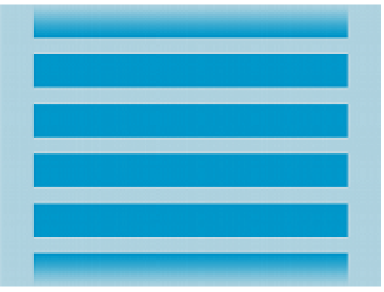

Figure 10: ListView

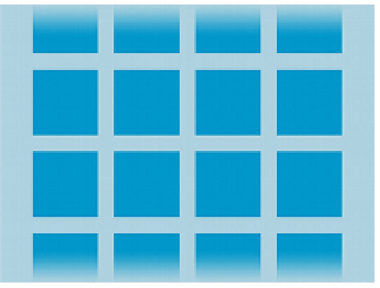

Figure 11: GridView

Uses for the Support Libraries

There are a few distinct uses for the support libraries. Backward compatibility classes for earlier versions of the platform is just one of them. Here is a more complete list of ways we can use the support libraries in our app:

- **Backward Compatibility for newer APIs -** A large amount of the support libraries provides backward compatibility for newer framework classes and methods. For example, the Fragment support class provides support for fragments on devices running versions earlier than Android 3.0 (API level 11).

- **Convenience and Helper Classes -** The support libraries provide a number of helper classes, particularly for user interface development. For example, the RecyclerView class provides an user interface widget for displaying and managing very long lists, useable on versions of Android from API level 7 and up.

- **Debugging and Utilities -** There are a number of features that provide utility beyond code you incorporate into your app, including the support-annotations library for improved code lint checks on method inputs and Multidex support for configuring and distributing apps with over 65,536 methods.

Android Versions and Its latest comparison

An important aspect of Android operating system is its different versions. These versions are improving and providing new services to users. As the smartphones' hardware improving and capable to provide more services the Android operating system also side by side improves itself. The latest usage comparison is as under.

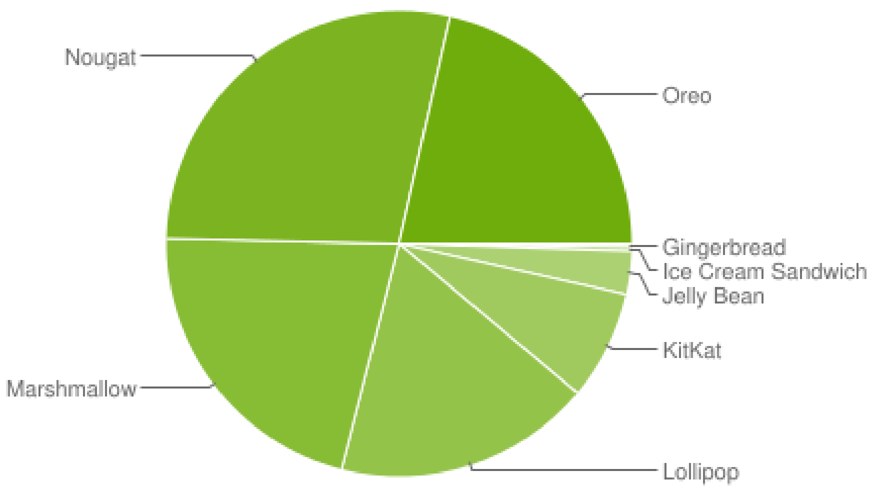

Figure 12: Data collected during a 7-day period ending on May 7, 2019.

Version	Codename	API	Distribution
2.3.3 - 2.3.7	Gingerbread	10	0.2%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	0.3%
4.1.x	Jelly Bean	16	1.1%
4.2.x		17	1.5%
4.3		18	0.4%
4.4	KitKat	19	7.6%
5.0	Lollipop	21	3.5%
5.1		22	14.4%
6.0	Marshmallow	23	21.3%
7.0	Nougat	24	18.1%
7.1		25	10.1%
8.0	Oreo	26	14.0%
8.1		27	7.5%

Figure 13: Tabular representation of the data collected during a 7-day period ending on May 7, 2019.

4.2 App design and Architecture:

Launcher Icon of the Application:

Figure 14 shows the launcher icon of the application. The resource for the launcher app has been resized for the low-density screens (ldpi), medium-density screens(mdpi), high-density screens(hdpi), extra-high-density (xhdpi) screens, extra-extra-high-density (xxhdpi) screens and for the extra-extra-extra-high-density (xxxhdpi) screens.

Figure 14: Launcher icon

Learn and Play:

This section helps the user of the application in most cases the autistic child to learn about the surroundings, such as animals, transports system, profession etc. This section also helps them to memorize these by a Matching Game they can play so that it helps them to learn about the surroundings more efficiently.

Social Stories:

This section is advancement of previous section. It basically includes Social Stories which is a very enhanced tool to and effective way of teaching appropriate behaviors to children with special needs

This section will help them in following ways:

- Better understand and follow rules and routines
- Gain insight into the perspectives of others
- Encourage the identification of important cues
- Promote better self-awareness
- Understand how their behavior impacts others

Create Stories:

This section is for the mentors/Guides. As before introducing any new social story to the user/children they can create new slide shows of the environment which will the base to the next story so that the user is not surprised or feel away from learning.

After that they can dynamically create new stories from the device as per the need.

Piano Event:

This section is an advancement of the first section i.e., Learn and Play. It focuses on the teaching approach in which the letter sounds are taught first and the letter names next. It is believed that letter sounds are more helpful and useful to pre-readers than letter names and therefore, should be taught first. Having students use their hands/body while they are learning is so very important to their brain development. When kids use their muscles and brains at the same time, they are less likely to forget what they learned. It's just like riding a bike. You can't forget how to do that, because you used your body and your brain to learn. It is also great to incorporate fine motor practice into the hands-on learning. This piano module will let the children have a hands-on way to practice.

Screen Flow and Design:

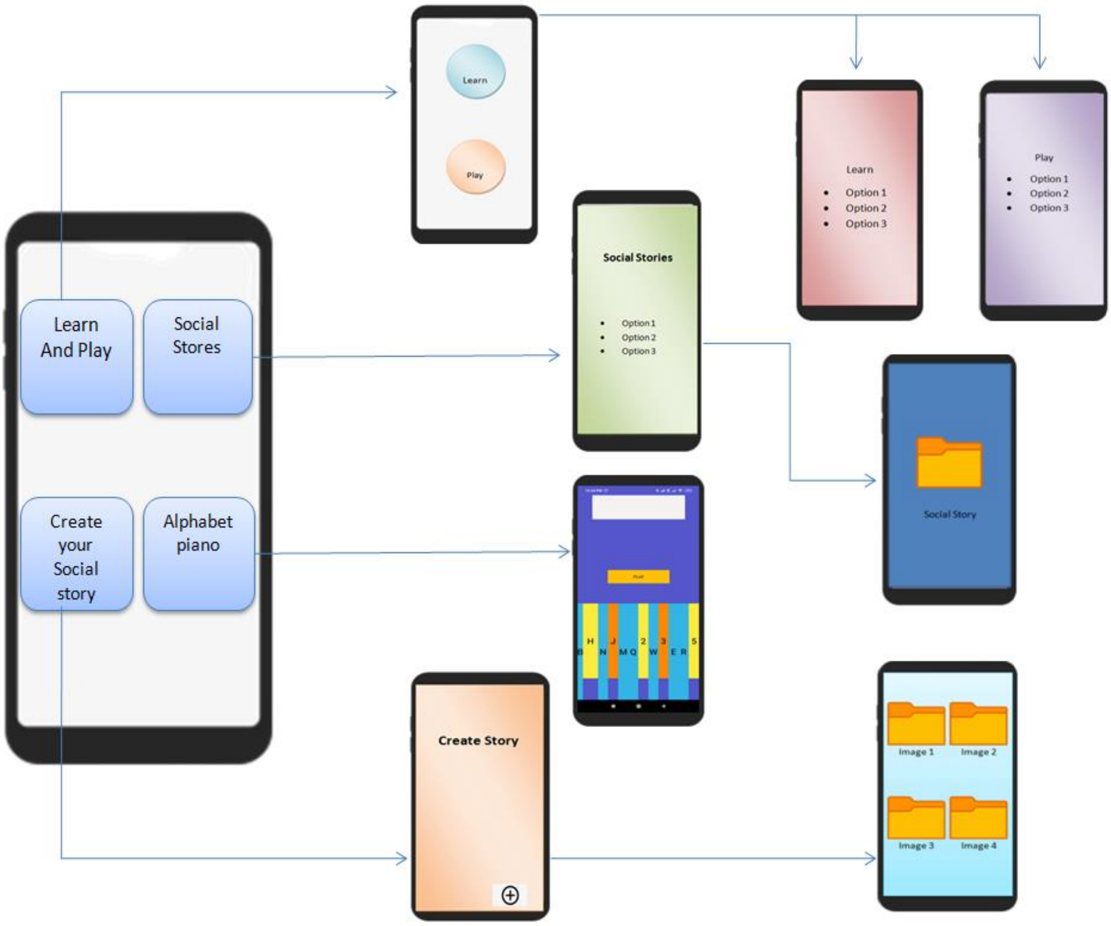

Figure 15: Screen Flow Diagram of the application

Use case Study:

Figure 16 shows how the two users can utilize the application. The role of the mentor/guardian is to create stories, monitor and evaluate the student's performance based on how the student responds to the game and social stories. The mentor needs to observe the behavioural changes in the user and create more dynamic social stories through this reading. The teacher can monitor and evaluate one's performance by showing results of the game through a graph per level of exercises. The student can repeat the games how many times that he wanted to play it. There will be no limit towards the usage of the app itself.

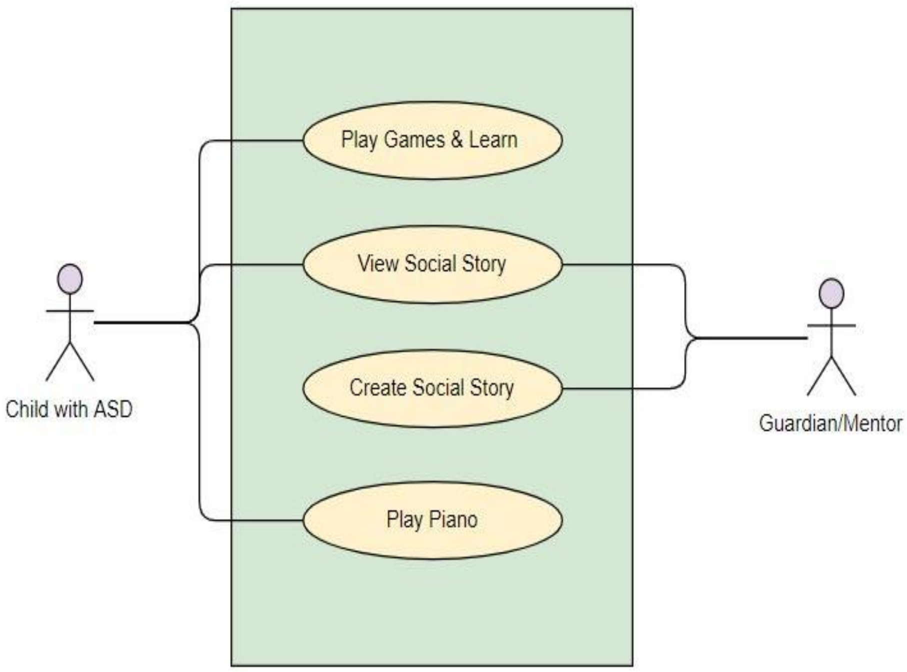

Figure 16: Use-Case Diagram of the application

Context Diagram:

Figure 17 shows the interaction between the users through the application. The diagram comprises two actors which represent the different user rights; User and Teacher or the Guardian. Teacher or the guardian role applies to administrators who can only create the stories of each student and can evaluate each score of the students and Student role may refer as the receiver. The teacher or guardian can create, read, update, delete and evaluate, while the Students which are children who has Autism Spectrum Disorder can only play and view the video.

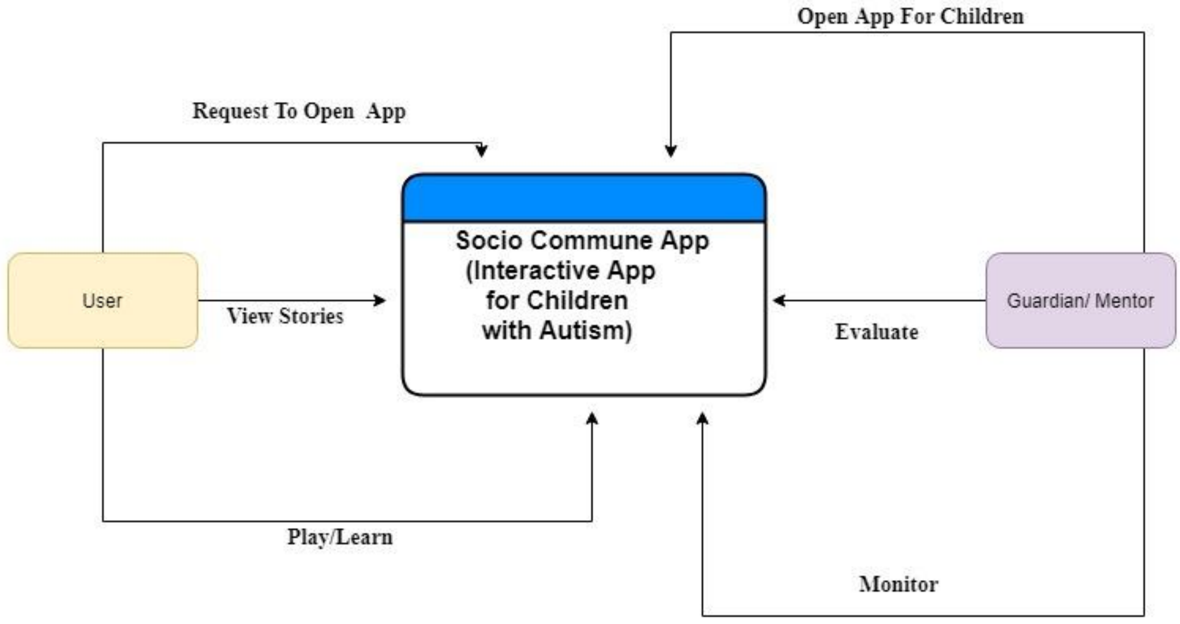

Figure 17: Illustration of the context diagram of the application

Activity Flow:

Activity diagram is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as an operation of the system.

The control flow is drawn from one operation to another. Activity diagrams are not only used for visualizing the dynamic nature of a system, but they are also used to construct the executable system by using forward and reverse engineering techniques.

Figure 18 illustrates the flow of control between all the activities and aids in visualizing the dynamic nature of the application. The figure comprises of 4 primary activities and 8 sub-activities. The application starts right from the moment it is launched. The basic activity is the home-screen from where the control flows to 4 different activities namely, Learn & Play, View Social Story, Create Social Story and the Piano Module.

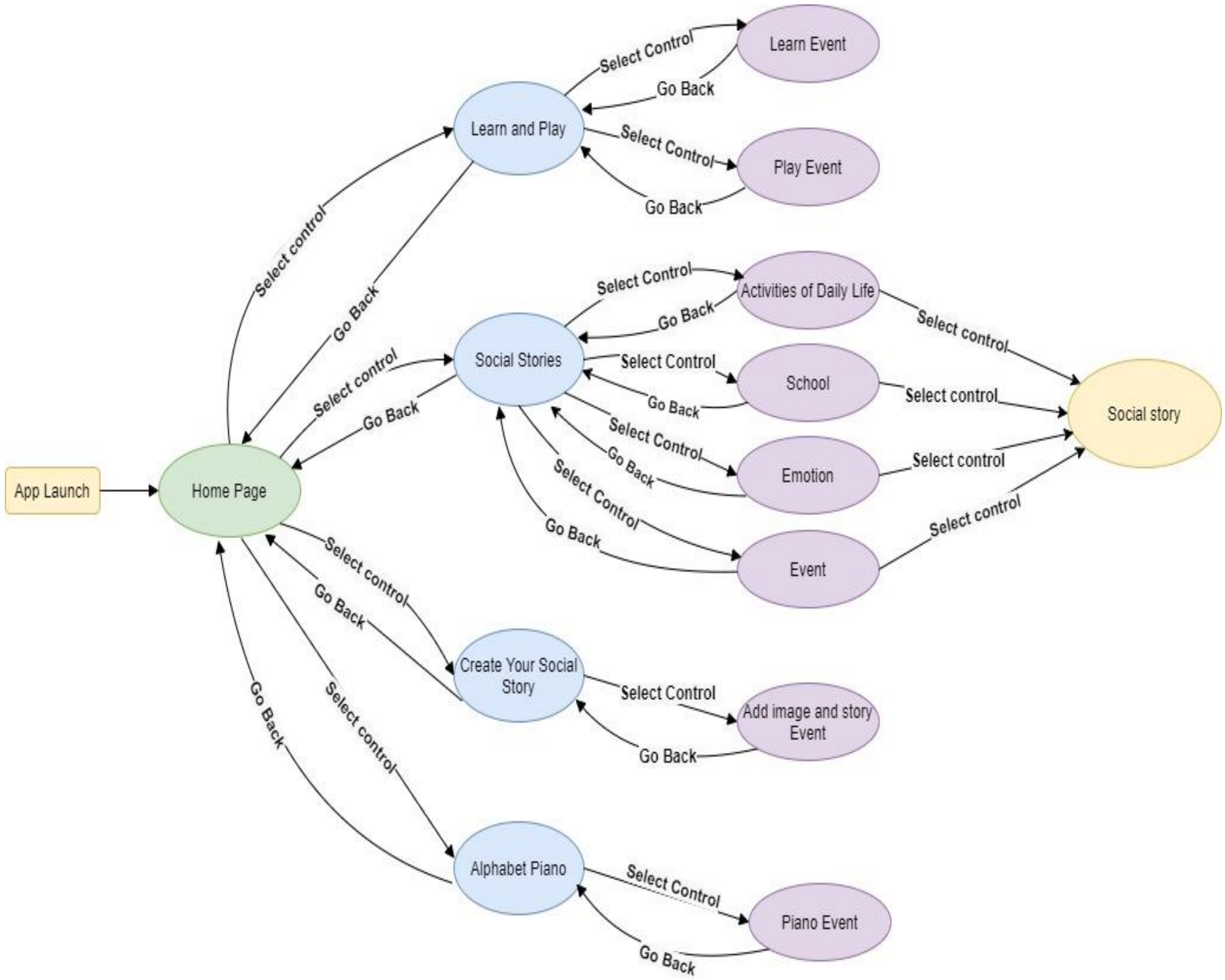

Figure 18: Activity Flow Diagram of the application

Chapter 5

Sample Codes

5.1 Code for developing the Piano Event

5.1.1 XML Code

```
<?xml version="1.0" encoding="utf-8"?>
<android.support.constraint.ConstraintLayout
xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="#5456C9"
    tools:context=".Piano">

    <Button
        android:id="@+id/button2"
```

```
        android:layout_width="0dp"
        android:layout_height="0dp"
        android:background="@android:color/holo_blue_light"
        android:text="@string/b"
        android:textSize="30sp"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toStartOf="@+id/guideline1"
        app:layout_constraintStart_toStartOf="parent"
        android:onClick="playB"
        app:layout_constraintTop_toTopOf="@+id/guideline11"
/>

    <Button
        android:id="@+id/button7"
        android:layout_width="0dp"
        android:layout_height="0dp"
        android:background="@android:color/holo_blue_light"
        android:text="@string/m"
        android:onClick="playM"
        android:textSize="30sp"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toStartOf="@+id/guideline5"
        app:layout_constraintStart_toEndOf="@+id/button6"
        app:layout_constraintTop_toTopOf="@+id/guideline11"
/>

    <Button
        android:id="@+id/button8"
        android:layout_width="0dp"
        android:layout_height="0dp"
        android:background="@android:color/holo_blue_light"
        android:text="@string/q"
        android:onClick="playQ"
        android:textSize="30sp"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toStartOf="@+id/guideline6"
        app:layout_constraintStart_toEndOf="@+id/button7"
        app:layout_constraintTop_toTopOf="@+id/guideline11"
        tools:text="@string/q" />

    <EditText
        android:id="@+id/editText"
        android:layout_width="300dp"
        android:layout_height="90dp"
```

```
        android:background="#F7F2F2"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintVertical_bias="0.050000012" />

    <Button
        android:id="@+id/button12"
        android:layout_width="0dp"
        android:layout_height="0dp"
        android:background="#FFEB3B"
        android:text="@string/_5"
        android:onClick="play5"
        android:textSize="30sp"

app:layout_constraintBottom_toTopOf="@+id/guideline14"
        app:layout_constraintEnd_toEndOf="parent"

app:layout_constraintStart_toStartOf="@+id/guideline12"
        app:layout_constraintTop_toTopOf="@+id/guideline11"
/>

        <android.support.constraint.Guideline
        android:id="@+id/guideline7"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:orientation="vertical"
        app:layout_constraintGuide_begin="20dp"
        app:layout_constraintGuide_percent="0.581" />


    <android.support.constraint.Guideline
        android:id="@+id/guideline14"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:orientation="horizontal"
        app:layout_constraintGuide_begin="20dp"
        app:layout_constraintGuide_percent="0.9" />

    <Button
        android:id="@+id/play"
        android:layout_width="200dp"
        android:layout_height="50dp"
```

```
        android:background="#FFC107"
        android:text="PLAY"
        android:onClick="play"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintVertical_bias="0.42000002" />

</android.support.constraint.ConstraintLayout>
```

5.1.2. Java Code

```
package com.example.myapplication;

import android.media.AudioManager;
import android.media.SoundPool;
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;

public class Piano extends AppCompatActivity {
    private final int NR_OF_MAXSTREAM = 12;
    int mBSoundId;
    int mHSoundId;
    int mNSoundId;
    int mJSoundId;
    int mOSoundId;
    int mPSoundId;
    int mTSoundId;
    int mUSoundId;
    int mVSoundId;
    int mXSoundId;
    int mYSoundId;
    int mZSoundId;


    private EditText editText;
    final float LEFT_VOLUME = 1.0f;
    final float RIGHT_VOLUME = 1.0f;
```

```
    SoundPool mSoundPool;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        mSoundPool = new SoundPool(NR_OF_MAXSTREAM,
AudioManager.STREAM_MUSIC,1);
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_piano);
        mVSoundId = mSoundPool.load(this,R.raw.pv,1);
        mXSoundId = mSoundPool.load(this,R.raw.px,1);
        mYSoundId = mSoundPool.load(this,R.raw.py,1);
        mZSoundId = mSoundPool.load(this,R.raw.pz,1);

        editText = findViewById(R.id.editText);
    }

    public void playE(View
view){mSoundPool.play(mESoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0
,1);}
    public void playR(View
view){mSoundPool.play(mRSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0
,1);}
    public void play5(View
view){mSoundPool.play(m5SoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0
,1);}

    public void play(View view)throws Exception{
        String s = String.valueOf(editText.getText());
        int len = s.length();
        for(int i = 0;i < len;i++)
        {
            char c = s.charAt(i);
            switch(c){
                case 'b':
                case
'B':mSoundPool.play(mBSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'h':
                case
'H':mSoundPool.play(mHSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'n':
                case
```

```
'N':mSoundPool.play(mNSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case
'3':mSoundPool.play(m3SoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'e':
                case
'E':mSoundPool.play(mESoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'r':
                case
'R':mSoundPool.play(mRSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case
'5':mSoundPool.play(m5SoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case
'0':mSoundPool.play(m0SoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case
'6':mSoundPool.play(m6SoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'u':
                case
'U':mSoundPool.play(mUSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'v':
                case
'V':mSoundPool.play(mVSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'x':
                case
'X':mSoundPool.play(mXSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
```

```
                case 'y':
                case
'Y':mSoundPool.play(mYSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                case 'z':
                case
'Z':mSoundPool.play(mZSoundId,LEFT_VOLUME,RIGHT_VOLUME,0,0,1
);
                    break;
                default:break;
            }
            Thread.sleep(1000);
        }
    }
}
```

Chapter 6

Testing, Results, Discussion on Results

6.1 Testing

For the confirmation of the projects ability to sustain real life action, various types of tests and experiments have been designed and performed and the results are recorded to claim that the objective of the project has been achieved.

Types of Tests performed on the project are as follows:

- Unit Testing
- Stress Testing
- Compatibility Testing

- Gorilla Testing
- Install/Uninstall Testing
- Monkey Testing
- System Testing

UNIT TESTING:

Each unit of the application was tested before everything was integrated in a single application. The various units are Alphabet Piano, Social stories and games.

Each application was designed and tested as a unit before being integrated for the final application.

STRESS TESTING:

The application under test was tested under when a system is stressed beyond its specifications in order to check how and when it fails.

This is performed under heavy load like putting large number beyond storage capacity, complex database queries, and continuous input to the system or database load. The application was run rigorously playing continuous games and social story.

COMPATIBILITY TESTING:

The application was made to run on various running environment with different android versions and also different hardware. It was made to run from android 4.1.2 to the latest android 9. It was also tested under hardware with low as 1 GB RAM to 8 GB RAM.

GORILLA TESTING:

The application testing was performed mainly by the developers and the testers of the application mainly. In Gorilla Testing, one module or the functionality in the module is tested thoroughly and heavily.

The objective of this testing is to check the robustness of the application. For example, the alphabet piano was tested with very lengthy string of alphabets.

INSTALL/UNINSTALL TESTING:

Installation and Uninstallation Testing is done on full, partial, or upgrade install/uninstall processes on different operating systems under different hardware or software environment.

MONKEY TESTING:

The objective of Monkey Testing is to check if an application or system gets crashed by providing random input values/data. Monkey Testing is performed randomly and no test cases are scripted and it is not necessary to be aware of the full functionality of the system.

The application will be used by kids mainly so here it should be robust enough to handle random inputs provided.

SYSTEM TESTING:

Under System Testing technique, the entire system is tested as per the requirements. It is a Black-box type testing that is based on overall requirement specifications and covers all the combined parts of a system.

The final testing phase was to ensure the integrated software works fine. All the modules including social story, games, piano was put together in an application and tested.

6.2 Results

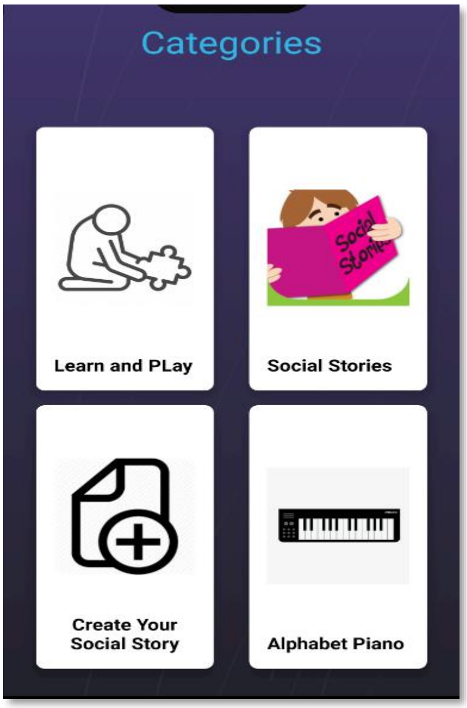

Figure 19: Screenshot of the Home Screen

Figure 20: Screenshot of View Social Story

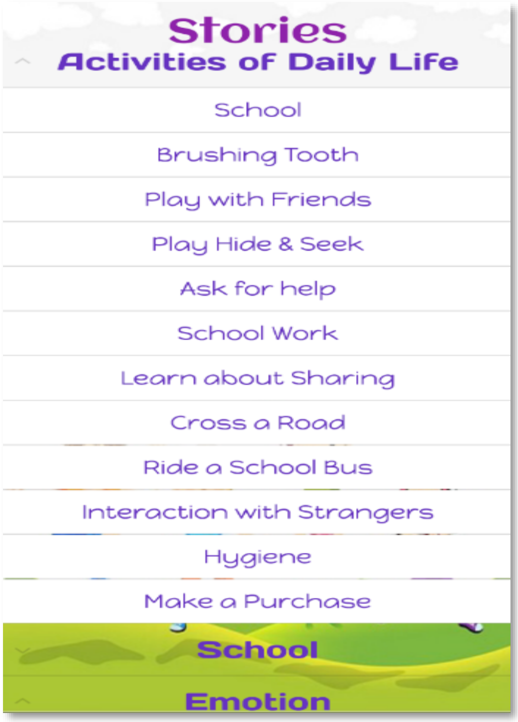

Figure 21: Screenshot of View Social Story

Figure 22: Screenshot of a Social Story

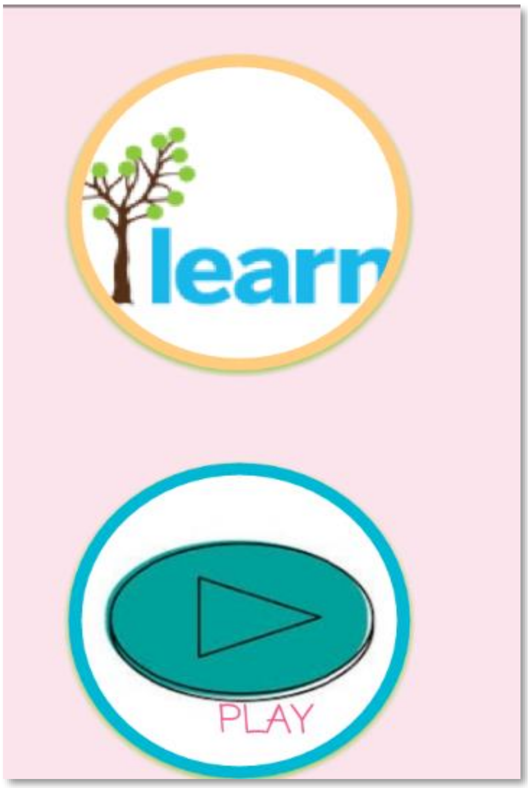

Figure 23: Screenshot of Learn & Play

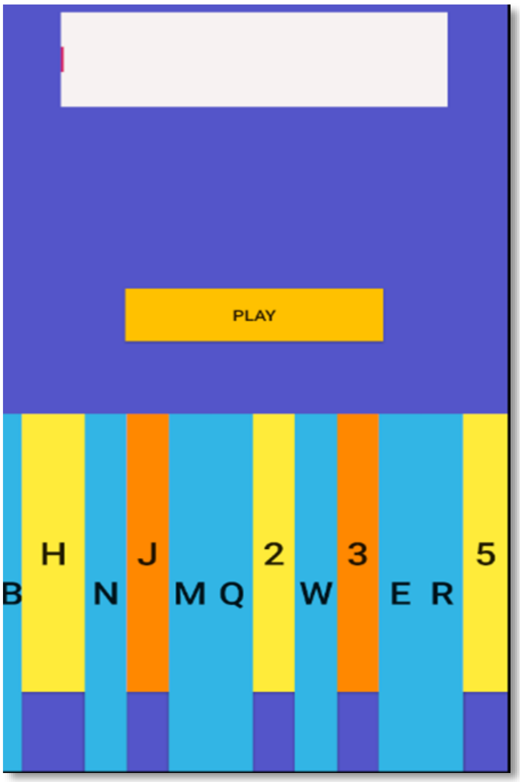

Figure 24: Screenshot of the Piano Module

6.3 Discussion:

The below figure summarizes the UI design principles that has been used in this project and in previous studies for mobile application. Some elements of usability that frequently used have been identified which are satisfaction, ease of use, effectiveness and efficiency respectively. These elements were used to provide better mobile application design. The design requirements showed potential to motivate participants.

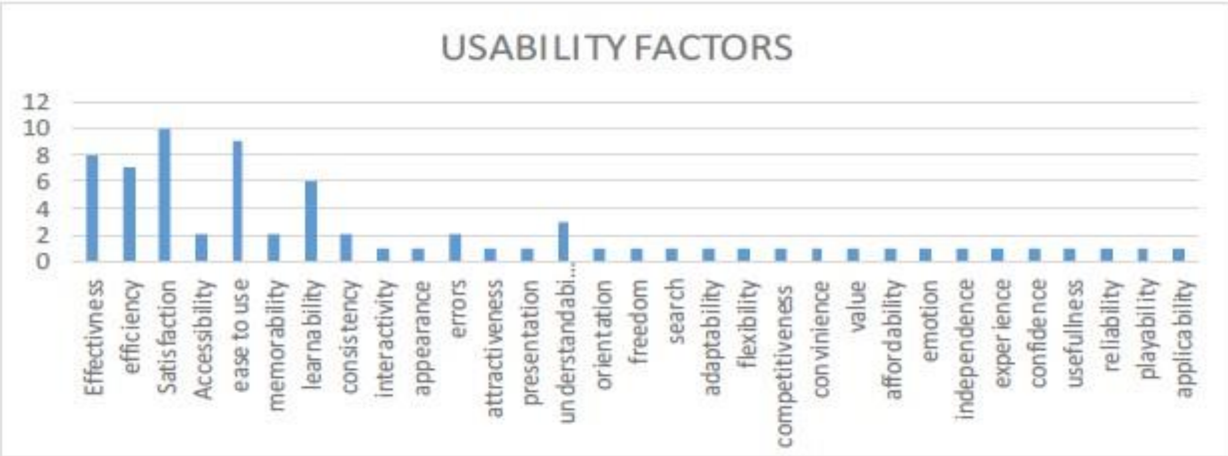

Figure 25: Comparison of the Usability Elements

Two (2) category of literature highlight in usability guideline for designing the interface of mobile application for autism	
Study on Documentation Related with Mobile Application for autism	Study on Documentation Related to Usability Guidelines and Elements
Finding	
Usability	
a. Effectiveness	a. Effectiveness
b. Efficiency	b. Efficiency
c. Satisfaction	c. Satisfaction
d. Ease of use	d. Ease of use
e. Understandable	e. Learnability
f. Appearance	

Figure 26: The relation design principles and mobile application for autism

Excepted results:

Users	Characteristics to be improved	Contribution
Autistic People	Disruptive behaviors	Decreases
	Oral language	Improves
	Solve communication issues	Helps
	Level of anxiety	Reduces

	Impulse to communicate	Increases
	Gestures vocabulary	Improves learning and consolidation
	Communication between peers and teachers	Improved
Education professionals and families	Personalized intervention	Adaptation of learning contents, methodology and evaluation
	Devices and software	Low cost or free
	Training	Helps professionals use the tools
	Coordination between professionals and family	Participation of all, generalized use of AACs
	Total communication	Helps in the intervention

Limitations of the Application:

The present system has failings and nonexistence in some of its processes. For its further development, the following details are highly recommended;

- The researchers would like to recommend this game to children with Autism and to children who wanted to learn the human body parts especially those who are intellectually disabled.
- Add more levels to improve one's learning capability and to make the game application more exciting and interesting.
- It is also recommended that the users of the application must familiarize themselves with it in order to maximize all its functionality.

Chapter 7

Conclusion and Future Work

7.1 Conclusion

Published studies on the use of mobile with people with ASD rarely describe the design of the technology under inspection and thus one straightforward goal is that authors in future should aim to report on this process. Developing novel software for an atypical group with specialist requirements necessitates collaboration across disciplinary borders and consultation with end-users. Practitioners with a background in participatory design emphasize the importance of including users not just to test early versions of a new program, but in the earliest stages of design. Psychologists and computer-scientists have much to learn from these examples of innovative ways of helping those without technological expertise, and often without language, to participate in the design process. Further research should explore whether co-designed programs out-perform those created by professionals alone. It is possible that mobile technologies might deliver good educational content but that participatory design can enhance motivation or reduce drop-out thus expanding the impact of the technology.

CAL studies report in the majority of cases on technologies used in classroom settings or in the lab. As computers and mobile become more and more common in the home, and as increasing numbers of people have access to mobile computing via smartphones and tablets, further research is needed to explore how CAL can be implemented across settings. Combining CAL with non-technology intervention components such as social skills groups or tutoring may lead to better outcomes, and has been used most widely when the target skill is in the interpersonal domain. This highlights the limitation of CAL for teaching social content, but also illustrates how expensive expert intervention can be supported by a daily dose of further learning materials via a computer. One oft-cited strength of CAL is the opportunity to provide immediate feedback to the user, helping to motivate and increase focus. Use of real-world reinforcers (such as sweets) may however be useful when the first challenge is to help the user engage with the hardware at all. This occurrence should not necessarily be seen as a disadvantage of CAL because many children unable to access a computer interface may also struggle to take in learning in traditional settings. This is an area where touchscreen and tangible technologies may be of particular value in bringing CAL to very young children and/or those with limited intellectual capacities.

As in all fields of psychology, the experimental method and randomized controlled trials for interventions represent the gold standard in evaluation of CAL. A small but high-quality group of studies indicate that it is feasible to apply this method to CAL and that, possibly, using a randomized controlled design may facilitate publication of a piece of software on the commercial stage. Studies should more fully exploit the value of CAL in permitting collection of data across time, and not just at pre- and post-intervention sessions, so that we can explore how learning develops over time and link this with other external measures. The focus of studies, especially when these are evaluating commercial products, should be on exploring how specific CAL features impact on outcome so that those with the most value can be replicated in future technologies. Generalization may be a challenge for CAL interventions as is it across the autism intervention literature; the best studies delve into this construct by measuring both close and distant generalization or by combining CAL with other therapeutic methods. Studies in CAL and autism should also incorporate measures of indirect benefits both to the user and those around them (e.g. family members, classmates and teachers) in order to provide a more comprehensive evaluation of the application of CAL in real life.

7.2 Future Work

Parents and teachers are increasingly taking matters into their own hands in selecting and applying technology in the home and classroom. While a device such as an iPad carries a considerable price tag, once purchased the user has access to hundreds of low-priced apps being marketed for people with autism, and thousands more which may also be appealing. Others such as augmented and aided communication apps like Proloquo2Go or Speak4Yourself are priced more highly but come with the promise of giving a nonverbal person with autism a voice. In this context, research can no longer afford to focus on whether mobile aided learning is beneficial for a person with ASD and instead needs to find ways of directing families and practitioners towards the best available technologies and guiding them to be used in the best possible ways. Information about questions such as whether autism-specific technologies are better than ‘mainstream’ alternatives, or how much time playing on a computer is appropriate for a child or young person needs to be based on research evidence and communicated to the community.

Issues of inclusivity are also in the foreground when one considers the real-world application of CAL. One might assume that best practice would be to make beneficial technologies available for free, but that may also mean that they are unsupported. For a technology to be useful, users also need somewhere to go for troubleshooting support and software needs upgrading as operating systems are updated. This may be particularly the case when creating technologies for adolescents and adults, where one common goal across technologies must be to foster independence and self-determination. Technologies for this group are thin on the ground, and discussion with families and practitioners suggests that adults with learning disability are expected to make do with technologies designed with preschoolers in mind.

New technologies are helping to break down some of the objections to CAL. It is also straightforward to update mobile apps or web-based supports regularly to add new content, fix bugs and respond to user feedback. Researchers in the CAL field are developing new approaches, building on the examples of existing CAL and utilizing this latest hardware, though few findings in this area have been published.

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