THE DESIGN PRINCIPLES OF EDUTAINMENT SYSTEM FOR AUTISTIC CHILDREN WITH COMMUNICATION DIFFICULTIES

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Abstrak

Bilangan kanak-kanak autisme semakin meningkat di seluruh dunia. Kanak-kanak autisme mempunyai tiga masalah utama iaitu daripada aspek bersosial, berkomunikasi dan tingkah laku. Terdapat kira-kira 50 peratus daripada individu dengan masalah autisme mempunyai masalah dalam membangunkan fungsi bahasa mereka disebabkan berlakunya kemerosotan dalam komunikasi. Peranti mudah alih dengan permainan bersifat pendidikan digunakan bagi membantu individu untuk berasa lebih selesa dan lebih santai melakukan aktiviti tersebut. Terdapat pelbagai aplikasi mudah alih yang tersedia untuk individu autisme. Namun, mereka sukar untuk menggunakan aplikasi tersebut. Ini terutamanya dari segi reka bentuk antara muka pengguna aplikasi tersebut. Kajian ini menganalisis aplikasi sedia ada untuk menentukan prinsip reka bentuk berkaitan dengan Aplikasi Didik Hibur yang sedang dikaji. Lima aplikasi telah dikaji dalam analisis ini. Objektif kajian ini ialah untuk mengenal pasti prinsip reka bentuk yang penting dalam mereka bentuk sesebuah aplikasi. Analisis ini telah mengenal pasti lima belas cadangan bagi prinsip reka bentuk tersebut. Cadangan tersebut ialah paparan antara muka yang mudah, saiz imej, beberapa gambar, ikon halaman rerumah, warna, mempunyai imej yang serupa dengan objek kehidupan sebenar, penggunaan aplikasi bagi penjaga, pelayaran, perlindungan kata laluan, audio yang bersesuaian dengan imej, bahasa aplikasi yang digunakan, penilaian parameter untuk mengukur pertumbuhan kanak-kanak, pilihan untuk memuat turun gambar, PECS berasaskan komunikasi dan fungsi sebutan ayat. Cadangan-cadangan ini ditawarkan dalam kajian ini ke arah mereka bentuk dan membangunkan aplikasi prototaip untuk kanak-kanak autistik. Kajian ini memperkenalkan prinsip reka bentuk sistem didik hibur yang digubal untuk membantu membangunkan kemahiran komunikasi kanak-kanak dengan spektrum gangguan autisme. Kajian ini juga menerangkan reka bentuk, pelaksanaan, dan penilaian aplikasi *ICanTalk* yang merupakan aplikasi didik hibur mudah alih yang boleh digunakan untuk meningkatkan kefahaman dan kemahiran komunikasi pengguna. Di samping itu, aplikasi ini membantu mereka untuk berhubung dengan masyarakat dan persekitaran. Ini terutamanya melibatkan kanak-kanak autistik yang mengalami masalah komunikasi. Aplikasi ini membolehkan penjaga untuk mencipta kandungan peribadi menggunakan gambar dan audio pada peranti mudah alih mereka (*tablet*). Penilaian aplikasi dengan guru menunjukkan bahawa aplikasi ini sangat berguna dan mudah untuk digunakan. Kesimpulannya, berdasarkan keputusan penilaian, didapati bahawa aplikasi *ICanTalk* adalah berkesan dalam membantu kanak-kanak autistik yang mengalami masalah komunikasi.

Abstract

The number of children with autism is increasing worldwide. Children with autism face three major problems; socializing, communicating, and behaviour. Approximately 50% of all individuals with autism have difficulties in developing functional language owing to communication deterioration. Mobile devices with installed educational games help these individuals feel more comfortable and relaxed doing such activities. Although numerous mobile applications are available for individuals with autism, they are difficult to use; particularly in terms of user-interface design. This study analysed the existing apps in order to determine the design principles applicable to the Edutainment App being studied. Five applications were involved in this analysis. As outlined in the objectives of this study, identifying these design principles is important in designing the app. The analysis identified fifteen suggestions for the design principles. These suggestions addressed, simple interfaces; image size; number of pictures; home page icon; colour; having images identical to real life objects; the use of caregivers; navigation; password-protection; audio appropriate to the images; the app language used; evaluating parameters to measure the child's growth; option for photo loading; PECS-based communication; and sentence pronunciation function. These recommendations are offered by this study towards designing and developing a prototype app for autistic children. This study introduces an edutainment-system design principle formulated to help develop the communication skills of children with autism-spectrum disorders. This study also describes the design, implementation, and evaluation of the ICanTalk app-a mobile edutainment app that can be used to improve users' understanding and communication skills and help them to connect with society and the surrounding environment particularly for autistic children with communication difficulties. This app allows caregivers to create personalized content using pictures and audio on their mobile devices (tablets). The evaluation of the app by teachers suggests that it is useful and easy-to-use. In conclusion, based on the evaluation results, it is found that the ICanTalk app is effective in helping autistic children with communication difficulties.

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter explains the disability of children with Autism in general and the assistive technology provided through the mobile device. It also provides the definitions of Autism spectrum disorder and Edutainment Apps. Besides, it discusses the state of the existing apps for autistic children.

1.1.1 Disabilities of Children with Autism

Throughout the world, there has been an increase in the number of children with disabilities (Dandashi, Alja'Am, & Saleh, 2013). At present, more than a billion people (or approximately 15% of the global population) are living with disabilities, and this number includes children (Kbar & Aly, 2014). Disability thus impacts society because families of disabled individuals are part of, and interact within, the society (Lee, Choi, Song, & Shin, 2014).

The global Education For All (EFA) and UN Convention on the Rights of Persons with Disabilities stressed the importance of education for people with disabilities and thus they encouraged the development of an approach to educate them (Lehtomäki, Tuomi, & Matonya, 2014). According to the Portuguese Child Support Institute, children can develop abilities, such as evolving attention skills, strengthen the memory, advancing and expanding imitation and imagination, through playing (Proença, Quaresma, & Vieira, 2014). This means that playing is an essential part of learning. Without incorporating play, learning can become abusive and cruel (Stasolla, Caffò, Picucci, & Bosco, 2013). One wrong belief is that children with disabilities are incapable of playing. The truth is that such children could play, only in a manner differs from

normal children. This means that the games of children with disability are not as complicated as those of normal children (Proença et al., 2014).

In this context, all the methods by which people with disabilities adapt to the challenges presented by the environment can be considered 'technological solutions' (Agree, 2014). This case is similar to the way technology has been developed in the form of mobile devices that have replaced desktops or laptops to provide instruction (Lancioni & Singh, 2014).

The Autism spectrum disorders (ASDs) are neurodevelopmental disorders that influence social interaction and communication with others; they are associated with stereotyped behaviours and activities (Sun, Allison, Auyeung, Matthews, Sharp, & Brayne, 2014). Autism is one of the most special cases of disabilities (Chowdhury, Newaz, Delwar Hossain, & Baidya, 2014). Children with this condition are increasing in number globally (Hirokawa, Funahashi, Itoh, & Suzuki, 2014).

In Malaysia, there is no official report for the number of children with autism (Neik, Lee, Low, Chia, & Chua, 2014). Also, the accurate statistics in Arab countries that can be relied on to show the exact numbers of autistic children are not available (Saleh, Aljaam, Karime, & El Saddik, 2013).

The early signs of this disability appear after six months, become consistent by two or three years, and then last throughout life (Coronato, De Pietro, & Paragliola, 2014). Autism is indicated by three symptoms: (1) social interaction in terms of challenges in recognising and understanding other people's emotions and expressing their own emotions; (2) communication in terms of verbal and non-verbal language; and (3) patterns of restricted or repetitive behaviours that are related to adapting to new environments (Schwenck & Freitag, 2014).

People with ASD exhibit delayed development of speech and language (Achmadi, Sigafoos, Sutherland, Lancioni, O'Reilly, & Marschik, 2014). A child with these symptoms will exhibit difficulties in learning and participating in an educational atmosphere unless the condition is addressed early (Hansen, Blakely, Dolata, Raulston, & Machalicek, 2014).

To help autistic children in learning, a number of methods and treatments are used today; these methods include various medications, speech or language therapy, assistive technology, sensory integration therapy, music therapy, visual schedules, gentle teaching, holding therapy, and vitamin supplements (Verschuur, Didden, Lang, Sigafoos, & Huskens, 2013).

Numerous works have proven that the ability to learn and communicate can be developed in children with ASD by using 'assistive technology' (Mustika, Kao, Cheng, Heh, Lin, & Tsai, 2014). Any tool that aids in teaching new skills, expands existing skills, or otherwise reduces the effect of disability on daily life is called 'assistive technology' (Lancioni et al., 2014). The existing uses of technology aside from its intended purpose justify the use of technology for treating children with ASD (King, Thomeczek, Voreis, & Scott, 2013). Moreover, children's brains also are still under development and the chances of improving their social and communication skills are greater compared to adults, because they are not fully exposed to the harshness of society (Petersen, Baalsrud, Eds, & Hutchison, 2014).

Mobile technology provides a proper educational environment to assist learning activities outside the classroom. Learning through the use of mobiles could expand the scope of learning anytime and anywhere. This concept has gained attention in describing the future of education (Zain, Mahmud, & Hassan, 2013).

Newer developments in mobile applications for children with ASD who use some developed mobile applications have proven that mobile information and communication technologies (ICTs) could improve participation in educational settings and social contexts; these application include iPads, Apple computers, and tablets (Mintz, 2013).

1.1.2 Edutainment for Autism

Children with Autism face three major problems: socialization problems, communication problems and behavioral problems (Still, Rehfeldt, Whelan, May, & Dymond, 2014; Bernardini, Porayska-Pomsta, & Sampath, 2013). Psychotherapy sessions lack the tools that may help children with Autism especially that most of the traditional tools are ineffective, as they traditional tools and methods are as they require the attendance of the children in the therapy sessions and that make them not easy to use. Sometimes, children declined to complete the sessions because they feel concerned and annoyed (Manap, Dehkordi, Rias, & Sardan, 2014). Children with ASD are usually incapable of sharing their feelings and problems with their therapists. Thus, methods and tools must be developed to allow them to communicate and interact with their environment despite their limitations (Rias & Dehkordi, 2013).

Pharmacological interventions are unsuitable for autistic people because Autism is believed to result from the irregular atypical development in the early embryonic stages of life. Medications can only reduce aggressive and harmful behaviour, as well as inattentiveness attitudes, and this could render educational intervention more useful (Noleine Fitzallen, Robyn Reaburn, 2014). Research has proven earlier intervention is the most effective for learning and development (Hutchison, 2014b).

Edutainment is a type of education that uses entertainment for educational purposes (Saleh, Prakash, & Manton, 2014). New research and approaches show that the adaptation of new technologies, such as mobile devices, at early stages the early can contribute to overcoming some of the challenges successfully (Lu, Chang, Kinshuk, Huang, & Chen, 2014). Evidences indicate that using mobile devices in the context of gaming are highly motivating for learners (Freitas, Ley, Eds, & Hutchison, 2014; Hussain, Mutalib, & Yasin, 2014). Children with ASDs have become more open to playing games on mobile devices. This is because of the small size of the screen and the touch screen interface, which help children focus by providing intuitive interaction (Petersen, Eds, & Hutchison, 2014). Evidence also suggests that many individuals with ASD have strong visual perceptual skills (Mazurek & Wenstrup, 2013).

Studies have shown that children with autism spend most of their time using electronic media and playing games (Mazurek & Engelhardt, 2013). Edutainment games present learning concepts in interactive ways and thus help children with autism learn, especially when multimedia elements are merged with tangible interfaces (Saleh, Aljaam, Karime, & El Saddik, 2013).

1.2 Problem Statement

The difficulties that affect individuals suffer from ASD are significantly different, although there are common identified characteristics. Difficulties are divided into three main areas, known as the "triad of impairments" (Bernardini, Porayska-Pomsta, & Smith, 2014): (1) Communication: Includes both problems with both verbal and non-verbal language; (2) Social interaction: Refers to problems of recognizing and understanding other people’s emotions as well as expressing their own emotions; and (3) Patterns of restricted or repetitive behaviours: Problems with adjusting to new environments.

Remarkably, very few studies explicitly target the population of children with ASD who demonstrate some of the most severe delays in communication, those who are minimally verbal (Shire, Shih, Distefano, Kaiser, Wright, & Kasari, 2014).

Most autistic children have communication challenges (Holt & Yuill, 2014). Delayed language acquisition during early and middle childhood and language difficulties are the most explicit characteristics of this disorder. These factors are contributors to communication deterioration, which is a critical aspect of ASD. These language difficulties present pragmatic features, such as the difficulty initiating and maintaining meaningful conversation (Kim, Junker, & Lord, 2014). Approximately 50% of people with this disorder exhibit insufficient development in any kind of functional language because of communication deterioration (Ribeiro, Araujo, & Raposo, 2014). Moreover, interaction and communication with autistic children is challenging because they lack verbal and nonverbal communication skills (M. Z. A. Aziz, Abdullah, Adnan, & Mazalan, 2014).

Technology devices help children with ASD learn while playing and capture their attention (Dehkordi & Rias, 2014). Mobile devices with educational games help these children to relaxed and be comfortable in doing such activities (Ribeiro, Araujo, & Raposo, 2014). This approach to learning has been widely introduced among children with ASD due to the small size of the device's screen that helps them to focus the attention and the touch screen interface provides a more intuitive interaction (Petersen, Baalsrud, Eds, & Hutchison, 2014).

However, this solution presents problems of its own. In particular, the currently available mobile applications intended to aid learning for individuals with autism are difficult to use (Lyan, Amjad, Shaden, & Khalid, 2015). The challenges have

something to do with the user interface design, which exhibits only limited features, including a fixed icon size and a display that includes all of the related vocabulary on the same screen. A number of children could actually learn more successfully if larger and fewer icons are placed on a screen (Xin & Leonard, 2014; Iyer & Kalbande, 2014).

In the field of communication, most of the available applications are aimed at developing the vocabulary of children with autism; however, these applications fail to concentrate on the communications skills that can be further improved through the adoption of an interactive process (Ribeiro, Araujo, & Raposo, 2014).

In addition, applications that target communication present highly complex systems with large vocabularies that function as a kind of text to speech program that is intended for higher functioning non-verbal individuals with ASD and those with other nonverbal disorders (Nancy, Rasche, Visser, Zoltowski, & Qian, 2014; Hutchison, 2014a). Moreover, a wide range of these apps support only the educational aspects of the condition (Freitas, Ley, Eds, & Hutchison,, 2014), but a number of recent studies have shown that autistic children spend most of their time playing games on a daily basis (Mazurek & Engelhardt, 2013).

Another challenge is that these applications are designed only for English-speaking children, and very few of the existing applications are available in different languages (Gay & Leijdekkers, 2014). In addition, although a large number of the applications are available on both Apple store and Google Play and are said to be intended for people with autism, most of these applications are supported only by anecdotal evidence (Lorah, Parnell, Whitby, & Hantula, 2014). There is no existing means for many of these applications to caution parents about the lack of scientific evidence supporting their effectiveness (Clark, Austin, & Craike, 2014).

In summary, edutainment app for children with ASD is carefully designed for Android devices. These app will have a focus on verbal communication problems, such that children with ASD can be helped in terms of communication and interaction with others. This is because children with ASD encounter challenges in expressing their needs verbally. In addition, the problems associated with the use of interface design, which contributes to the difficulty of using the apps, is accounted for in the design of the proposed app.

1.3 Research Question

It is necessary to answer the following research questions in order to find solutions to the problems discussed in the previous section:

1. How to identify requirements of design principles for mobile edutainment game for autistic children with communication difficulties?
2. How to develop of mobile edutainment game for autistic children?
3. How to evaluate the design of mobile edutainment game?

1.4 Research Objectives

The main purpose of this study is to design a useful and easy mobile edutainment game for children with Autism that can help in solving the problems of communication stated earlier. The following objectives are necessary to accomplish that:

1. To identify requirements of design principles for mobile edutainment game for autistic children with communication difficulties.
2. To develop mobile edutainment game based on the identify requirements of design principles for mobile edutainment game.
3. To evaluate the edutainment game through usability study.

1.5 Significance of Research

This study aims at establishing a serious of research to help children with autism, by designing and implementing a useful and easy to use Edutainment app. Best design principle means designing systems that are intrinsically motivating and fun to use, by applying those principle into app. The interaction design (IxD) is adopted as a primary tool to determine which principle is the most suitable to design Edutainment app for autistic children. The main purposes of using edutainment app for autistic children are therapy and educational purposes. The app is designed to improve their understanding and communication skills and to help them connect with the society and the surrounding environment, because the app is integrate with the interaction design principles. Moreover, the developed mobile edutainment app can is able to provide a new service to parents and teachers, helping them give their children the care and education they need. This will ultimately result in children with autism reaching a higher state of functionality. They will be growing up to live happier, more productive lives, and we will all benefit from their contributions to society.

1.6 Research Scope

The study focuses on the children that range from 5 to 7 years of age with Autism communication difficulties and mobile apps. In this regard, problems related to both verbal and non-verbal language deficiencies took a great part of the study. The study relied on the information available from existing documents and from interviews with three teachers at Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis located in Malaysia. In addition, the design of the prototype of mobile app mentioned in this study demands condition like the one set (Using Eclipse tool for Java language, Android platform, SQLite, Play store) which facilitates the work and enables interaction with the users. At the final stage, 10 teachers and 5 autistic children with

communication difficulties between ages 5-7 from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis in Malaysia were chosen to participate in usability study. The usability testing method include questionnaire and interview that were used to get feedback from teachers.

1.7 Organization of the Thesis

This thesis proposes the design principle of the mobile edutainment game for autistic children. This Chapter establishes the background of the study.

Chapter 2 provides related background and related works on all major research issues covered in the thesis. Firstly, the study briefly presents the rate of prevalence of Autism among some countries and assistive technologies for children with Autism. Secondly, it focuses on the five of existing apps for autistic children (Proloquo2Go App, iCanLearn, CommApp, TapToTalk and AAC speech communicator). Thirdly, the interaction design (IxD) is adopted as a primary tool to determine which principle is the most suitable to design edutainment app for autistic children with communication difficulties.

Chapter 3 provides the research methodology of this study. It consists of four main phases to solve the identified problem.

Chapter 4 describes the analysis of existing apps and individuals with ASD are using these, in order to obtain the style of the elements, which are added to the propose of design principles to produce a good design for autistic children with communication difficulties.

Chapter 5 explains the design and development of the prototype by using Object-Oriented approach using UML language and using Eclipse tool for Java programming language.

Chapter 6 presents the result for evaluation the usability of new design of ICanTalk app.

Chapter 7 discusses the conclusion and future work of this research. In addition, the chapter includes the contribution of this research study and the limitation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literatures related to this study. It starts with the facts on the use of the Assistive Technologies for autistic children. This study also explains the concept of Assistive Technologies for children with this deficit (mobile device). Technology becomes more accessible to educators, especially to support attractive way to younger children with Autism. A study on past apps in related areas is necessary before proceeding to identify requirements of design principles to develop mobile edutainment app for ASD. The existing apps for ASD and interaction design (IxD), which are considered a basis to propose the design principles, are explained in detail.

2.2 Autism Spectrum Disorders

According to the "World Health Organisation's International Classification of Functioning, Disability and Health (ICF)", the term disability refers to a deficiency and disability of body organs and structure, as well as restrictions related to different types of activity (Vincent-Onabajo & Malgwi, 2015).

Disability may be caused by a number of different reasons, which include genetic conditions, illnesses, environmental causes or an accident. Disabilities are divided into the following main types: (1) Mentally challenged or mental retardation (MR); (2) Cerebral Palsy (CP); (3) Communicative disorders (DSL); (4) Learning disability (LD); (5) Attention deficit hyperactive disorder (ADHD); and, (6) Childhood autism or Autism (Mago, 2014). Autism is known as a special type of disability, and the number of children with this condition is increasing globally (Chowdhury et al., 2014).

The term autism can be traced back to the Greek word ‘autos’, which means ‘self’. The term was initially used in the field of psychiatry to characterise symptoms of withdrawal. In 1943, Leo Kenner first discovered this condition (Husni, 2013). The reason of the ASD is a neurodevelopmental condition that affects the cognitive development of the child (Picardo et al., 2014).

2.3 Autism Spectrum Disorder Traits and Symptoms

Children with this disorder display a number of symptoms such as: (1) Repetitive behaviour: In this case, the child repeats doing certain things unintentionally. As the case of accumulating and taking apart the same block repeatedly, instead of moving to the next block; (2) Communication: children’s, in this case, face difficulties in expressing themselves, include problems of beginning in narrating any event or statement. The child expresses whatever comes to his mind first without following the random order in starting a conversation. They are unable to direct thoughts in a reasonable order and that is why they face such problems in communication; and, (3) Social Impairment: autistic children are unable to understand the tone or gestures of the people around (Iyer & Kalbande, 2014). Some of the more common symptoms of autism are (Mejía-Figueroa & Juárez-Ramírez, 2013):

i. Social Skills:
    - Inability or failure to respond to his/her name.
    - Poor or no eye contact.
    - Seems to be unresponsive or ignoring the other persons even when called at.
    - Resists being hugged or touched.
    - Appears to lack empathy.
    - Prefers to be alone.
    - Doesn’t communicate needs.

ii. Language Skills:

- Doesn't speak or has delayed speech.
- Loses capability to say words or sentences.
- No eye contact when communicating.
- Abnormal tone or rhythm when speaking.
- Won't start conversation or keep one going.
- Uses words or phrases by repetition, not using them correctly.
- Doesn't appear to understand simple questions or directions for his age.

iii. Behaviour:

- Repetitive movements.
- Has specific routines and can be disturbed or stressed from any change.
- Constant movement.
- Restrictive and strange interests.
- Sensorial sensibility or insensibility, such as will not feel pain, or sensible to noise.
- Shows no imaginative play.
- Odd and restrictive food preferences.
- Self-harming activities.

Almost half of the people with the disorder have insufficiency in developing any kind of functional language because of the communication deterioration (Holt & Yuill, 2014). Instability in communication skills is a common symptom showed by children with ASD (Brown & Elder, 2014). Their ways of communication differ from one to another, some of them use complete sentences in communicating, while others use one word to express essential needs, and some others do not talk at all (Stasolla, Damiani, & Caffò, 2014).

The symptoms of ASD begin to appear at the age of six months and at the age of 2 or 3 years, the disorder develops and established to continue as a disorder during childhood and adulthood (Coronato et al., 2014). Moreover the world witnesses increasing in the number of individuals with ASD (Hirokawa et al., 2014). The debate to find effective services has risen as a response to the increasing in numbers of the individuals with ASD in the last 10 years. The most recent reports released by the "Centre for Disease Control and Prevention (CDCP)" estimate that as many as 1 in every 68 children are affected by ASD, a 78% increase from 2002 to 2010 (Otero, Schatz, Merrill, & Bellini, 2015). Early intervention to treat the disorder is proved to be very useful for autistic children (Galitsky, 2013). There is an agreement among experts regarding education, care and therapy as being beneficial to improve the children's capabilities (Salter, Davey, & Michaud, 2014).

The United Nations general assembly declared the 2nd of April of every day as the day to celebrate the world autism awareness day. This occasion is announced to intensify the consciousness about the illness, and to encourage activities and to develop knowledge about the necessity of early treatment. Special education programs and behaviour therapy are designed to help children with ASD to increase and develop their functioning and to help them improve their social and communicative skills that may help them to acquire job and to decrease the symptoms (Danasekaran, Annadurai, & Mani, 2014).

There are no studies available to indicate the rate of prevalence of ASD in Southeast Asia. Malaysia, for instance, has no official registry of autistic children. This is due the fact that ASD is somehow considered as a type of learning disabilities and developmental incapacities (Ministry of Education Malaysia, 2012). What is asserted is that there is an obvious increase in the numbers of autistic individuals in the country.

The National Autism Society of Malaysia (NASOM) indicates that during the past three years, the rate of individuals with ASD has reached 30% (Neik et al., 2014).

In Malaysia, the prevalence of ASD is estimated at 1.6 per 1000. However, there are no available data concerning the theories, assessments, and interventions which used to treat children and adolescents with ASD (Kadar, McDonald, & Lentin, 2015). In the present time, autistic disorder children interact significantly with robots. For this reason, they play an effective role in upgrading the methods of the therapy of autism. The disability to interact with the surrounding society is the main problem autistic children face, so robots are used to teach them verbal and non-verbal communication. Autistic children feel more comfortable in dealing with robots and encourage them to develop their social interaction. This indicates that robots can help in the rehabilitation of autistic children in Malaysia (Miskam et al., 2013).

In Arabic countries, the rate of detected individuals with ASD is not as spread and common in the developed countries, besides; the lack of information about the diagnosis in these countries made the rate is different from one country to another. Cultural differences, level of education, lack of services, and low levels of experience and professional training these entire factors play role in creating such differences. However, people with ASD in Arabic countries are neglected to some point and do not receive the required attention (Hutchison, 2014a).

Several researches were carried out in UAE, Saudi Arabia, and Bahrain, which proved the variety of spreading the disorder between these countries. The change in prevalence of the disorder happens in accordance with other studies around the world. European studies, for instance, show that the prevalence in China has a range of 1.9 to 72.6 percent of 10,000 population, and the range has expended to 2.8 to 94 percent of

10,000 population) (Salhia, Al-nasser, Taher, & Al-khathaami, 2014). In Oman, 0.14 child over the 1000 Omani children population with the age ranging from months to 14 years old have ASDs (Al-Farsi et al., 2013).

The Iraqi Institute for Autism works as a community centre to treat autistic children, adjust their behaviour and teach them as much as possible was established in February last year. However, the Iraq does not have a reliable static to indicate to the rate of the prevalence of the disorder. In addition, international studies also show interest in the situation of autism in Iraq, describing some of the basic issues. The Autism Research Centre, Cambridge University conducted a study in 2011 concerning these problems asserted that there is a steep increase of autistic diagnosed cases registered after 2003, wherein 75 children out of every 1,000 at age 5 to 10 years old are affected by autism. Gilford University published a study on its website in 2012 showing that there are 5,000 Iraqi children are fighting autism, and it affirmed that the lack of capabilities and specialized centre causes an increase in the diagnosed cases (Sakr, March, Hamid, Ali, & Jazza, 2015). The annual increase in the diagnoses of ASD around the world is fixed with a rate of 67 children being diagnosed every day with the disorder. The Centre for Disease Control and Prevention (22/10,000) estimated the rate of increase in the cases of ASD in Iraq is reaching 15.8% from other childhood psychiatric disorders (Sarhan, 2013).

Public and health and education community in India do not have much awareness and knowledge degrading ASD. The rareness of personnel and specialized centres in isolated and remote areas worsen the situation. Moreover, the role of teachers in screening for Autism Spectrum Disorders is not taken into consideration. Children with ASD in India are rated to reach 2.3 million (Anil, 2014). Table 2.1 illustrates the autism prevalence among some countries (2000-2008):

Table 2.1:

Autism prevalence among some countries (Al-khafaji, Al-shaher, & Al-khafaji, 2013).

COUNTRY	NUMBER	SOURCE OF DATA
Thailand	180000	Minister of Mental Health, 2006
India	2000000	Action for Autism India, 2007
Philippines	500000	Philippines Autism society, 2007
China	1100000	Peking Health Science Centre, 2005
Mexico	50000	Ministry of Health, 2005
United Kingdom	650000	National Autistic society,2006
United States	1500000	America Autism society, 2007

2.4 Assistive Technologies for Children with Autism

High cost arises from treating Autism Spectrum Disorders children to governmental health services are growing. Within the UK, for example, it is estimated that over 500,000 people have some form of autism, with recent studies estimating that this figure is rising. Children with autism typically exhibit impairments in social imagination, communication and interaction. This often leads to difficulties in social and adaptive functioning, which can result in challenging behaviours that poses significant difficulties for parents and caregivers (Bodine, Helal, Gu, & Mokhtari, 2015). It is also reported that approximately 50% of people diagnosed with autism do not talk but are highly visual oriented, with the presence of strong visual-spatial skills (Al-khafaji et al., 2013). Most of autistic children are visual learners (Nancy et al., 2014).

The life of people with ASD has tremendously changed by using the information and communication technology (Okpube, 2014). The common trend nowadays calls for applying ICT in the education programs to provide effective instruction in the classroom and solving communication problems. In teaching children with autism, technology enjoys a special place as it improves communication and learning which may help overcoming some of the problems that autistic children face. Assistive technology is now being used for children with autism (Obiyo & Etonyeaku, 2013).

Technology has increasingly become available to educators, where tablets and smart phones are already considered as technological support that is particularly interesting for young children with ASD (Matson, 2014). Numerous studies have shown that assistive technology options are currently available to help facilitate learning and communication for autistic children (Mustika, Kao, Cheng, Heh, Lin, & Tsai, 2014).

Assistive Technology is highly reliable to help and support children to activities of daily living (Hook et al., 2014). The term "Assistive Technology" refers to any device or piece of equipment that facilitates teaching new skills, augments existing skills, or otherwise reduces the impact of disability on daily functioning (Lancioni et al., 2014).

Researchers in special education are to some extent aware about the potential of assistive technology tools in helping children and youth with Autism. The actual benefits of assistive technology may be reduced or not apparent depending on the quality of the software. This could be true since, first, the content of many software are not age appropriate. Second, much educational software is unable to reach educational goals and are used as a tool for mere entertainment. Third, many programs do not promote learning (Dandashi et al., 2014).

There is an agreement between the teacher and instructor regarding the fact that assistive teaching technology can motivate and develop the mind of individuals with ASD and help them to acquire new knowledge. The ability to use Tablet, Smartphone and computer by autistic children has been taken into account. In addition, several numbers of children with ASD in special school located in Klang Valley, Malaysia have been the subjects of tests to measure their skills in using the Learning Application. These applications were developed by adding different elements such as audio, video, animation, text and graphics (Kamaruzaman & Azahari, 2014).

Information and Communication Technologies (ICT) have proven their ability to induce radical changes in human habits, activities and life. ICT have changed what it means for partners to cooperate, for friends to communicate, for families to obtain better quality of life, etc. ICT have influenced the way children socialize, entertain and learn (Papagiannakis, 2013).

Learning and acquiring knowledge through ICTs have changed the way a learner in learning and gaining knowledge (Martin, 2014). iPad and tablet applications have been considered effective and efficient learning and skills development platform among autism children (Clark et al., 2014). The previous studies displayed in Table 2.2 below, on the use of ICT to help children with Autism.

Table 2.2:

The previous studies related to the use of ICT to assist Autistic children

AUTHOR(S)	YEAR	OBJECTIVE(S)	RESULTS
Balaji, Raja,Kanaga Suba and Vivekanandan	2012	Implementation of best practices for children with autism and normal children in Rural Area using MANET	Design a web based teaching system which can provide with a customized platform for every autistic child listening to the class
Buzzi Claudia, Buzzi Marina, Gazzé Davide, Senette Caterina and Tesconi Maurizio	2012	Teaching low- functioning autistic children	Implementing basic ABA programs. Compared to previous work based on AAC and DTT, the novel aspect is related to the distributed web-based architecture that enables the use of the SW anywhere, anytime and on different devices
Dimitrova Maya, Vegt Niko and Barakova Emilia	2012	Using robots to reward and stimulate children doing tasks together can be helpful in improving their social skills	Designing a System of Interactive Robots for Training Collaborative Skills to Autistic Children
Balaji and Khanaa	2012	Education for autistic children	A Novel Web- Based Teaching System for Autistic Children in Rural Area using MANET
De Urturi Zelai Sáenz, Zorrilla Amaia Méndez and Zapirain Begoña García	2011	Education: what to do in certain situations, basic knowledge about Healthcare medical specialties	Designing and implementing a multimedia Application within the framework of Serious Games
Helena Song Sook Yee	2012	Communication solutions for autistic persons in relating to their families and others in the community	The Major Trends and Issues from Mobile Technology for Children with Autism Spectrum Disorder
Rahman, Shujon Naha, Proteek C. Roy, Ishrat Ahmed, Samiha Samrose and Rahman Ahmed	2011	Takes care of the diversity of tastes among the autistic children of a classroom and helps the teacher to teach in a class participated by both autistic and neurotypical children	Designing and implementing an intelligent Classroom software

2.4.1 Augmentative and Alternative Communication AAC for Autism

Significant delay with respect to speech and language development is common among children with developmental delay/disabilities, including individuals with Autism (Achmadi et al., 2014). The clinicians often aim to teach him or her to use one or more Augmentative and Alternative Communication (AAC) options.

Speech generation devices (SGD, see example in Figure 2.1) or voice output communication aids (VOCA) are some of the most commonly used and researched mobile AACs. Although these devices tend to produce either speech or print feedback, the relative benefits of each depend greatly on the individual user and context of use (Kientz, Goodwin, Hayes, & Abowd, 2013). However, AAC devices are frequently bigger and more expensive than mobile devices, and provide access to a small range of mainstream applications (McNaughton & Light, 2013). In addition, there is many educational software that are unable to reach educational aims (Dandashi et al., 2014).

Figure 2.1: The GoTalk is a commonly used speech generation device that predates the use of general purpose mobile devices for similar purposes (Kientz et al., 2013).

2.4.2 Video Modeling Interventions for Children with Autism

Video modeling is a common intervention in which the child watches short, filmed clips of a model demonstrating the targeted behaviour or behaviours and is then given the opportunity to engage in the targeted skill or skills. This cycle is repeated until the child consistently demonstrates the targeted behaviours. To date, there is a large body of literature demonstrating that video modeling procedures effectively increase a range of social skills, including conversational speech (Macpherson, Charlop, & Miltenberger, 2014). The video modeling (iPad used to play the video models) may be an effective tool for teaching for some individuals with autism (Alexander, Ayres, Smith, Shepley, & Mataras, 2013).

The videos are also short, usually between 2 and 4 minutes long, which doesn't require a long attention span from a child with autism. As well as, many individuals with autism remember information more visually than verbally and they also have excellent memories and, if they are watching the correct behaviour or skill repeatedly, they may be more likely to engage in the skill. Furthermore, some children with autism also avoid eye contact, which may make it more difficult to teach certain skills using in vivo models (Marcus, 2014). The video modeling has never been fully and widely used in autism learning classrooms, compared with other interference approaches, which is less effective and impactful (Wilson, 2013).

2.4.3 Robots (Humanoid Robot) as Assistants for Autism Therapy

Robots are gaining momentum in 'breaching' through many facets of human life, most evidently making breakthroughs and contribution in areas of medical and rehabilitation. Humanoids create alike anthropomorphic and have a shape similar to humans functions (Figure 2.2) (Shamsuddin et al., 2013).

In recent years, robots have been increasingly used in education and autism diagnosis and treatment. When interacting with robots, people are mainly impressed by the robot's appearance. A variety of robots with different appearances and functions are currently being used around the world as therapy assistants in autism treatment: The Humanoid robot NAO, has also been used in a number of studies with the general aim of autism diagnosis and treatment and the specific aim of helping autistic children with imitation, joint attention, interaction, communication, making eye contacts, showing emotions, and/or eye gaze attention (Taheri, Alemi, Meghdari, PourEtemad, & Basiri, 2014). The screenshots in Figure 2.3 shows the recorded video when NAO is interacting with each of the children. Note that during the experiment each child was accompanied by his own teacher. The teacher's role is to provide 'comforting presence' to the child throughout the interaction. This is deemed necessary as the experiment will be the encounter between the child and the robot (Miskam, Hamid, Yussof, Shamsuddin, Malik, & Basir, 2013).

However, the empirical evidence to support the effectiveness of educational robotics is still limited (Benitti, 2012). Furthermore, cost is also an important factor for many children when acquiring such devices. For these reasons, most of the robotic-assisted therapy devices are commonly used in clinic centres or hospitals (Hutchison, 2014b).

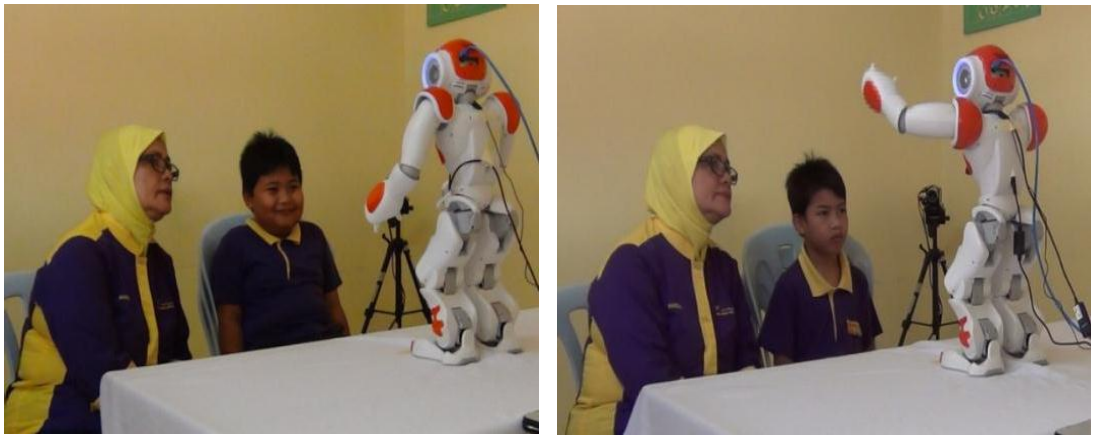

Figure. 2.2: Child (A) and (B) interacting with humanoid robot NAO (Miskam, Hamid, Yussof, Shamsuddin, Malik, & Basir, 2013).

2.4.4 The Computer Use for People with ASD

Most computer applications designed for people with autism focus on the relationship between one user and one computer and aim to help with specific behavioral problems associated with autism (Chanchalor & Chusinkunawut, 2013). Computers are motivating for children with autism due to their predictability and consistency, compared with the unpredictable nature of human responses. In regard to social interaction, the computer does not send confusing social messages (Boucenna et al., 2014). Computer games for ASD are usually custom-made to give sensual response to the user, which is naturally appealing such as sounds, music, variable tone intensity, character vocalizations, rapid action, spinning objects, and special effects to attraction and endure responsiveness to learning content (Martin, 2014).

However, there are anxiety that the use of computers can prevent spontaneous speech and social interaction in autistic children (Picardo et al., 2014). Moreover, some of these children are not able to use a computer (Iyer & Kalbande, 2014). As well as, many individuals with autism have difficulty using a computer mouse. Try a roller ball (or tracking ball) pointing device that has a separate button for clicking. Autistics with motor control problems in their hands find it very difficult to hold the mouse still during clicking (Grandin, 2002).

2.5 Interaction Design

Interaction design is the discipline of designing interactive products to support people in their everyday lives. It defines the behaviour of systems and is concerned with form and content, as related to system behaviour and user input (Preece, Rogers, & Sharp, 2007). IxD embodies three dimensions – form, content, and behaviour (as shown in Figure 2.3). A form represents the physical layout of the interface and includes colours, fonts, buttons, labels and figures. Content refers to what is being presented to the user.

Finally, behaviour denotes how the content is presented to the user and is concerned with user experience and feelings after accessing the content presented (Aziz, Husni, & Jamaludin, 2013). This definition is useful for many design disciplines, although the precise focus on form, content, and behaviour will vary depending on what is being designed (Cooper, Reimann, & Cronin, 2007). Furthermore, it is implicitly understood that the aim of interaction design is to produce good use qualities. What is good depends on the design domain. Productivity tools are generally good if they support the users' professional goals without violating their personal goals (Jonas Löwgren, 2001).

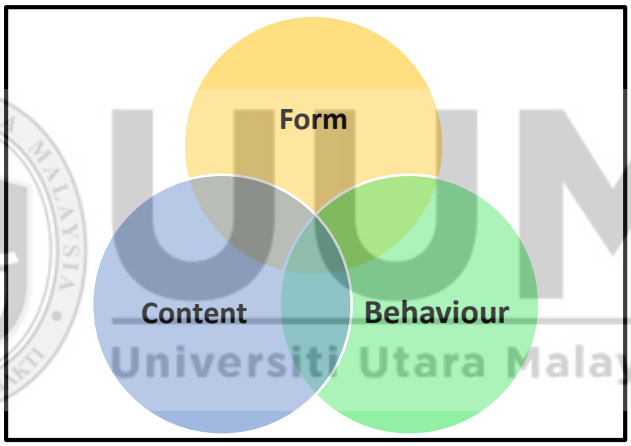

Figure 2.3: IxD Dimensions with Form, Content, and Behaviour (Cooper et al., 2007).

2.5.1 Background of Interaction Design

In the late 1970s and the early 80s, a dedicated and visionary set of researchers, engineers, and designers in the San Francisco Bay Area were busy inventing how people would interact with computers in the future. At Xerox Parc, SRI, and eventually Apple Computer, people had begun discussing what it meant to create useful and usable "human interfaces" for digital products (Cooper et al., 2007).

In the mid-1980s, two industrial designers, Bill Moggridge and Bill Verplank (who were working on the first laptop computer, the GRiD Compass), coined the term "Interaction Design" for what they were doing. However, it would be another ten years before other designers rediscovered this term and brought it into mainstream use (Zou, 2009). The methodology was fully developed by Alan Cooper (Alves, 2013).

In design, human-computer interaction, software development, and interaction design (often abbreviated as IxD), is defined as "the practice of designing interactive digital products, environments, systems, and services." Like many other design fields, interaction design also has an interest in form, but its main focus is on behaviour. What clearly marks interaction design as a design field-as opposed to a science or engineering field-is that it is a synthesis of and an imagining things as they might be; more so than focusing on how things are (Cooper et al., 2007).

Interaction design is a new field of design, and it changes the relationship of humans and products from "use" to "interact." It starts to focus on the interaction of both sides (humans and products). Inevitably, human-centred and user-friendly criterions become significant to product design (Hutchison, 2014b).

It is a difficult task to monitor the evolution and the advances of concepts, methods and applications related to Information and Communication Technologies (ICT), which are always changing or improving. Such transformations are mainly related to user interaction with mobile applications (Hutchison, 2014b). Hence, the professionals who work with interaction design need continuously updating models and design approaches; especially for applications that use new interaction technologies, such as technologies for gestures, touches, sounds, movements and others. Therefore, the technological resources for social interaction and the resources for communication and exchange of information should connect seamlessly with non-technical traditional

forms (Milne, 2007). Moreover, the integration of interaction design into the practice of software development may improve the process to support the development of products, which could be more adherent to user needs and expectations (Jakob Nielsen & Norman, 2014).

2.5.2 Affective Interaction Design

Throughout the process of interaction design, designers must be aware of the key aspects in their designs that influence emotional responses in target users. The need for products to convey positive emotions and avoid negative ones is critical to product success. These aspects include positive, negative, motivational, learning, creative, social and persuasive influences, to name a few. One method that can help convey such aspects is the use of expressive interfaces. In software, for example, the use of dynamic icons, animations and sound can help communicate a state of operation, thus creating a sense of interactivity and feedback. Interface aspects, such as fonts, colour palettes, and graphical layouts can influence an interface's perceived effectiveness. Studies have shown that affective aspects can affect a user's perception of usability (Preece, Rogers, & Sharp, 2007).

Interaction design should be placed highly in a product for its core interface, functionality, and features (Petersen et al., 2014). A developer should follow interaction design principles closely, especially for mobile applications. Thus, the interface and the layout would be able to drive the participants to use the prototype confidently (Petersen, Baalsrud, Eds, & Hutchison, 2014). Moreover, "interaction designers strive to create meaningful relationships between people and the products and services that they use, from computers to mobile devices to appliances and beyond" (Alves, 2013).

2.5.3 Interaction Design for Autistic Children

The context for this study is the use of edutainment apps for children with autism in Malaysian Primary Schools. Learners with autism can suffer, to varying degrees, from the triad of impairment, namely abnormal communications, abnormal social development and repeated behaviour (Bernardini et al., 2014).

Interventions to support individuals with autism typically begin very early in life-immediately after diagnosis - and often include the use of a wide variety of visual tools. These artifacts draw on text, images, and tangible objects to represent both concrete and abstract real-world concepts. The use of these visual artifacts has been shown to reduce the symptoms associated with cognitive, communication, and social disabilities; particularly for individuals with Autism (Cohen & Sloan, 2007).

Mobile devices with educational games help these children to relax and be comfortable in doing such activities (Ribeiro, Araujo, & Raposo, 2014). Educational games present learning concepts in interactive ways and thus help children with autism to learn; especially when multimedia elements are merged with tangible interfaces (Saleh, Aljaam, Karime, & El Saddik, 2013). However, this solution presents problems of its own. In particular, currently available mobile applications that are intended to aid learning for individuals with autism are difficult to use. Their challenges have something to do with the user interface design, which exhibits only limited features (Lyan et al., 2015). For general game play, the developer must consider ease of use for people with autism, as they require a certain level of difficulty (Barry, Kehoe, & Pitt, 2008). Hence, the educational software design process for users with autism must adapt specifically to the needs of its target audience (Shields, 1999).

At the outset of this study, it was proven that technology is attractive to learners with autism. However, it later emerged that interface design needs to be revised, if it is to offer optimal opportunities for understanding and learning for special needs learners (Barry & Pitt, 2006). To date, the design principles that relate to interaction design for cognitive impairment are general in nature and not related sufficiently close to the needs of children with Autism (Barry & Pitt, 2006). In the current study, the Interaction Design provides means for envisioning how design principles can be used for the development of applications to augment communication skills for children with ASD.

2.5.4 Designing Tips for Children with Autism

To create an effective and engaging user interface, a designer must have a command of the basic visual properties i.e., colour, typography, form, and composition, and must know how they can be used to effectively convey behaviour and information, and create a mood or visceral response. Interface designers also need a fundamental understanding of the interaction principles and interface idioms that shape the behaviour of a product (Cooper et al., 2007). However, in order to develop mobile apps for autistic children, numerous researchers have highlighted various principles to help designers to design and implement applications that better fit the needs of the target group (i.e., children with autism). They are (Lyan et al., 2015; Bodine & Hutchison, 2014; Ribeiro et al., 2014):

- The number of pictures that appear on each page should be within the acceptable limit of pictures.
- Use images as close to real objects/situations as possible, instead of infantile or cartoon style images, this provides a greater chance for these people to recognize objects/situations.

- The home page icon should be distinguished. There should also be an icon to clarify the apparent of other pages.
- Communication based on the Picture Exchange Communication System (PECS): This is a system based on images specifically developed for children with impairments in communication. Through it, children can communicate creating sentences by selecting pictures that represent objects and actions.
- Colour: The colour black is often found to be repulsive.
- Audio and Images: Audio aspects should correspond with the images.

2.6 Mobile Technology and Application for Autism Spectrum Disorders

Mobile Technology, through successful research, has demonstrated effective message interferences for children's with ASD (Stockall & Dennis, 2013). Many research confirms that mobile technology is an encouraging instrument for persons with ASD (Allen & Shane, 2014). Mobile technologies include applications delivered on mobile phones, tablets, iPad ,or other mobile devices intended for personal use (Kientz et al., 2013).

Technological advances have led to a shift in the use from more traditional ICT resources such as the computer, to newer mobile devices. Touch screen devices such as the iPad are becoming a popular choice for many children (both typically developing and with ASD) and offer many advantages over traditional devices; they are compact, portable, reinforcing, and potentially cost-effective (Clark et al., 2014). These new mobile technologies are frequently smaller and cheaper than traditional augmentative and alternative communication (AAC) devices, and provide access to a wide range of mainstream smartphone applications (e.g., texting, browsing the internet, GPS navigation).

Potential benefits of mobile technologies the introduction of the iPad and other mobile technologies has offered many potential benefits to individuals with complex communication needs who require AAC (McNaughton & Light, 2013). The average cost of an iPad is under $500 dollars, while a ProxTalker AAC device can cost over $2000 (Nancy et al., 2014).

Aided, high technology systems have advanced into a new territory with the development of applications for iPads, tablets, iPhones, and smartphones. An application, or more commonly referred to as an "app", is software installed on a computing device (such as iPhone, iPad, tablets, or smartphone) that provides a specific function on the host device (Gilbert, 2013). Plus, nowadays a considerable number of games have been developed for mobile devices. Besides the mobility itself and the easier interaction through multi-touch, one of the advantages of using tablet devices, is the potential to use the device to engage more than one user at a time in a social context, when applying this technology aligned to cooperative strategies (Ribeiro et al., 2014).

Furthermore, the cost-effectiveness of mobile applications contributes to their attractiveness as a mode of delivery for early interventions. Applications are low in cost in comparison with face-to-face educational and therapeutic interventions for ASD (Clark et al., 2014). In addition, mobile technology has several advantages for the autistic child and carer (Leijdekkers, Gay, & Wong, 2013): (1) access to tools to play and communicate ubiquitously; (2) Easy access to games, music, education tool on the go; (3) the carer can easily identify what the child likes to play with and track progress; (4) multimodal input/output with an intuitive interface; (5) easy to use of camera and video; (6) easy integration of external sensors that wirelessly transmit data to the device providing additional feedback; (7) an action (e.g. taking a picture) can

be positioned in context using GPS, time and other data, which can be used at a later stage; (8) using one of the many apps available, can be help from the carer; and, (9) mobile device include feature to provide better accessibility for autistic children.

2.7 Mobile Game Based Learning for Autism

Edutainment is a blend of two words - "Education" and "Entertainment" or educational entertainment. Edutainment content assists in active form of learning, helps in increasing retention and builds skills and competence. It helps to create interesting, situational learning environments that closely reflect a learner's true working environment. Edutainment deepens understanding by introducing the elements of fun for enhancing and retaining knowledge (Singh & College, 2014).

During childhood, individuals want to have friends to play with and are interested in learning and participating in activities. When they grow up as the adults, they want to have buddies to think and work with. Autistic children should also have these things in order to mitigate their inappropriate behaviours, such that they would have the ability to live and interact with the others in society (Runcharoen, 2014). There has been a recent increase in the adoption of mobile apps for communication by families of individuals with autism. A recent survey revealed that families reported that more than 90% of individuals with complex communication challenges use their mobile device, not only for AAC, but also for non-AAC purposes, such as entertainment (85%) and learning (70%) (McNaughton & Light, 2013).

According to Quinn (2000), mobile learning is "the intersection of mobile computing and e-learning and includes anywhere, anytime resources; strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment" (Martin & Ertzberger, 2013).

The main benefits of mobile learning are reported as follows (Madani, Ayed, Jemni, & Sampson, 2013):

(a) Enables on-demand access to learning resources and services, as well as instant delivery of notifications and reminders; (b) offers new opportunities for learning that extend beyond the traditional teacher-led classroom-based activities; (c) encourages learners to participate more actively in the learning process by engaging them to experiential learning such as learning by doing; (d) enables learning and performance support by exploiting real-life context; and (e) supports on-demand access, communication and exchange of knowledge with experts, peers and communities of practice.

With the advancement in mobile technologies, mobile devices provide a flexible way of learning. A mobile device is usually equipped with camera, microphone, and speaker, which can aid in the content design of educational software and is very helpful while working with children with ASD (Bodine, Helal, Gu, & Mokhtari, 2015).

Mobile learning provides an educational experience which is altering the nature of knowledge (formal and informal) and is focusing on the user's experience of learning through mobile devices. It provides a wide range of educational and learning material in a uniquely engaging manner (touch-screens), whilst giving them the option to choose from information which will enrich their knowledge and improve their skills (Holthaus, 2014). Educational applications for mobile devices motivate the children and engage their attention while focusing on solving problems, improving their memory, their reading and writing skills (Skiada, Soroniati, Gardeli, & Zissis, 2014).

Fifty-eight percent of the 25 top selling educational apps target toddlers/preschool children, demonstrating the perceived potential of apps as educational tools by teachers. Apps have the potential to target a wide array of functional skills necessary for effective communication including joint attention, turn-taking, vocabulary development, increasing length and complexity of language, and pre-literacy skills (Stockall & Dennis, 2013). Previous research has shown that children and adolescents with ASD spend a majority of their free time with electronic media such as video games (Engelhardt & Mazurek, 2013).

Teaching socially acceptable communication skills is a major educational priority for children with ASD, is likely to be fairly complicated when the person has little or no speech (Sigafoos et al., 2013). On the other hand, preference for autistic children may differ from what is received by typical children in the mainstream education. Autistic children will need special attention and special goal when it comes to their education (Kamaruzaman & Azahari, 2014). The multitouch displays (e.g. Tablets) these entertainment-based assistive technologies also help children with autism learn how to work with others, be patient and understand emotions. Recently, research projects made the compelling argument that children with autism are more willing to initiate play and to interact appropriately when using entertainment-based assistive technologies (Escobedo et al., 2012).

Edutainment refers to a type of education that integrates entertainment for educational purposes and uses games to facilitate learning (Saleh et al., 2014). Edutainment games serve an important function in teaching children with autism by presenting learning concepts in interactive ways, particular in a manner that merges learning components with multimedia elements and tangible interfaces (Saleh et al., 2013).

2.8 Existing Apps for Autistic Children

Interest in the potential use of mobile technology in the classroom and in support of children with ASD has recently gained considerable attention globally. A potential exists for flexible, individualised, and persuasive mobile applications that can help autistic children overcome challenges in terms of their social and life skills (Mintz, 2013). To design an application for user, the typical first step is to understand the users' condition and their requirements. Successful product design for children with Autism involves learning from other designs which have features similar to the ones you want in your product (Nancy, Rasche, Qian, Visser, Zoltowski, & Qian, 2014).

It is extremely difficult for autistic children to communicate verbally or non-verbally. In the last decade, there have been significant technological advancements in this field where technologies have been developed to support autistic children to develop verbal and non-verbal communication skills. During the literature review of state-of-the-art technologies, apps from both iPhone and Android domain have been reviewed that are being used in ASD, the most popular in the market which have shown some of success in assisting persons with communication difficulties through the mobile device (Nancy, Rasche, Visser, Zoltowski, & Qian, 2014; Islas, González, & Mejía, 2013; Yee, 2012). The study discussed five of the apps such as Proloquo2Go App, iCanLearn, CommApp, TapToTalk, and AAC speech communicator, which were studied during the review.

2.8.1 Comm App

IPhone application named Comm App has been created using the principles of Applied Behaviour Analysis (ABA) to allow children with autism or any other language deficit to easily and effectively communicate their basics needs and wants in five main categories: food, drink, clothing, toys and emotions using actual photographs and real

voices (Jang et al., 2013). The app can easily be turned into an AAC device by simply installing it onto a device, providing savings of thousands of dollars. The application's main purpose is to let non-verbal children communicate what they want quickly and easily. However, it can also be used as part of a child's ABA therapy to teach basic language skills. As a basic communications tool, the app focuses on five main categories as shown in Figure 2.4 (Khan, Tahir, & Raza, 2013).

Figure 2.4: Comm App (Khan, Tahir, & Raza, 2013).

Appealing User Interface users appreciated the colour scheme and overall layout of the app. Also, users found it easy to navigate through the app and search for respective items (Khan et al., 2013).

2.8.2 iCanLearn App

iCanLearn, a mobile flashcard app for creating social stories for autistic children, enables users to create personalised content utilising text, pictures and audio with their mobile devices. When their devices are connected over Wi-Fi, users of the iCanLearn software can also share content (Bodine, Helal, Gu, & Mokhtari, 2015). The features in the process of development of the app are described below (Bodine et al., 2015):

i. **Appearance and Text:** the design theme for iCanLearn is simple and uncluttered. A sentence case with sans serif font was selected for ease of reading.

ii. **Navigation:** navigating the transition from screen to screen (see Figure 2.5).

iii. **Audio:** most of the audio being recorded was going to be spoken by users and played back by the tiny speakers of the mobile devices, so quality was not as important as file size and app performance.

iv. **Playback Control:** standard playback symbols were chosen for the playback controls: triangle for play, square for stop, and circle for record. Buttons with words on them were not selected as they can cause problems when translating an app into another language.

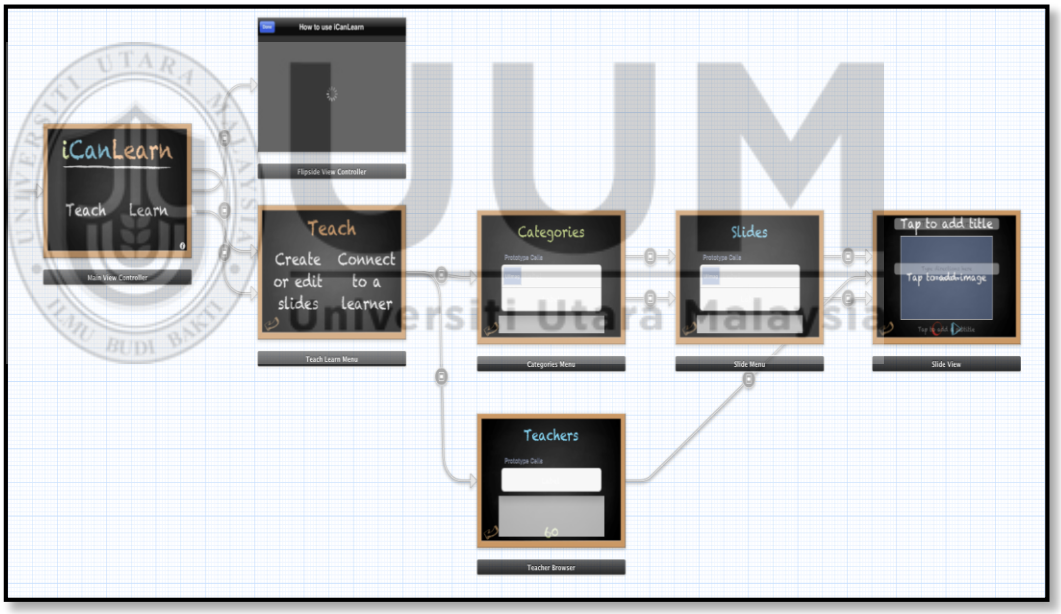

Figure 2.5: Storyboard of iCanLearn (Bodine, Helal, Gu, & Mokhtari, 2015).

2.8.3 Proloquo2Go App

Proloque2Go is the most well-known of all the assistive communications apps on iPad. It is also one of the priciest. Still the $689 you spend ($500 for iPad and $189 for Proloque2go) is far cheaper than dedicated AAC devices. Proloque2Go is a full-featured augmentative and alternative communication solution for autistic children

who have difficulty speaking. Proloquo2Go has been designed to be extremely flexible. It is rich with vocabulary organized for beginning communicators on up to those who need a more complex core vocabulary (see Figure 2.6).

Figure 2.6: Vocabulary of Proloquo2go App (Minan, 2014).

For those who don't need symbol or photo support for each word, there's an option to type in messages with word prediction. Now is option of putting this app on an iPad2 or iPad mini. Proloquo2Go has been used successfully with individuals diagnosed with autism, cerebral palsy, Down syndrome, developmental disabilities, apraxia, stroke, traumatic brain injury, among others (Minan, 2014).

2.8.4 TapToTalk App

TapToTalk is an application that lets parents, teachers, and speech and language professionals (SLPs) turn handheld devices like smart phones and tablets into AAC (Augmentative and Alternative Communication) devices to help nonverbal and partially verbal children communicate, that should serve as an effective AAC service for most children with autism. Applications for AAC are often Picture Exchange

Communication (PECs) based interactive applications designed as communication solutions to help individuals whom experience difficulties in speaking to express their needs using pictures and/or typing coupled with automatically generated spoken dialog. Application in this domain include TapToTalk, as shown in Figure 2.7 (Al-Arifi, Al-Rubaian, Al-Ofisan, Al-Romi, & Al-Wabil, 2013).

Figure 2.7: TapToTalk Screen Shot (Islas et al., 2013).

TapToTalk turns an iPhone, iPad or iPod touch into an augmentative and alternative communication (AAC) device. TapToTalk makes communication fun, like another "game" on this cool device. Just tap a picture and TapToTalk speaks (see Figure 2.8) (http://www.taptotalk.com). Each picture can lead to another screen of pictures. This free TapToTalk app allow users to choose among different sets of AAC albums based on the needs of the non-verbal child or adult. Samples albums are available for children and adults and in different languages; including English, Spanish, French, German and Italian. TapToTalk is a must have app for special needs children with autism, down syndrome, cerebral palsy, apraxia and other speech delays.

Figure 2.8: TapToTalk home page

In addition, you can take the photos and edit the names. Similarly, you can record with the microphone of the device your sound and be able to use it almost instantly (Islas, González, & Mejía, 2013). A few factors may contribute to the mastery of the use of the application. The images on the screen are very large making it easier for the participants to see the items as well as the ability to correctly press each item without accidently hitting another (Strickland, 2011).

2.8.5 AAC Speech Communicator

AAC speech communicator is a pictogram-based application for autistic children with speech disabilities as displayed in Figure 2.9; it is basically a mode of communication that formulates grammatically correct sentences using a list of pictograms and reads them (text-to-speech) (Lorah, Tincani, Dodge, Gilroy, Hickey, & Hantula, 2013).

The main purpose of both the apps is to facilitate the autistics in communicating. Moreover, another positive feature of AAC Speech Communicator is the large number of categories that help autistics communicate in a better way (Khan, Tahir, & Raza, 2013).

Figure 2.9: ACC speech communicator (Khan, Tahir, & Raza, 2013).

It is different from most of existing products by being free, by its grammatically correct natural language generation features (inflection, tenses, using the setting user gender to alter first person sentences one and more) and by usage of gesture search on mobile phones where keyboard is not reliable because is small screen. The application includes 5000 icons obtained from arasaac.org, where 900 are properly categorized, and others are accessible through search. It supports French language well, and there is an early prototype for English too (Khan, Tahir, & Raza, 2013).

2.9 Summary

As a conclusion, this chapter is explained the substantial increase in prevalence rates for ASD over the last years has sparked debate regarding cause and critical need for effective services. Also, basic concepts that related and can applied to help disabilities children with Autism especially in education field. To design a more effective and attractive edutainment game application. It also has reviews some related literature

about assistive technology and mobile applications with the highlight at some of the existing apps, as a platform to help in the design of edutainment app to improve the communication skills for autistic children. However, the currently available mobile applications intended to aid learning for individuals with autism are difficult to use. To increase the probability of successful learning in autistic children, the app design for autistic children will need to meet a set of design principles. These principles based on Interaction Design (IxD), can be implemented to help through this development process.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section will be dealing with the research's methodology. The methodology's steps include the following: the awareness of the problem, suggestion, development in addition to the evaluation and conclusion. The methodology of the research is not merely collecting methods in order to perform a research, it is a way that is designed systematically for the sake of providing solutions to the problems (Kothari, 1990). In addition, this chapter will talk in details about the ways adopted in achieving the objectives mentioned in chapter 1 (Vaishnavi & Kuechler, 2007). The method seeks to build and estimate the IT artifacts in order to meet the needs of humanity, this method - in particular - pays attention to the process of constructing artifacts besides the design of the final product (Henver & March, 2004).

3.2 Research Procedure

The design began with the awareness of the problem, the existing knowledge is used to provide suggestions for its solutions, afterwards a trial is made for the artifacts implementation, which relies on the solutions that were suggested. This phase of the research is called the development stage in this methodology. The functional characteristics whether they were implicit or explicit in the suggestion are used so as to evaluate the implementations i.e. if those implementations were partially or fully successful. The research process effort accomplish repeatedly the development, evaluations and the suggestions. The arrow of circumscription show us the way the iteration ranging from being a cycle that is partially completed to the problem awareness. At the end, the conclusion presents the end of the specific design research.

Moreover, the study's comprehensive research design is shown in Figure 3.1, depending on design science methodology.

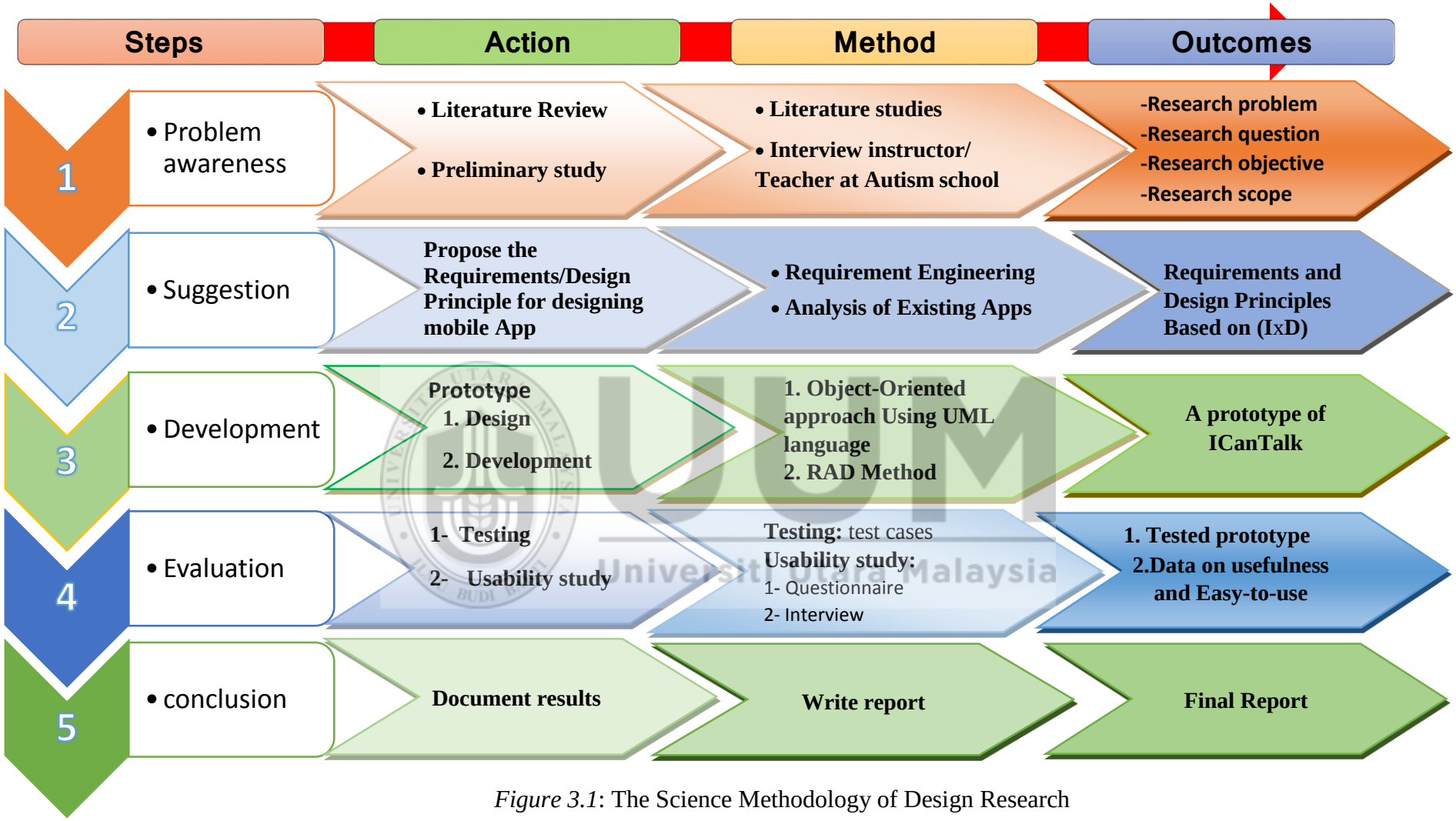

Figure 3.1: The Science Methodology of Design Research

3.2.1 Awareness of the Problem Phase

The first phase of the methodology involved understanding the research scope and objectives. Data were collected to gain more information regarding the main issue of the research, which was autistic children with communication impairments, and the current design of mobile apps. This was done by conducting a literature review and a preliminary study.

3.2.1.1 Literature Review

The document review technique complements the information gathered from primary sources (Kumar, 2005). Documents are quite significant in all studies due to the fact that they are a good source of knowledge and the pure evidence provided by them facilitates an easy and smooth research (Patton, 2002). Documents can be categorized into journals, conference proceedings, websites, books and other documents related to the topic of interest (Shittu & Jaleel, 2009).

3.2.1.2 Preliminary Study

The preliminary study involved conducting interviews. The gathering of information about user requirements can be done through direct interviews (Huda Wahida, 2013; Hoffer, George & Valacich, 1999). To design an application for a user, the first step is typically to understand the users' condition and their requirements. According to Jacobson, Christerson, Jonsson and Övergaard (1992), the purpose is to capture the functional requirements of the stakeholders such as the instructors/teachers at schools or care centres for autistic children.

The survey involved the administration of face-to-face interviews with three teachers at Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis in Malaysia (see Figure (3.2)) (Chien, Jheng, Tang, Tseng, & Chen, 2015; Banire, Jomhari, &

Ahmad, 2015). The participants were asked some open-ended questions from an interview guide. This type of interview enables the researcher to ask additional questions that are not on the interview protocol. The responses to these types of questions may provide useful information that can be used to understand the research topic from different perspectives. The interviews were recorded using an IC Recorder device. The information gathered from the participants was recorded with their permission (D. Cohen & Crabtree, 2006). The data were collected through questions, as shown in Appendix A. These questions were adapted from (Chien, Jheng, Tang, Tseng, & Chen, 2015; Ahmad, 2013; Bradshaw, 2013; Baron-Cohen, Cox, Baird, Charman, Swettenham, & Doehring, 2000). Furthermore, the interview contained questions in relation to the respondents' experience in the education of autistic children and their usage of technology as a support tool to enhance their skills.

The interviews were important for information gathering at the beginning of the study (Wildemuth, 2009). The main benefits of the interview process was to support the qualitative data that had been collected, to assist in determining those problems that needed the highest priority, and to identify the components that should be taken into account in designing an edutainment app model for autistic children (Kaur, 2006).

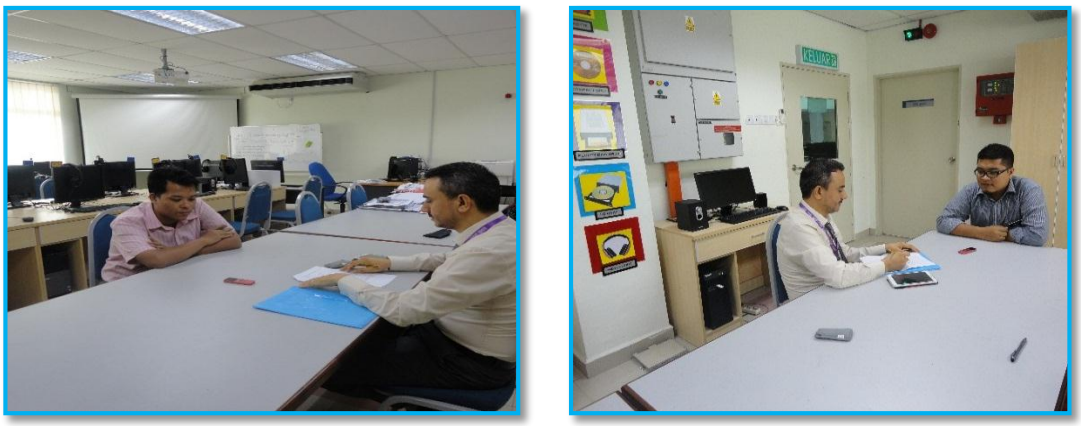

Figure 3.2: Teachers interview for data collection

The system calls for an information technology that will make it easier to capture, communicate, track, explore, verify, confirm, view, and manage the many hierarchical and interrelated requirements that are necessary for large or small systems (Barker, 2000). All requirements were documented after being collected. Model of requirement should be presented in an understandable way like modeling the requirement.

3.2.2 Suggestions Phase

The activities were carried out by forming appropriate suggestions. Furthermore, the related works in the literature were reviewed in order to gain a detailed understanding of the current mobile apps design. The analysis of the existing apps, as found in Chapter 2, was carried out to determine the appropriate design principles of the Edutainment app for autistic children with communication difficulties based on interaction design (IxD), particularly the apps discussed in Chapter 2, which serve as the basis for further studies into the principles, the details of which are given in Chapter 4. Through this method, Objective 1 of this study was achieved.

3.2.3 Development Phase

In the development phase, the prototype was developed and implemented. First, the designing was carried out. This included the designing tasks to ensure that the functions were properly arranged under the category of artifacts, such as (the use case diagram, active diagram, sequence diagram, class diagram, and state diagram). In addition, the database design was outlined for refinement purposes. In order to design the model, the UML (Unified Modelling Language), which is a graphical language for visualizing, specifying, building and documenting the artifacts of software-intensive systems (Booch, 2005), was used in this study. Besides that, the design principles that make the app easy to use were also taken into consideration through the analysis of existing apps.

From the start, it was obvious that in order to design such an app, it was necessary to gather as much input as possible from teachers in the field. This study employed the RAD method (Rapid Application Development) to develop the app. Martin (1992), in his book on Rapid Application Development, defines the key objectives of RAD as: high quality systems, fast development and delivery and low costs (Beynon-Davies, Carne, Mackay, & Tudhope, 1999). In addition, many mobile applications are developed using RAD in which multiple versions of the software are quickly developed, assessed by end users (Karthikeyani, 2011).

Compared to other methodologies, RAD generally improves user/designer communication, user cooperation, and user commitment, and promotes better documentation. Moreover, RAD promotes fast, efficient, and accurate method for system development (Hassan, 2012). Moreover, a number of people see RAD as a complete approach to information systems development in that it covers the entire life cycle, from initiation through to delivery (Beynon-Davies et al., 1999).

RAD methodology is use in this study to support the development of the edutainment app in a systematic and fast responses manner. Among the advantages are to assist developer to analyze requirements and design systems in an iterative manner, fast responses from users, and immediate fix the changes of system. This study was able to improve on various elements of the application during its stages of development. Thus, RAD methodology is suitable to support this study.

The development took place according to the artifacts. The prototype was run on a mobile device. The prototype mentioned in this study demanded conditions like the ones set out in Table 3.1, which facilitated the work and enabled interaction with the users.

In this study, reference has been made to apps that make use of the Android platform in their operation. Mobile devices like smartphones and tablets use an operating system which is known as Android (Simm, Ferrario, Gradinar, & Whittle, 2014).

The Linux Kernel is the basic Android used in their operating systems. The framework of the Android is made up of system services as well as libraries which supply graphics, inputs and application services (Andrus, 2015). Lastly, the content providers are given the chance to create custom interfaces to store and retrieve different kinds of data stores, like file systems or SQLite databases (Al-khafaji et al., 2013).

Eclipse is an integrated development environment (IDE). It is considered an open source software development environment (Murphy, Kersten, & Findlater, 2006). Eclipse has been written in Java, and is used as well for the development of apps in Java. The Eclipse environment is safe enough to encompass many projects within it. On the other hand, many files can be included within a project. The editor is considered to be user-friendly, while the auto complete property presents a whole syntax while typing (Tigrek, 2012).

Table 3.1

Prototype Development Environment

Prototype Development Environment	
Program language	Using Eclipse tool for Java programming language
Operating System	Android platform
Database	SQLite
Deployment	Play store

The development of the prototype was completed before the start of the actual data collection. At this phase, Objective 2 of the study, which was to design and develop a mobile app for autistic children, was achieved.

3.2.4 Evaluation Phase

A test cases and usability test is one of the basic methods in the evaluation phase because it requires users to use the product. The moderator of the test gives predetermined tasks one at a time to the test user who in turn performs the tasks with the user interface (Daradkeh, 2010; Nielsen, 1994). In this study, the user satisfaction was evaluated through the execution of the prototype. Meanwhile, the performance of the app was determined through the requirements that involved two sections: Prototype testing and usability study methods.

The test case method was used to acquire feedback about the functionality of the prototype. Functionality tests were executed to ensure that the prototype functioned as desired. The tests were carried out by the developer of the prototype.

Usability is an important characteristic of a product (Tahrina, 2012). According to Nielsen (1994), usable systems are often easy to learn, efficient, not prone to error, and provide satisfactory service, thus helping to increase productivity, reduce costs, and improve user satisfaction. Usability testing is an evaluation method for measuring how well users can use a specific software system.

It provides a third-party assessment of the ease with which end users can view the contents or execute an application on a mobile device. An effective usability test must be able to elicit feedback from users as to whether they can use an application without (or almost without) difficulty and how they like using the application, as well as evaluate the levels of task performance achieved by the users (Nayebi, Desharnais, & Abran, 2012; Wang, Ofsdahl, & Morch-Storstein, 2008).

Numerous methods have been suggested for testing the usability of apps (Thompson, McClure, & Jaeger, 2003). The usability methods employed in this study were by way

of questionnaires and interviews (Hussain, Mutalib, & Zainol, 2014; Rivero, Kawakami, & Conte, 2014). A total of 10 teachers, and 5 autistic children between the ages of 5 to 7 with communication difficulties from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis, were chosen to participate in this usability study (Skiada, Soroniati, Gardeli, & Zissis, 2014; Ribeiro,Araujo, & Raposo, 2014). At this stage, Objective 3 of the study was achieved.

3.3 Procedure

As mentioned above, this study applied the questionnaire and interview method. Before beginning the usability testing, the ICanTalk app was installed in a Samsung Galaxy Tab 4 mobile device model, which uses an Android operating system, and this was then given to the teachers. The teachers of the participants were given instructions on the use of the "ICanTalk" app [see Figure (3.3)]. Hence, the teachers were given detailed instructions so as to help the participants adapt to the new app [see Figures (3.4, 3.5)]. The teacher and the child sat together, and the child was given full control of the mobile device [see Figures (3.6, 3.7)].

Figure 3.3: Teachers being given instructions on the use of the "ICanTalk" App

Figure 3.4: The teacher being given instructions on how to use the new app

Figure 3.5: The teacher being given instructions on how to use the new app

Figure 3.6: One of the participants interacting with "ICanTalk" App

Figure 3.7: One of the participants interacting with "ICanTalk" App

This test required the researcher to visit the school a few times within a span of two weeks (a total of 4 sessions). Even though a fixed time frame was not given, approximately 10 to 15 minutes were allocated on each visit to each of the children to use the app (Hussain, Mutalib, & Zainol, 2014; Dehkordi & Rias, 2014). Then, a researcher asked the teachers of the participants to complete a questionnaire that included questions about their perception of the usefulness and easy to use of the ICanTalk app based on their observation of the children's interaction with the app during each session. These questions, adapted from (Chien, Jheng, Tang, Tseng, & Chen, 2015; Zaman & Bhuiyan, 2014; Khan, Tahir, & Raza, 2013; Salim, Zulkifli, Mohamed, Razak, & Saad, 2009) were used for the questionnaire method (refer to Appendix B). The questionnaire took an average of 10-15 minutes to complete.

According to Gunduz and Pathan (2013), a questionnaire is an easy, effective, and efficient way to gather data in scientific studies. It is a well-written set of questions to which respondents record their answers, usually within rather closely defined alternatives (Muhsen, 2011). Upon completion of all the questions, the responses of the participants from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis were coded to be analysed using the SPSS program.

The second method for the purpose of usability testing was by means of interviews to expand the supporting information and to increase the accuracy of the data on the usability of the app (Gunduz & Pathan, 2013; Frauenberger, Good, & Keay-Bright, 2011). A survey was included in this interview via questions which were directly administered to the teachers at Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis. An interview guide was used to ask open-ended questions of the participants. This type of interview enabled the researcher to ask additional questions that were not in the interview protocol. An IC Recorder device was used to record the interviews (see Figure (3.8)). The information gathered from the participants was recorded with their permission (Cohen & Crabtree, 2006). During these interviews, the teachers were asked concerning the extent to which the autistic children responded to the ICanTalk app in order to get feedback through the teachers' observations of the autistic children's interaction with the app during each session. In addition, the questions that were asked in this interview would help the researchers to estimate the teachers' perspective of this app. This would provide rich data regarding the prototype and its effect on the children. All the above data were collected by means of the questionnaire and interview methods, as exhibited in Appendices B and C. Finally, all the data and results were discussed in chapter 6.

Figure 3.8: Interview of teachers for usability test

3.4 Sampling

The usability tests involved in this study were conducted by means of questionnaires and interviews. In 1993, Jacob Nielsen explained that the benefit of small sample sizes is simply the return on investment since testing costs tend to increase with each additional participant in the study. Because 5-6 participants will encounter 80% of usability problems, there is little additional benefit to running more than 5 to 6 people through the same study (Lyan, Amjad, Shaden, & Khalid, 2015). A total of 10 teachers, and 5 autistic children between the ages of 5 to 7 years with communication difficulties from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis were chosen to participate in the usability test. 10 teachers at the autism school took part in the questionnaire method (Hussain, Mutalib, & Zainol, 2014; Skiada, Soroniati, Gardeli, & Zissis, 2014; Fagan, 2013; Faulkner, 2003). The interview was conducted by the researcher with 3 teachers at Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis (Chien, Jheng, Tang, Tseng, & Chen, 2015).

3.5 Instrumentation

The measurement instruments used for this study were the functionality tests, questionnaires and interviews. The data were gathered by the interview and questionnaire methods. In short, the evaluation in this study included:

i. Evaluating the functionality: Six items were adopted in the questionnaire (Daradkeh, 2010) to test all the functions in the ICanTalk app. Each function in the prototype was tested to ensure that the prototype functioned as desired.

ii. Evaluating the usability: The interview method was undertaken with three teachers at Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis. The interviewer followed the specified interview questions for the interview session (refer

Appendix C). These questions were adapted from (Chien, Jheng, Tang, Tseng, & Chen, 2015; Zaman & Bhuiyan, 2014) and focused on their perception of the impact that the ICanTalk app had on the child's communication skills.

The questionnaire method was targeted at obtaining the teachers' perception towards the app (Gunduz & Pathan, 2013). The questionnaire method for data gathering (detailed in Appendix B) started with three sections (Sections A, B, and C). Section A was for the demographic data, Section B was for the measurement of the perceived usefulness, while Section C was for the measurement of perceived easy to use. Moreover, these questions were adapted from (Chien, Jheng, Tang, Tseng, & Chen, 2015; Khan, Tahir, & Raza, 2013; Salim, Zulkifli, Mohamed, Razak, & Saad, 2009) . All the questions in the questionnaire were measured using the Likert Scale format ranging from 1 to 5 (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree) (Agha, 2015; Hussain, Mutalib, & Zainol, 2014; Marcus, 2014).

3.6 Data Collection and Analysis

Data were collected from the users when they carried out the tasks referred to by the prototype and usability testing. After the participants had used the app, the data were gathered by means of questionnaires and interviews with the teachers at the autism school to gauge their understanding and perspective of the ICanTalk app. This provided rich data regarding the app (Ribeiro, Araujo, & Raposo, 2014; Teoh, Ong, Lim, Liong, & Yap, 2009). Data analysis can be defined as the process whereby the data is investigated, cleaned, transformed and modelled with the objective of finding constructive and practical information that is helpful in making a conclusion and arriving at a decision (Deetz, 2001). It can also be defined as the process of

systematically detailing and arranging the gathered data. In this study, the SPSS was utilized for the quantitative data analysis.

3.7 Reliability Test

The reliability of the usability evaluation questionnaire was addressed. The most common method of estimating the reliability of questionnaires is to use Cronbach's coefficient alpha (Alzaza & Zulkifli, 2007), which estimates the consistency of the items that are included in a questionnaire. It is usually expressed on a numerical scale beginning from zero (very unreliable) to one (extremely reliable) (Streiner, 2003). Thus, the values of Cronbach's alpha were calculated using the statistical package for social science (SPSS) version 20.0 to determine the data inter-item reliability, which assesses the degree of internal consistency between multiple measurements of a dimension. The instrument was able to gather the intended data because the Cronbach's alpha values for usefulness and easy to use were 0.881 and 0.885, respectively, indicating that it was highly reliable (Cronbach's alpha greater than 0.7). Thus, these measures satisfied the internal reliability criterion (Muhammad Firos, 2014; Coakes & Steed, 2009; Salim, Zulkifli, Mohamed, Razak, & Saad, 2009).

3.8 Summary

This chapter outlines in detail the methodology that this study has gone through. There are five stages, in which each stage involves activities and output. It reflects the objectives stated in Chapter 1. Moreover, the way to collect the data by using interview and literature review. Having explained about the methodology, the following chapter describes about the analysis involving the existing apps explained in Chapter 2 to determine appropriate design principle based on interaction design (IxD), for edutainment app for autistic children with communication difficulties.

CHAPTER FOUR

ANALYSIS OF EXISTING APPS

4.1 Introduction

This chapter analysed the existing apps available for people with autism in order to determine the design principles applicable to the app being studied based on IxD. While chapter two introduces about those apps, this chapter extends the discussion by identifying the basic principle in designing the components of edutainment system for autistic children with communication difficulties.

4.2 Interaction Design for Autistic Children

IxD is a field that focuses on design for user experience (UX). However, it is more geared towards complex dialogue between a human and an interactive device, in this case a mobile device (Aziz & Husni, 2012). IxD embodies three dimensions – form, content, and behaviour as depicted in Figure 4.1. A form represents the physical layout of the interface that includes among others colours, fonts, buttons, labels, figures. Content refers to what is being presented to user. Behaviour denotes how the content is presented to user and concerns with user experience and user's feeling after accessing the content presented (Aziz, Husni, & Jamaludin, 2013).

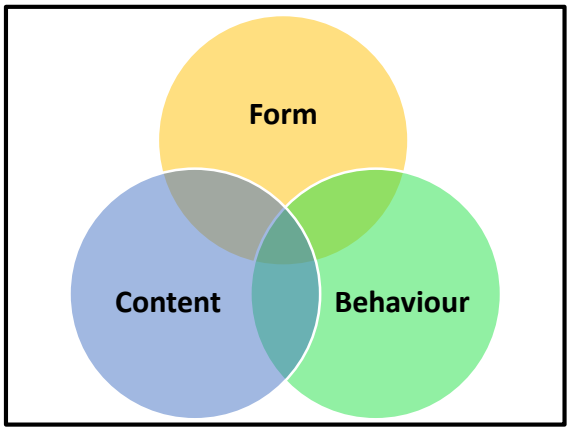

Figure 4.1: IxD dimensions with form, content, and behaviour (Cooper et al., 2007).

A good design often brings out positive feelings to users (Cooper et al., 2007). It is inline with core affect theory (Barrett, 2006) that suggested that positive affect should be realized from within the user for a maximum and effective effect of any application. Hence, a good design could help stimulate autistic children to improve their communication skills by providing an interactive interface, which is specifically designed to compensate their difficulties, in order to facilitate the process of learning.

4.3 Analysis of Existing Apps for Autistic Children

The typical first step to designing a mobile app is to understand the target users' problems and their requirements. To design a successful product for children with autism, it is recommended to learn from and understand other designs that have similar features (Nancy, Rasche, Qian, Visser, Zoltowski, & Qian, 2014).

To increase the probability of successful learning in autistic children, the app design (Edutainment app) for autistic children will need to meet a set of requirements. Best design principles can also be implemented to help through this development process (Kerssens-van Drongelen & Cooke, 1997). Hence, this study analysed the existing apps available for people suffering from ASD, which are stated in chapter 2 (CommApp, iCanLearn, Proloquo2Go App, TapToTalk, AAC speech communicator). The apps are analysed based on their advantage and disadvantage (Lyan, Amjad, Shaden, & Khalid, 2015; Khan, Tahir, & Raza, 2013).

From the analysis of existing apps for autistic children, an app design principles are proposed based on interaction design (IxD), that would fulfil the users' requirements in a better manner. The principles consist of high level design objectives and goals that guide the design decisions in the app development life cycle. The principles reflect knowledge and understanding around human training and behaviour.

The principles also provide non-ambiguous statements on specific conceptual decisions, which when followed should reflect the needs pertaining to physical artifacts (Mariage, Vanderdonckt, & Pribeanu, 2005).

The apps that were analysed in this study are selected from both iPhone and Android domain, and these are being used by individuals with ASD. This analysis will help an app designer in several ways (Dehkordi & Rias, 2014; Ahmad, 2013; Khan, Tahir, & Raza, 2013):

i. Identifying the existing products' features or aspects, which could be improved by either adding extra features to make its use easier/more comfortable or by changing its look to be more attractive to specific groups.

ii. Proposing a design principle for an app, which would lead to a better fulfilment of the users' requirements.

iii. Identifying technologies or ideas that are transferable or applicable to a new function or area.

4.3.1 CommApp

Comm App is an iPhone application based on the Applied Behaviour Analysis (ABA) principle. It is designed to aid autistic children with communication difficulties in meeting their essential desires and requirements. This basic communications tool has five categories: food, toy, clothing, drink, and emotions used with the help of voices and photographs, as shown in Figure 4.2 and 4.3 (Khan, Tahir, & Raza, 2013).

Figure 4.2: CommApp Screen Shot (Khan, Tahir, & Raza, 2013).

Figure 4.3 : Categories of CommApp (Khan, Tahir, & Raza, 2013).

The application's main purpose is to let non-verbal children communicate what they want quickly and easily. However, it can also be used as part of a child's therapy to teach basic language skills. The app is simple and fun to use through the colorful and intuitive user interface. Photo and Voice library containing over 100 actual photographs of food, drink, clothing and toys. Also includes 9 emotions and four common requests icons.

Advantages of Comm App:

This app offers these important features (Khan , Tahir, & Raza, 2013):

i. Appealing User Interface: users appreciated the colour scheme and comprehensive layout of the application.
ii. Users found it easy to navigate through the app and search for respective items.
iii. Effective mode of communication - users were of the opinion that if the issues of limited categories, vague interface, and unclear admin section and emotion icon were addressed properly this app could be very helpful for autistics.

Disadvantages of Comm App:

There are some notes about this app (Lyan, Amjad, Shaden, & Khalid, 2015; Khan, Tahir, & Raza, 2013):

i. The buttons specially the ones that takes user to main menu should be properly labeled.
ii. Vague Interface.
iii. There is no error message appears and help and documentation.
iv. More items should be presented.
v. Limited Categories: the categories classification should be broader.
vi. Admin Section unclear: this is basically the settings page but it does not clarify this ambiguity anywhere.
vii. The admin section should be password protected.
viii. Emotions icon – the icon needs to be labeled so that autistics can have a better understanding.

4.3.2 iCanLearn App

iCanLearn is a mobile flashcard application (App) which used for creating social stories for Autistic children. The app allows users to create personalized content using text, pictures and audio on their mobile devices (smart phones and tablets). Users of this application software can also share the content by connecting their devices over Wi-Fi (Bodine, Helal, Gu, & Mokhtari, 2015).

While specifically designed for children, especially those who suffer from an ASD or other social functioning impairments, this app is also useful for anyone at any age. Moreover, iCanLearn serves as a particularly helpful medium to overcome a common social obstacle among autistic children: it enables these children to learn without the condition of first requiring them to allow another person into their personal space as they review flashcards, as shown in Figure 4.4 (Alam, Magiera, & Ahamed, 2015).

Figure 4.4: Main menu of iCanLearn (Alam et al., 2015).

The workflow of the app is fairly straightforward. A user selects their role: Teacher or learner as shown in Figure 4.3, then they select whether or not they want to connect to another device or just view flashcards on the device they are holding. Finally, they select a category of slides and the slides they wish to view (see Figure 4.5).

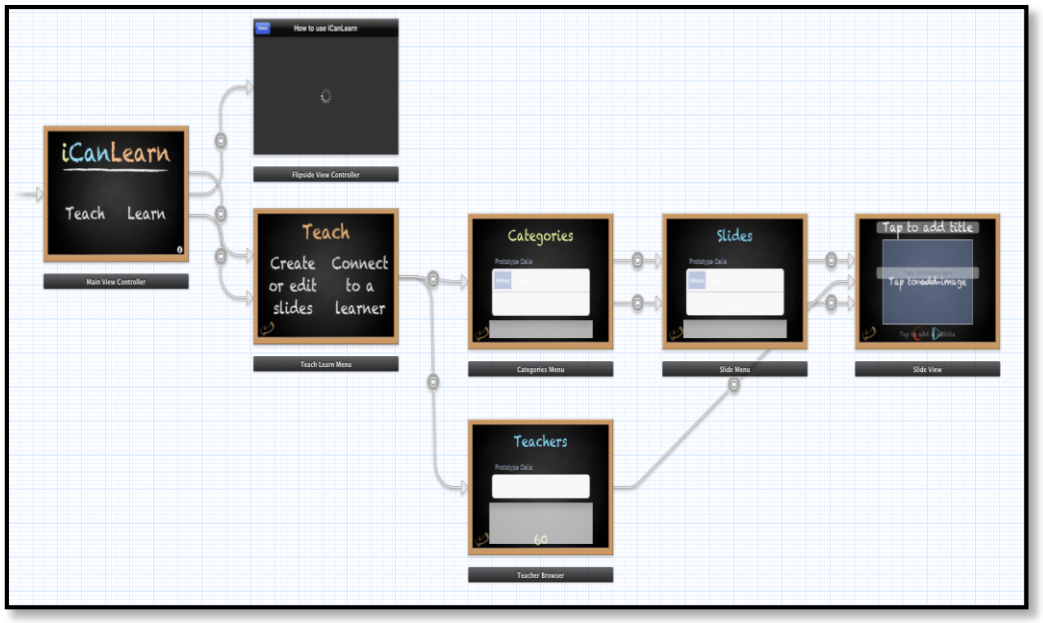

Figure 4.5: Storyboard of iCanLearn (Bodine et al., 2015).

The design idea for iCanLearn App is to use a design that most people associate with learning. Though it is going out of style at an ever-increasing rate, most people still recognize and can make the connection between a chalkboard and education. Therefore, a chalkboard theme was chosen for the app. A chalkboard graphic is utilized as the background for almost every screen (Bodine, Helal, Gu, & Mokhtari, 2015).

The design of text is essential in a flashcard app. It is probably the one thing that all flashcard apps have in common. The app contain two text fields: a title and a subtitle. The idea was that when you create the slides, you would type the title of the slide, and then type some directions or hints in the subtitle field.

The pictures of iCanLearn App implementing pictures was not as simple as one might expect. Much thought was directed at storing and retrieving the images. For example, storing the images in a Core Data, SQLite database would have a negative effect on the performance of the app, so instead, they are written to disk and a file path is stored as a string in Core Data. Furthermore, the app is giving users the ability to take their

own pictures right within the app as well as accessing stored photos on their device that they had already taken or downloaded from the Internet is essential. This presented a choice point of whether or not to compress and resize images.

The images had to be resized. If they were not, they looked pixelated when they were displayed on the screen. Another challenge to overcome was that the image view components displaying the images in the flashcards are sized differently depending on the device. On the other hand, the Audio of iCanLearn App are Recording and storing audio presented another set of choices and challenges (Alam et al., 2015).

The features in the process of development of the app are described below (Bodine, Helal, Gu, & Mokhtari, 2015):

Advantages of iCanLearn App:

i. Appearance and Text: the design theme for iCanLearn is simple and uncluttered. A sentence case with sans serif font was selected for ease of reading.
ii. Navigation: navigating the transition from screen to screen.
iii. Audio: as with the images, elected to store the audio on the device's hard drive and store the file path as a string in Core Data. Most of the audio being recorded was going to be spoken by users and played back by the tiny speakers of the mobile devices.
iv. Playback Control: standard playback symbols were chosen for the playback controls: triangle for play, square for stop, and circle for record. Buttons with words on them were not selected as they can cause problems when translating an app into another language.

The challenges in the process of development of the app are described below (Bodine, Helal, Gu, & Mokhtari, 2015):

Disadvantages of iCanLearn App:

i. The user interface design is difficult to use, especially the steps a user would take in order to view slides as a learner , Select "View slides" from the learn menu, Select a category, Select a slide) (See Figures 4.6, 4.7, 4.8 and 4.9).

ii. The user interface of iCanLearn App is not very comfortable. Black color is often found repulsive.

iii. Images: Implementing pictures was difficult due to trouble with the storage and retrieval of the images. For example, storing the images in a Core Data, SQLite database would have a negative effect on the performance of the app, so the images are written to a disk and a file path is stored as a string in Core Data.

iv. Users of this application software should share the content by connecting their devices over Wi-Fi.

v. The App language used in this application are designed for English-speaking children.

Figure 4.6: view slides as a learner (Bodine et al., 2015).

Figure 4.7: Select "View slides" from the learn menu (Bodine et al., 2015).

Figure 4.8: Select a category (Bodine et al., 2015).

Figure 4.9: Select a slide (Bodine et al., 2015).

4.3.3 Proloquo2Go App

Difficulty or inability to speak is a common symptom of autism. Augmentative and alternative communication (AAC) applications addressing such conditions are often Picture Exchange Communication (PECS). These are interactive applications designed as communication solutions to assist individuals who experience speaking difficulties. With these PECS-based apps, they could express their needs with the use of pictures and/or through typing along with automatically generated spoken dialogue. Among the PECS apps is Proloquo2Go (Al-Arifi, Al-Rubaian, Al-Ofisan, Al-Romi, & Al-Wabil,, 2013), an AAC software intended to teach children how to construct sentences with the use of symbols and pictures. Proloquo2Go also has the following features: text-to-speech function in American and British children's voices; word prediction; and customisable vocabulary and interface for different users, such as beginning communicators up to those who require a vocabulary with a more complex core as shown in Figure 4.10 (Gilbert, 2013).

Figure 4.10: Vocabulary of Proloquo2go App (Minan, 2014).

At present is option of putting this app on an iPad or iPad mini. Proloquo2Go has been used successfully with individuals diagnosed with autism, cerebral palsy, Down syndrome, developmental disabilities, apraxia, among others. However, there are some of advantages and disadvantages about this app (Minan, 2014).

Users of Proloquo2Go touch the screen of the iPad with their fingertips to select an icon of choice. The device then reads aloud the item in a voice that can be customized. The Proloquo2Go app also has several formatting options, allowing users to customize placement of icons, number of icons on the screen, and how to display an item (Ahmad, 2013). It is designed to grow along with the user. The multi-level Crescendo vocabulary offers three vocabulary levels in 23 different grid sizes. Users can easily transition as language skills expand whilst customizations are retained. Core words appear in the same location across folders to support learning through motor planning. Through an easy to use template system, these benefits also extend to user created folders. as shown in Figure 4.11 (Krcek, 2015).

Figure 4.11: To select an icon of choice (Krcek, 2015).

However, there are some of advantages and disadvantages about this app (Minan, 2014; Nancy, Rasche, Qian, Visser, Zoltowski, & Qian, 2014; Vass, 2010):

Advantages of Proloquo2Go:

i. Prevents accidental selections for users with motor impairments**.**
ii. The app grows with the user**.**
iii. Access to pre-recorded expressions and sounds.
iv. Natural sounding voices available.
v. It can be used to send emails, messages, tweets, and social media posts.
vi. Multi-user support.
vii. No internet connection is necessary.
viii. Simplify navigation by automatic Snapback to Home or Previous after making a selection.
ix. Keyboard available for text-to-speech option.

Disadvantages of Proloquo2Go:

i. More complex systems with larger vocabularies that behave as a text-to-speech program for higher functioning non-verbal individuals with Autistic children and other nonverbal disorders.
ii. Users are limited to images provided by the app.
iii. Limited word prediction with the text-to-speech.
iv. Core vocabulary is not research based.
v. Colour coding system for vocabulary is random.
vi. Organized around categories, difficult for novel sentence generation without extensive customization.
vii. Programming can be "fiddly" due to not being able to create individual user profiles easily.
viii. Only available for iOS devices.

4.3.4 TapToTalk

TapToTalk serves as an effective AAC service for a majority of children with autism. It is an application that enables parents, teachers, and speech and language professionals (SLPs) to turn handheld devices, such as smartphones and tablets, into AAC devices to assist nonverbal and partially verbal children in communicating. Applications for AAC are often Picture Exchange Communication (PECs) based interactive applications designed as communication solutions to help individuals whom experience difficulties in speaking to express their needs using pictures and/or typing coupled with automatically generated spoken dialog. Application in this domain include TapToTalk, as shown in Figure 4.12 (Al-Arifi, Al-Rubaian, Al-Ofisan, Al-Romi, & Al-Wabil, 2013).

Figure 4.12: TapToTalk Screen Shot (Islas et al., 2013).

The App is available free for iPhone, iPad and Nintendo, as well as an App for the computer. However, these only come with a basic starter album that contains a very limited set of phrases as shown in Figure 4.13. In order to utilize the full customizable functions and be able to use your own pictures and create personal albums to fit adult

persons, you have to subscribe to the service, which is $99.95 a year, per person. Compared to some of the pricing of other communication apps, and considering the possible long term use of the App, this is more expensive than some of the other apps available (Islas, González, & Mejía, 2013; Strickland, 2011).

Figure 4.13: TapToTalk Screen Shot (Islas, González, & Mejía, 2013).

The use of the TapToTalk application with the iPad allows for pre-recorded human voice messages. The use of human voice may result in an increased likelihood that untrained community members in untrained settings may be more likely to respond to the TapToTalk - emitted communication attempts than if the pre-recorded message was played in a synthesized voice. In addition, you can take the photos and edit the names. Similarly, you can record with the microphone of the device your sound and be able to use it almost instantly (Islas et al., 2013). A few factors may contribute to the mastery of the use of the application. The images on the screen are very large making it easier for the participants to see the items as well as the ability to correctly press each item without accidently hitting another (Strickland, 2011). When the user clicks 'hungry', the voice says "I am hungry", and the user is directed to the next screen, which looks like this Figure 4.14:

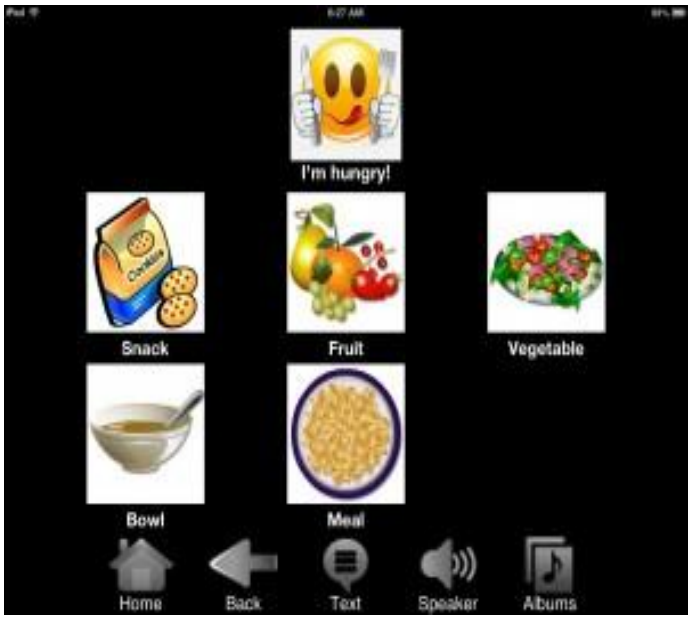

Figure 4.14: Screenshots of the flow for the category (Islas, González, & Mejía, 2013).

That screen allows the user to make a specific choice of food items from a field of five. Each choice from the main page directs the user to a more specific list from which to choose, allowing the user to express basic wants and needs. Research indicates that increasing communication in children with disabilities correlates with a reduction in inappropriate (sometimes aggressive or self-injurious) behaviours (Venkatesh, Phung, Duong, Greenhill, & Adams, 2013). However, there are some of advantages and disadvantages about this app (Lyan, Amjad, Shaden, & Khalid, 2015; Islas, González, & Mejía, 2013; Vass, 2010).

Advantages of TapToTalk:

i. TapToTalk is an app that allows children with limited verbal abilities to communicate.

ii. Free version available allows you to try before you buy.

iii. Free to download sample, then need to purchase TapToTalk Designer for $99.95 USD per year (subscription).

iv. The parents or teachers don't need to have an Internet connection to get the photos uploaded.

v. It has the basics categories of communication and has prerecorded sounds of the pronunciations.

vi. Simple navigation buttons.

vii. Has 2,000 symbols available as well as ability to import your own.

viii. Computerised speech in the free sample.

ix. Record own speech in the TapToTalk Designer.

x. Available on iPhone, iPod Touch, iPad.

Disadvantages of TapToTalk:

i. No Message/Text window limiting sentence construction or symbol combinations, e.g. "I want" + "drink".

ii. Limited to 8 choices per page and portrait mode only on the iPhone and iPod Touch.

iii. It doesn't have the option for loading the photos, just the icon that will allow this.

iv. Yearly subscription fee.

v. Upgrade for $99.99 and then can design own boards/albums.

vi. Very limited amount of symbols.

vii. Using 'web-based' editing to create your pages (Albums) which means there is no direct access to using your devices in-built camera.

viii. You can't edit the grid (page) layout in the free version

ix. Colourful symbols (no photos).

x. Confused by the variety of pictures representing sadness.

xi. The sounds of words are unclear.

xii. Older children who could read the text under each pictures selected the right picture much more quickly and easily than younger ones.

xiii. To formulate the sentence using pictures only. Younger children are similar to autistic children in this case because autistic people are visual learners and all have to rely on pictures to formulate any sentence.

xiv. Main disadvantages for Tap-to-Talk, as "center picture inside each category" is distracting the users.

4.3.5 AAC Speech Communicator

A pictogram-based application designed for autistic children with speech disabilities as displayed in Figure 4.15, AAC Speech Communicator is essentially a mode of communication that can formulate and read (text-to-speech) grammatically correct sentences utilising a list of pictograms. Its key purpose is to facilitate autistic children's communication. In addition, the AAC Speech Communicator has another positive feature: it has a huge number of categories that can assist autistics to communicate better. This includes 1000 icons, which are categorised and search-accessible. Language-wise, the app has a prototype for English and supports French fairly well (Khan, Tahir, & Raza, 2013).

Figure 4.15: ACC speech communicator (Khan, Tahir, & Raza, 2013).

Communicator developed as part of e-Accessible service system runs on iOS tablet devices (iPad and iPad 2) and can show 6, 12 or 20 symbols at once, using one of three pre-defined open source galleries. Communicator is designed to support multiple users on one device as well as one user on multiple devices. Moreover, easy-to-learn communication tool for anyone with speech disabilities, which forms grammatically correct sentences when a series of pictograms are clicked and then speaks them aloud (text-to-speech). Because of the pictograms, this tool is especially good for children or those who have limited reading and writing abilities, as well as, other features include (Khan, Tahir, & Raza, 2013; Blagajic, Semanjski, Saric, Janda-Hegedis, Vuković, & Car, 2012):

Advantages of AAC Speech Communicator:

i. Good use of prepositions: preposition were used in such a way that it render the meaning of the sentence without any room for ambiguity.
ii. Huge number of categories: another positive feature of AAC Speech Communicator is the large number of categories that help autistics communicate in a better way.
iii. Proper sentence formulation: users appreciated the idea of proper sentence formulation.

However, on the contrary understanding the functionality of AAC speech communicator was not very easy for the users that related with some of problems into user interface design. On the other hand, the user faced more difficulties regarding its usability, especially that shows the main screen of the app (Khan, Tahir, & Raza, 2013):

Disadvantages of AAC Speech Communicator:

i. The user interface of AAC Speech Communicator is not very comfortable. Black colour is often found repulsive.
ii. Difficulty to Learn – Due to the monotonous user interface, the app showed poor learnability.
iii. Categorization – users were of the opinion that instead of so many categories dumped on the main screen, they should be handled in a precise and understandable manner.
iv. Crashes: the application crashes immediately when user taps on its icon after first installation. Such situations need to be handled.
v. Users suggested that there should be an option for them to add custom images and audio to help recognize familiar people and locations like family members, home, school, etc.

On the other hand, to develop mobile apps for autistic children there are numerous of researchers highlighted various principles to help designer to design and implement the application that better fits the needs of the target group (Children with Autism). They are:

i. A monotonous user interface causes poor learnability (Zapata, Fernández-Alemán, Idri, & Toval, 2015; Ribeiro, Araujo & Raposo, 2014; Sahin & Cimen, 2011).
ii. The color black is often found to be repulsive (Zapata et al., 2015).
iii. Texts should be easily understood to avoid confusing terms or actions (Zapata et al., 2015).
iv. Too much information or commands on a single screen should be avoided (Zapata et al., 2015).

v. Guided Interfaces: Difficulties may be reduced by using a small set of answers from which one has to be chosen (Ribeiro, Araujo & Raposo, 2014).

vi. Visual Interfaces: People with autism often have impairments in abstract thinking and in paying attention, and ease in concrete thinking, memorization and in understanding visual spatial relationships. They usually learn easily through visual representations (Iyer & Kalbande, 2014; Marks, Hegwer, Schrader, Longaker, Peters, Powers & Levine, 2003).

vii. Real Images: use of images as close to real objects / situations as possible, instead of infantile or cartoon style images (Ribeiro, Araujo & Raposo, 2014).

viii. Use less words and more images for instructions (Iyer & Kalbande, 2014).

ix. Rewards of the system in case of achievement of a certain task can be selectable by teachers, thus the teachers have a chance to select most appropriate digitized rewards (voice, picture, animation) from their repository for each individual (Sahin & Cimen, 2011).

x. Customized Environment: Each autistic child has particular skills and characteristics (Ribeiro et al., 2014).

xi. Use of Tutor: A tutor is used to guide the user through the App. He explains how the app works and presents the tasks that have to be accomplished by the players (Zapata, Fernández-Alemán, Idri, & Toval, 2015; Ribeiro, Araujo & Raposo, 2014; Iyer & Kalbande, 2014).

xii. Communication based on the Picture Exchange Communication System (PECS): This is a system based on images specifically developed for children with impairments in communication. Through it, children can communicate creating sentences by selecting pictures which represents objects and actions – a card "I want" and a card "Eat" (Ribeiro, Araujo & Raposo, 2014).

In addition, many children with ASD learn functional communication with the PECS that is a pictorial symbol based system that was developed for children with communication deficits (Nancy et al., 2014). The system uses basic behavioral principles and techniques to teach children functional communication by using cards with symbols to represent the meaning instead of using verbal words (Wendt, 2012).

xiii. No assessment: Children love to play games. An educative game cannot be a time killer. Instead, it should contribute to the child's growth in some way. There should be some assessing parameter in the game to measure the child's growth (Iyer & Kalbande, 2014).

4.4 Design Principle of Edutainment Apps for Autistic Children

From the analysis of existing apps, this study has put forward proposed principles for an optimal design of a new edutainment system based on IxD. This design, which will combine the benefits for each applications, thus avoiding their existing issues, likewise made a number of design decisions to provide an app which better fits the target group's needs. The following are the recommendations of this study about proposed design principles for autistic children based on IxD, as shown in Table 4.1:

Table 4.1

Proposed Design Principles for Autistic Children Based on Interaction Design (IxD)

Dimension	Design Principles	Suitable Design
FORM	1. User Interface	Designed to be simple, without much visual stimuli, in order to maximize the chance of concentration, comprehension and learning of the children.
	2. Number of pictures	In each page, the number of pictures should be within the acceptable limit.
	3. Screen size	The screen size of the images should be made very large to make it easier for the users to see the items and to enable them to correctly press/tap each item on the screen without accidently hitting another icon/button.
	4. Icon	The icon of the home page should be easily distinguished.
	5. Colour	An alternative colour should be used since, often, the colour black is found to be repulsive.
CONTENT	6. Guide the user through the app	To guide the user through the app, a caregiver should be made available.
	7. Admin section	The admin section should be protected with a password.
	8. Picture Exchange Communication System	Communication should be based on the Picture Exchange Communication System (PECS), which uses images specifically developed for children with communication impairments.

	9. Audio	The audio aspects should correspond with the images. It should also be user-friendly and in an appropriate number.
	10. Language	The language used in this app should be given consideration.
	11. Upload photo	There should be an option for loading the photographs.
	12. Pronunciation	There should be a function enabling the pronunciation of the completely formulated sentence.
BEHAVIOUR	13. Evaluating parameter	There should be some evaluating parameter in the App to measure the child's growth.
	14. Image life	Having images identical to real life objects facilitates easier recognition and allows children to learn more efficiently and effectively.
	15. Navigation	There should be simple navigation buttons.

As denoted in Table 4.1, all three dimensions are covered. The form dimension lists five elements with their specific design styles – user Interface, number of pictures, screen size, icon, and colour. The content dimension comes with seven elements and design styles – guide the user through the app, admin section, PECS, audio, language, upload photo, and pronunciation. The behaviour dimension also encompass three elements together with their suitable styles – evaluating parameter, image life, and navigation. This study suggest that all the specified design principles for the three

dimension should be considered when designing for an Edutainment app for autistic children to improve their communication skills, and thus lead to more user satisfaction and learning success in the autistic user community.

4.5 Summary

This chapter analyses existing apps in order to determine the design principles applicable to the Edutainment app being studied. A total of Five apps were involved in the analysis. As outlined in the objectives of this study (stated in Chapter 1), identifying these design principles is important in designing the app. The analysis identified fifteen suggestions for the design principles. These suggestions concerned the following: user Interface; screen size; number of pictures; icon; colour; guide the user through the app; admin section; PECS; language; audio; upload photo; pronunciation; evaluating parameter; image life; and navigation. These recommendations are offered by this study towards designing and developing a prototype app for autistic children.

CHAPTER FIVE

APP DESIGN AND DEVELOPMENT

5.1 Introduction

This chapter explains the design and development of the mobile app prototype, based on the details in Chapter 4. It has discussed the list of functional and non-functional requirements and the specification for every use case. In addition, it has shown the use case diagram, activity diagram, sequence diagram, state chart diagram, and class diagram sequentially. Eventually, this chapter display the user interface design for app prototype.

5.2 Requirements of the Mobile App

The definition of app's requirements for the mobile app (ICanTalk) are the most significant phase to develop an accurate and useful application. Application's requirements divide into two main categories, which are as follow:

i. Functional requirements.

ii. Non-Functional requirements.

5.2.1 Functional Requirements

The functional requirements are the functions or techniques used, for app. They are given in Table 5.1 where:

- M: Mandatory.
- D: Desirable.
- O: Optional.

Table 5.1

Functional Requirement

No.	Requirement ID	Requirement Description	Priority
1	**ICanTalk_1**	**LOGIN**	
2	ICanTalk_1_1	The app display the mathematical equation after pressing on "Caregiver" hyperlink.	M
3	ICanTalk_1_2	Caregiver can login to his tasks page by type the result of equation.	M
4	ICanTalk_1_3	The app check the validation of the result and display the page of caregiver's tasks.	M
5	ICanTalk_1_4	The app will display the login page again and display the error message if the pin is wrong.	M
6	**ICanTalk_2**	**ADD TASK**	
7	ICanTalk_2_1	The app display the page of caregiver's tasks list.	M
8	ICanTalk_2_2	Caregiver select one of the app's activity.	M
9	ICanTalk_2_3	Caregiver select "Add Task" hyperlink.	M
10	ICanTalk_2_4	The Caregiver insert the number and title of instruction.	M
11	ICanTalk_2_5	Caregiver select specific photo from gallery or take photo.	M
12	ICanTalk_2_6	Caregiver can add audio comment to picture.	M
13	ICanTalk_2_7	Caregiver save the task with its audio comment on database.	M

14	**ICanTalk_3**	**DELETE TASK**	
15	ICanTalk_3_1	The app display the page of caregiver's tasks list.	M
16	ICanTalk_3_2	Caregiver select one of app activities to display its tasks.	M
17	ICanTalk_3_3	Caregiver select "Delete Task" button.	M
18	ICanTalk_3_4	The app display all the tasks under selected activity	M
19	ICanTalk_3_5	Caregiver can delete one of the tasks.	M
20	**ICanTalk_4**	**VIEW IMAGES INTERACTION**	
21	ICanTalk_4_1	The app display three icons for child's activities.	M
22	ICanTalk_4_2	Child can choose one of its activities.	M
23	ICanTalk_4_3	The app display the pictures under selected activity.	M
24	ICanTalk_4_4	The app play the audio comment with picture.	M
25	**ICanTalk_5**	**ASSIGN TASK**	
26	ICanTalk_5_1	Caregiver press on "Assignment" hyperlink.	M
27	ICanTalk_5_2	The app display buttons to select pictures and record the audio options.	M
28	ICanTalk_5_3	Caregiver select pictures for assignment.	M
29	ICanTalk_5_4	Caregiver record the audio as an option of answers and save the assignment.	M
30	ICanTalk_5_5	The app display existing assignments for child.	M

31	ICanTalk_5_6	Child do one of existing assignments in the database.	M
32	ICanTalk_5_7	The app display pictures of selected assignment and play the audios.	M
32	ICanTalk_5_8	Child select the right audio comment of displayed picture.	M
33	ICanTalk_5_9	The app can check correctness of the answers.	M
34	ICanTalk_5_10	The app display the message for result if it is right or not.	M

5.2.2 Non Functional Requirements

The non-functional requirement of application describes a pragmatic and methodical approach to application development and the measurement of quality attributes, such as usability, reliability and performance. The non-functional requirements of the app are shown in Table 5.2.

Table 5.2

Non-Functional Requirement

No.	Requirement ID	Requirement Description	Priority
1	**ICanTalk_6**	**RELIABILITY ISSUES**	
2	ICanTalk_6_1	The app should has the ability of handling a given tasks within a given period without errors and the app must be available and in operation all the real time.	M
3	ICanTalk_6_2	If the app crashed, it should behave perfectly normal when reuse again.	M

4	**ICanTalk_7**	**USABILITY ISSUES**	
5	ICanTalk_7_1	The app must be easy to use and design best user interface.	M
6	ICanTalk_7_2	The app should be easy to learn and remember.	M
7	**ICanTalk_8**	**RESPONSE TIME / SPEED**	
8	ICanTalk_8_1	The app should process the transactions in the lowest time. The actors may feel frustrated with the high speed.	M

5.3 Use Case Diagram

The use case diagram is one of modeling methods that formalizes the main functional requirements in the ICanTalk. Use case diagram describes what an application does from the standpoint of an external observer rather than how. The aim of use case is to understand the processes in what the app do and its functionalities. An actor is who involved in that task. In this study, there are two main actors, which are the caregiver (such as teacher or parents) (Banire, Jomhari, & Ahmad, 2015; Mintz, Branch, March, & Lerman, 2012) and child. The complete interaction between the app's functions and the actors are explained in Figure 5.1. The details of every use case such as description of cases, pre-condition, characteristics of use case, flow of events, post-condition, rules of use case, constraint sequentially, activity diagram, sequence diagram, state chart diagram and class diagram as explain in (Appendix I).

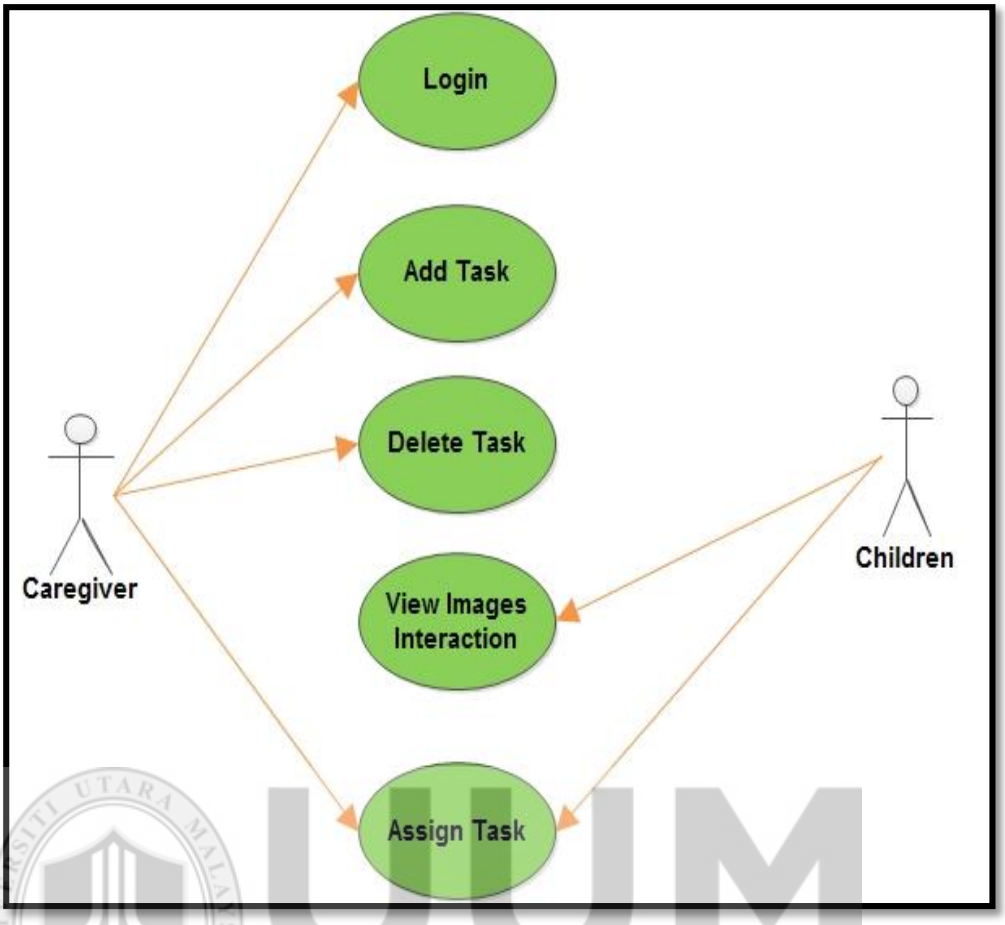

Figure 5.1: Use Case Diagram for ICanTalk App

5.4 Prototype Development

Generally, there are several principles of design for implementing a success and useful mobile app. For the purpose of design a mobile app for children with autism, the principles of design lead to produce an effective and creative app. However, these principles have been conducted and analysed in previous chapter in details. Therefore, the App of children with autism of this study has been designed depend on the results and decision of previous chapter. With the intention of development the prototype in this study, the JAVA development tools (JDT) has been used under Android platform, with SQLite for the database. In addition, the tool utilized to develop the prototype is Eclipse (IDE). Eclipse is a multi-language software development environment comprising a base workspace and an extensible plug-in system for customizing the

environment. However, the prototype app has been implemented all the functional and non-functional requirements. The functions and interfaces of the mobile app will discuss in details in the next section.

5.4.1 Home Page

The ICanTalk mobile app has been released with two different languages, which are Malay and English. Malaysian is a default language for app's appearance. Furthermore, at the ICanTalk app, staff in Language centre (University Utara Malaysia) translated the words from English into Malay Language (refer Appendix G). However, the home page has a language button to switch between app's language. As well, it has the entrance button to caregiver tasks, and the active picture, which is entrance to the tasks of children. All above function has shown in the following figures. Figures 5.2 and 5.3 show the home page of the ICanTalk App. It is seen that the app is available in Malay and English language.

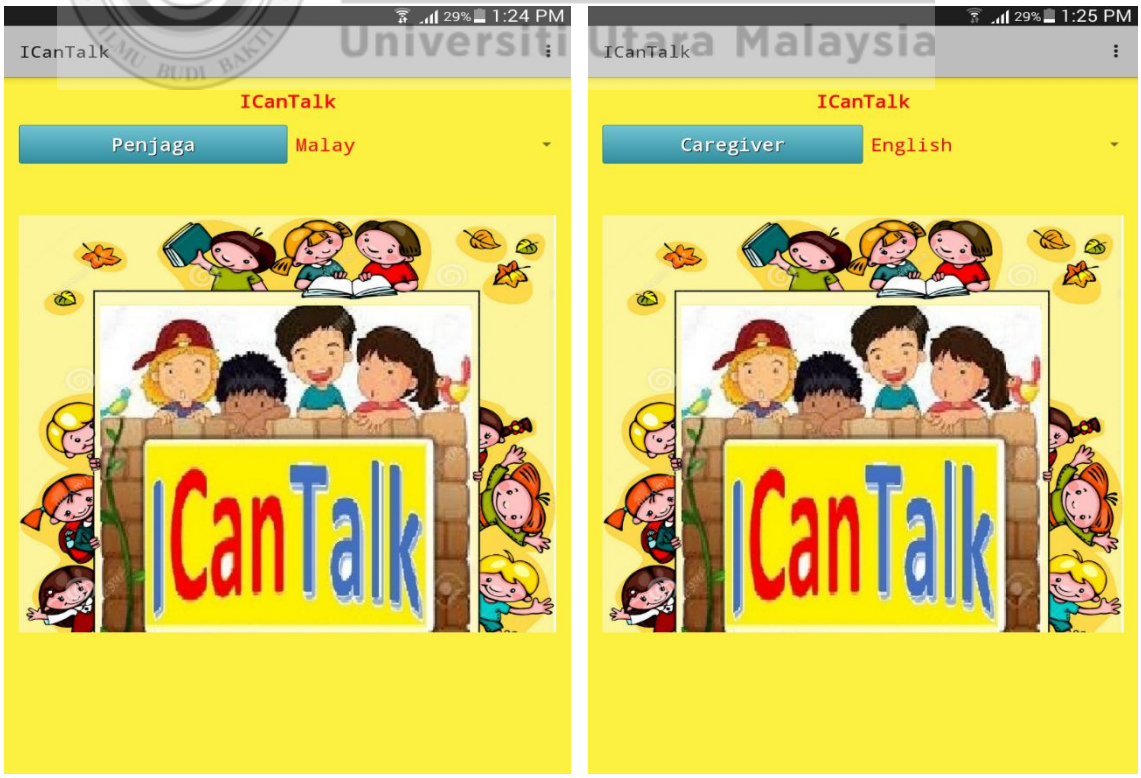

Figure 5.2: Main interface of the ICanTalk in Malay and English language

Figure 5.3: Screenshot of button to switch between app languages

5.4.2 Interaction Function Interface

The home page has the icon of main function of app, which is called interaction. It deals with the children to improve their communication skills by displaying a photos and play audio comment related to every photo and shows the main categories of photo. The prototype contains three categories that related for children main interface:

i. Daily special needs: Daily special needs approach deals with understanding the need and requirement of the children following the procedure of gathering requirements, through combine between Picture Exchange Communication System PECS and live photos. PECS, in which pictures are used to as a tool for communication to help children with communication difficulties, and frequently used to increase functional communication in autistic children (Christinaki, Vidakis, & Triantafyllidis, 2014; Boesch, Wendt, Subramanian, & Hsu, 2013).

ii. Safety instructions: Safety instructions approach deals with children learning and understanding the requirements through combine between Picture Exchange Communication System (PECS) and live photos.

iii. Assignment: This function is shared for both of caregivers and children. It is used to evaluate the performance and improvement of child's case.

The child chooses one of category activity from home page. Then, the app will display all the photos under selected activity. After pressing on the specific photo, the app display the photo on different page and play the audio, which related to selected photo. The figures 5.4 to 5.6 below shows the steps of this function.

Figure 5.4: Screenshot of children main interface in English and Malay language

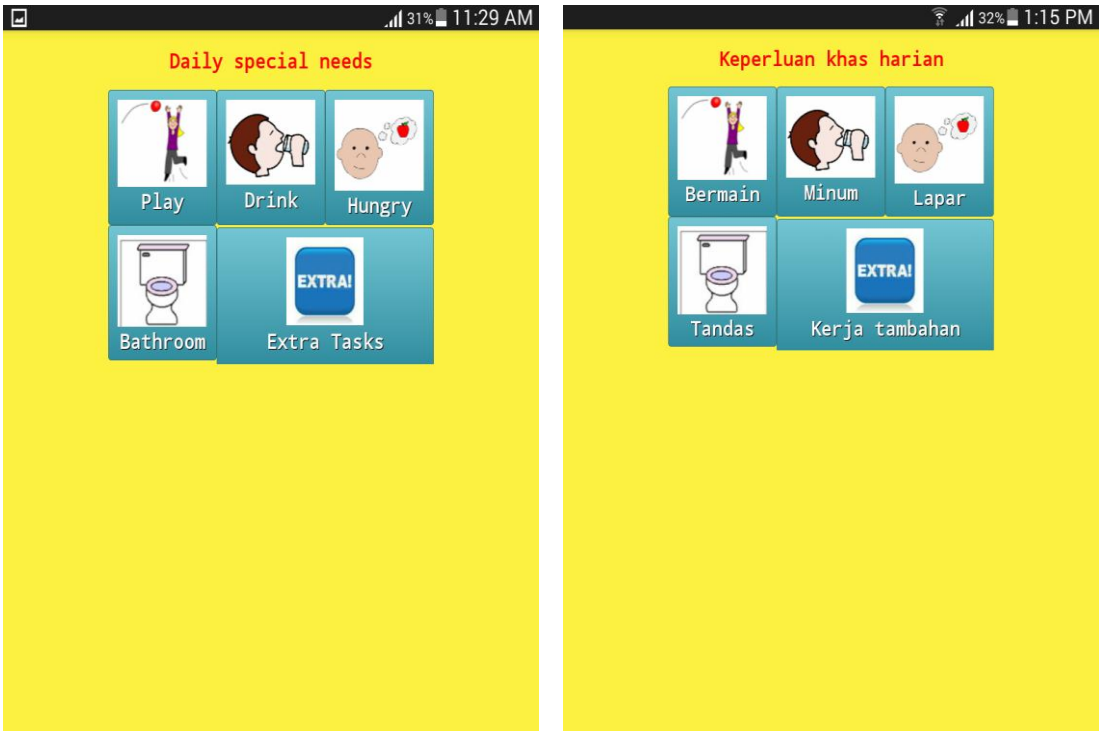

Figure 5.5: Screenshot of daily special needs categories in English and Malay language

Figure 5.6: Screenshot of Safety instructions categories in English and Malay language

5.4.3 Caregiver Tasks Interface

The caregiver is the second actor for the mobile app and they have many tasks to do. Firstly, the caregiver has to login to apply his tasks, therefor, the app display the login page which has a mathematical equation and the caregiver type the right result and press answer button to login. Then, the app will redirect the actor to his/ her tasks, which are, add task and delete task. The following figure shows the login page.

Figure 5.7: Screenshot of caregiver login in English and Malay language

1. Add Task

An add task function deals with insert new photo with its comment to app's database. It starts with identifying the target activity and press on add task button. The app display interface to get number and title of the new task. Later, the caregiver select a photo either from gallery or take a photo and add an audio comment to that photo and press insert button to save the photo to database. The following figures explain the steps of add task process.

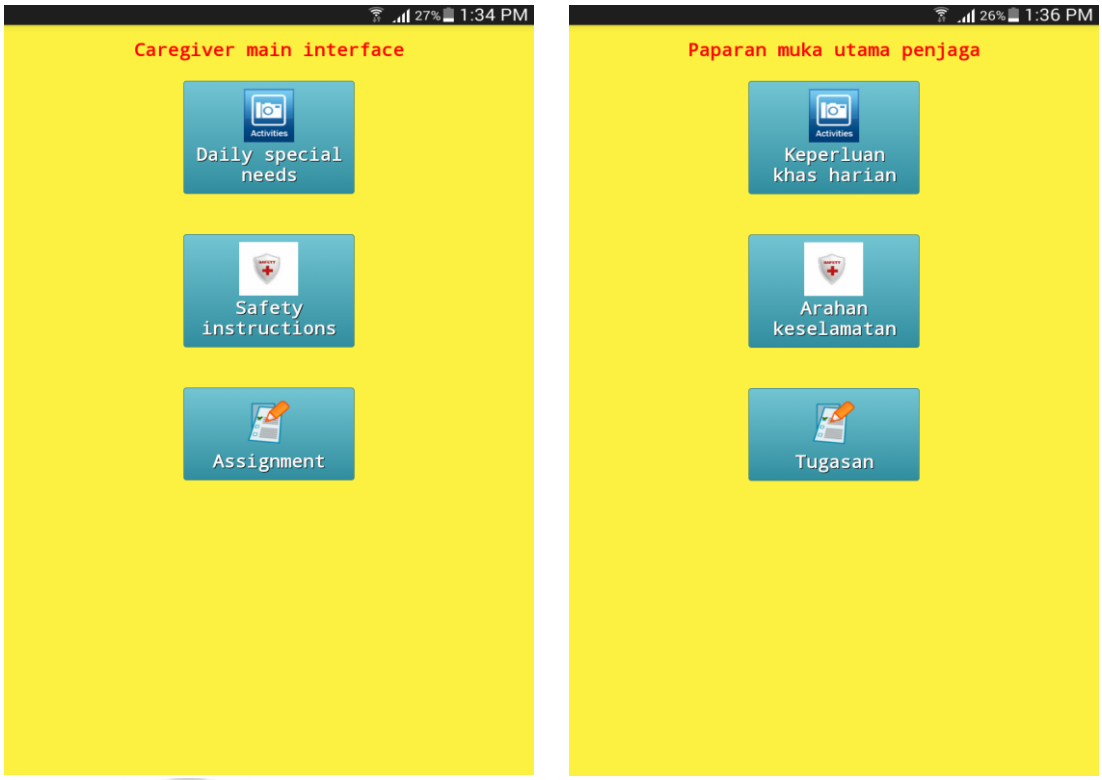

Figure 5.8: Screenshot of Caregiver main interface in English and Malay language

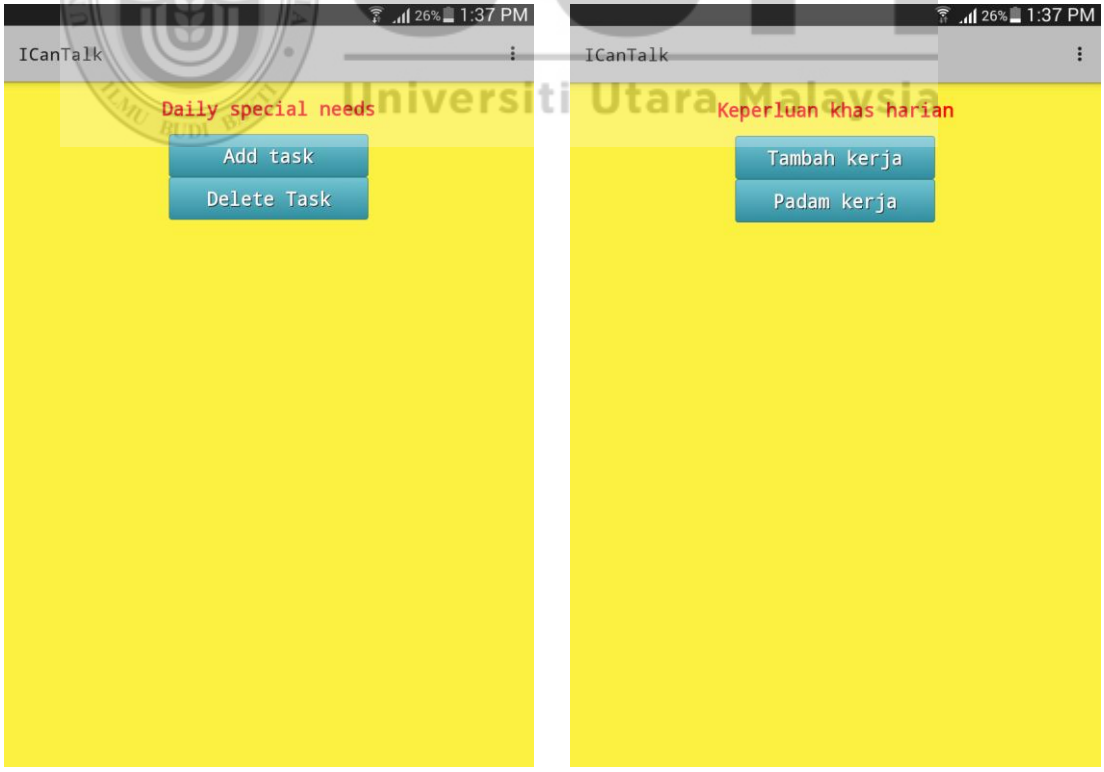

Figure 5.9: Screenshot of caregiver task in English and Malay language

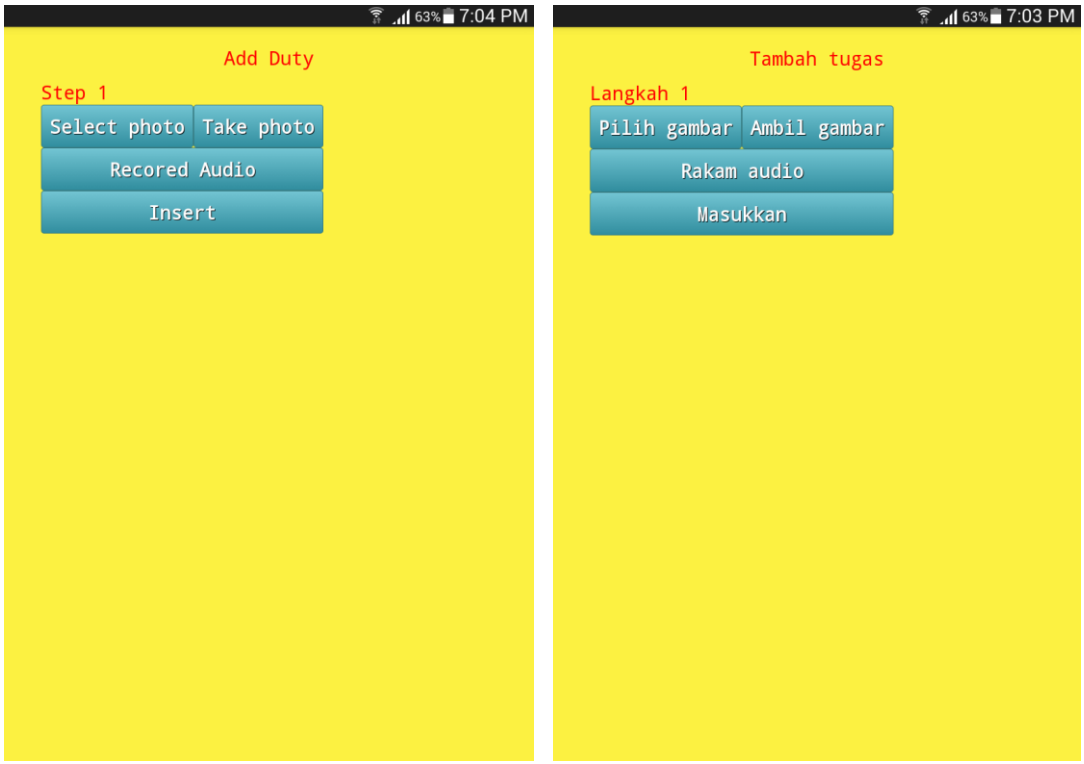

Figure 5.10: Screenshot of caregiver add task in English and Malay language

2. Delete Task

On the other side, the delete task function removes existing tasks from app's database. Later on, pressing on delete task button for selected activity, the app display all the tasks' titles with delete button in separated page. The caregiver click on delete button for specific task. The app deletes that task from the database permanently. The figures bellow is shown the interfaces of delete task processing.

Figure 5.11: Screenshot of caregiver delete task in English and Malay language

5.4.4 Assignment Function Interface

Finally, the assignment is a shared function for both of children and caregivers. For caregiver side, the caregiver press on assignment button from tasks list. The app display some buttons to select photos and record the audio as an answer options and identify the number right option for new assignment. Lastly, the caregiver click the insert button to save the new assignment in the app database. On the other side, the child select assignment task icon. The app display the existing assignments to select one. The app shows the photos of selected assignment with three audio options of answer. The child play the audio options and type the number of right option. The assignment function shows in the following figures.

Figure 5.12: Screenshot of caregiver add assignment in English and Malay language

Figure 5.13: Example of children view assignment screen page in English and Malay language

5.5 Summary

This chapter begins with an emphasis on the app ICanTalk requirements. Both are set functional requirements and non-functional. It is then translated into UML diagrams, including use case diagram, activity diagram, sequence diagram, state chart diagram, and class diagram consecutively. Having designed the App, a prototype has been developed to help autistic children to enhance their communication skills with other. Hence, the prototype has been explained with helps of snapshots.

CHAPTER SIX

EVALUATION

6.1 Introduction

The evaluation of the ICanTalk prototype, which is the third objective of this study, is discussed in this chapter. Usability testing and test cases were implemented, as outlined in Chapter 3, to determine the usability of the ICanTalk app (Nielsen, 1994). Data were gathered from interviews and questionnaires. The results are then discussed. The functionality test is essential to make sure that the app works as planned before testing its usability so that users will have a good experience when trying the app. The test case method was used for functionality test to determine all functions of the ICanTalk app. The testing process is also explained, and the results are then discussed.

6.2 Evaluation Procedure

The procedures for the usability test vary. The subsequent paragraphs explain these procedures in detail.

6.2.1 Test Cases

A very important stage during the cycle of software development is the test cases. Every case ends with the evaluation and verification process, through which all the errors are eliminated. The primary goal of testing is to identify and remove most errors in the system and to form a test suite that includes several test cases applied during the maintenance phase. Errors typically occur in the system during different stages (Hussain, Jomhari, Kamal, & Mohamad, 2014). Thus, testing should be implemented at various levels to check for errors that occurred during these phases. Test cases have been implemented by the ICanTalk developer. Every function of the prototype was tested. Questions were asked regarding the functionality of the ICanTalk app.

6.2.2 Usability Test

Interview and questionnaires were the usability test methods used in this study. The usability test was performed to make sure that children find the ICanTalk app to be useful and easy to use based on the requirements and design principles detailed in Chapters 4 and 5. Therefore, their perceptions on the usefulness and easy to use of the ICanTalk app were collected through their teachers by using the questionnaire method. The questionnaire involved a sample of 10 teachers from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis. Meanwhile, the study was also supported by interviews to expand the supporting information and increase the accuracy of the data on the usability of the app. The interview method was undertaken with three teachers at Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis.

6.3 Results

The results shown in this section highlight the results from the usability testing and test cases. Separate discussions are conducted for the results. The results for test cases are described first, followed by the results from the usability test.

6.3.1 Result of Test Cases

To ensure that the users are not distracted by any technical errors that may affect their experience, the functions were tried one by one in the ICanTalk app. The primary goal of the test cases was to collect information on whether the ICanTalk app passed or failed in terms of functionality, as explained in Table 6.1, which reveals the result of the test on caregiver login selection. The test results for all the app functionalities are shown in tables below.

Table 6.1

Test Case 1: Caregiver Login Functionality

Test Case1: The login process to the ICanTalk	**Priority(H,L):** High
Test Objective: Display the page of caregiver's tasks.	
Test Description: the test case 1 explains the login process. Caregiver can login to his tasks' page by type the result of equation.	
Requirements verified: Yes	
Test environment: Tablet Phone, Galaxy Tab 4, Android 4.4.2 and Eclipse IDE	
Test step/Pre Condition: 1. Caregiver press "Caregiver" hyperlink. 2. The app display the login page. 3. Caregiver type the result of displayed equation. 4. The app check the correctness of answer. 5. The app display the page of caregiver tasks.	
Actions: The actor (caregiver) types the right result and press "Answer" button.	**Expected Results:** The app display the page of caregiver's tasks.
Pass: Yes	**Fail:** No
Problem: Nil	
Notes: Successfully Executed	

Table 6.2

Test Case 2: Add Task Functionality

Test Case2: Caregiver Add Task	**Priority(H,L):** High
Test Objective: The app offers two ways to either choose a photo from gallery or take a live photo from real world.	
Test Description: Add task use case allow the caregivers to choose a meaningful photo, add an audio comment, and save it on the app database. The app offers two ways to either choose a photo from gallery or take a live photo from real world.	
Requirements verified: Yes	
Test environment: Tablet Phone, Galaxy Tab 4, Android 4.4.2 and Eclipse IDE	
Test step/Pre Condition: 1. The app display the activities' list of caregiver. 2. The caregiver press on one of activities. 3. The app display caregiver's tasks. 4. The caregiver press "Add Task" button to make new task. 5. The app display two choices to select photo for the task, from gallery or take live photo with record button. 6. Caregiver select specific photo via previous ways. 7. Caregiver press "Record Audio" button to add audio comment to photo. 8. Caregiver say the audio comment. 9. Caregiver press "Insert" button to save the audio. 10. The app will save the new task and back to the page of caregivers' tasks.	
Actions: The caregiver press "Add Task" button to make new task.	**Expected Results:** A new task has been made and saved in the app's database.
Pass: Yes	**Fail:** No
Problem: Nil	
Notes: Successfully Executed	

Table 6.3

Test Case 3: Delete Task Functionality

Test Case3: Caregiver Delete Task	**Priority(H,L):** High
Test Objective: Caregiver can delete one of the tasks.	
Test Description: This use case allows to caregivers to delete the existing tasks. Delete task display tasks activities to choose task and delete it.	
Requirements verified: Yes	
Test environment: Tablet Phone, Galaxy Tab 4, Android 4.4.2 and Eclipse IDE	
Test step/Pre Condition: 1. The app display the activities' list of task. 2. The caregiver press on one of those activities. 3. The app display the list of caregivers' tasks. 4. The caregiver press "Delete Task" button to delete one of existing task. 5. The app display all the tasks of selected activity with delete button. 6. Caregiver select a specific task and press "Delete" button to delete it. 7. The app will delete the selected task. 8. The app will save the changes and back to the page of caregivers' tasks.	
Actions: The caregiver press "Delete Task" button to delete specific task. Then, caregiver can delete one of the tasks.	**Expected Results:** The app will delete the selected task.
Pass: Yes	**Fail:** No
Problem: Nil	
Notes: Successfully Executed	

Table 6.4

Test Case 4: Interaction Functionality

<table>
<tr><td colspan="2">Test Case4: Children Interaction</td><td>Priority(H,L): High</td></tr>
<tr><td colspan="3">Test Objective: The app shows the categories for children.</td></tr>
<tr><td colspan="3">Test Description: This use case allows to children to shows the categories of app one by one depend on the activities' category and play the audio comment.</td></tr>
<tr><td colspan="3">Requirements verified: Yes</td></tr>
<tr><td colspan="3">Test environment: Tablet Phone, Galaxy Tab 4, Android 4.4.2 and Eclipse IDE</td></tr>
<tr><td colspan="3">Test step/Pre Condition:
1. The app display the home page of app, which has an icon for every task category.
2. Child press on the icon of any category.
3. The app display all the tasks under selected category as well as the tasks which created by the caregiver under extra tasks icon.
4. Child press on specific photo of selected category.
5. The app display the photo page and play the audio comment.
6. The app display the icon of main categories on the top of page.</td></tr>
<tr><td colspan="2">Actions: The child open the home page of app to interact with it.</td><td>Expected Results: The app display the icon of main categories on the top of page.</td></tr>
<tr><td colspan="2">Pass: Yes</td><td>Fail: No</td></tr>
<tr><td colspan="3">Problem: Nil</td></tr>
<tr><td colspan="3">Notes: Successfully Executed</td></tr>
</table>

Table 6.5

Test Case 5: Assignment Functionality

Test Case5: Assign Task (Caregiver Functionality)	**Priority(H,L):** High
Test Objective: Caregiver make an assignment.	
Test Description: This use case allows to the caregiver make an assignment by select some photos from gallery or take live photo and three options for the answer.	
Requirements verified: Yes	
Test environment: Tablet Phone, Galaxy Tab 4, Android 4.4.2 and Eclipse IDE	
Test step/Pre Condition: 1. The app display the tasks' list of caregivers. 2. Caregiver press "Assignment" button to make new assignment to test the improvement of children. 3. The app display all the photos. 4. Caregiver select some photos to make a new assignment. 5. The caregiver add three comments as an answer options and identify the right answer for every selected photo. 6. Caregiver press "Insert" button to save the new assignment to the database. 7. The app display the saved assignments.	
Actions: Caregiver press "Assignment" button to make new assignment to test the improvement of children.	**Expected Results:** A new assignment has been made and the child has done an assignment.
Pass: Yes	**Fail:** No
Problem: Nil	
Notes: Successfully Executed	

Table 6.6

Test Case 6: Assignment Functionality

<table>
<tr><td colspan="2">Test Case 6: Assign Task (Children Functionality)</td><td>Priority(H,L): High</td></tr>
<tr><td colspan="3">Test Objective: Child press on “Assignment” icon to do the test.</td></tr>
<tr><td colspan="3">Test Description: This use case allows to the children to do the assignment by choose the right option after checking all the options.</td></tr>
<tr><td colspan="3">Requirements verified: Yes</td></tr>
<tr><td colspan="3">Test environment: Tablet Phone, Galaxy Tab 4, Android 4.4.2 and Eclipse IDE</td></tr>
<tr><td colspan="3">Test step/Pre Condition:
1. Child press on “Assignment” icon to do the test.
2. Child choose one of these assignments.
3. The app display the photos of that assignment.
4. Child play the audio comments, which related to these photos.
5. Child select the right option and press “Answer” button.
6. The app display a message if the answer right or wrong.</td></tr>
<tr><td colspan="2">Actions: child go to the “Assignment” hyperlink to display existing assignments.</td><td>Expected Results: the child has done an assignment.</td></tr>
<tr><td>Pass: Yes</td><td colspan="2">Fail: No</td></tr>
<tr><td colspan="3">Problem: Nil</td></tr>
<tr><td colspan="3">Notes: Successfully Executed</td></tr>
</table>

After completed developing the ICanTalk app, the study tested the functionality of ICanTalk app and filled the test cases information, which illustrates the functionality of the ICanTalk to verification each function of ICanTalk app. The results of verification (as shown in tables above) show that the ICanTalk is functionality implemented in a way that is true and distinctive with high quality. Meanwhile the study found that the all hyperlinks for each tasks work perfectly.

The findings has shown in the previous paragraph that all caregivers and children were able to execute the tasks. This further illustrate that all functions in the ICanTalk work as desired, in supporting users' task provided in the App.

6.3.2 Results of Usability Test

The usability test method involved in this study are questionnaire and interview. Hence, the result of usability test begins with questionnaire method. Then, the results on interview method follow.

6.3.2.1 Results of Teachers Questionnaire

The questionnaire approach for data gathering starts with three sections (Section A, B, and C). Section A is for the demographic data. Section B is for the measurement of perceived usefulness. Section C is for the measurement of perceived easy to use.

A. Demographic Profile

The first section in the questionnaire focuses on the general information regarding the participant, including age, gender, and years of experience in teaching autistic students. A total of 10 teachers from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis were included in this study. Detailed results are shown in Table 6.7 and Figure 6.1. Six (60%) participants were female, whereas four (40%) were male. Based on the result, female teachers comprised a higher percentage than male teachers.

Table 6.7

Gender of Participants

Gander	Frequency	Percent
Male	4	40.0%
Female	6	60.0%
Total	10	100%

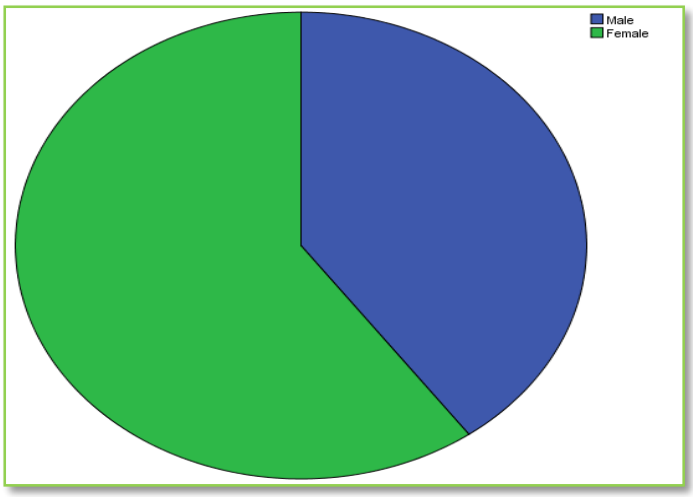

Figure 6.1: Gender of Participants

In Table 6.8 and Figure 6.2, shows that the most of the participants 5 were dominantly in the 29-36 age range, followed by 30% (3) participants between the ages of 37-45 years old, while remains from ages (22-28) and above 45 the same percentage (10%).

Table 6.8

Age Group

Age	Frequency	Percent
22-28	1	10.0%
29-36	5	50.0%
37-45	3	30.0%
Above 45	1	10.0%
Total	10	100%

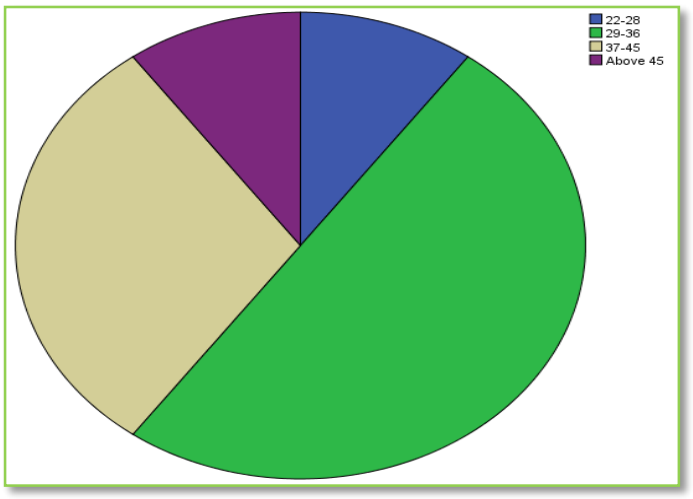

Figure 6.2: The age of participants

As far as the years of experience of the participants in teaching the autistic children, the table 6.9 and Figure 6.3 below, shows that the highest percentage for the years of experience between 5 to 10 and more than ten years are 80.0% with eight respondents. This is followed by respondents' experience in teaching between 2 - 5 years is 20.0% with two respondents.

Table 6.9

Years of experience in teaching

Years of experience in teaching	Frequency	Percent
2- 5 years	2	20.0%
5-10 years	4	40.0%
More than 10 years	4	40.0%
Total	10	100%

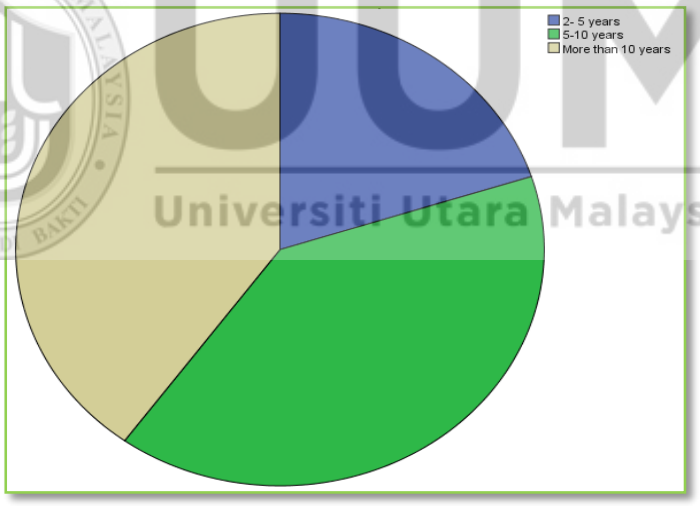

Figure 6.3: Years of experience in teaching

B. Perceive Usefulness

The second section of the questionnaire, which consists of seven questions, asks how much subjects perceived ICanTalk as being useful. The results are discussed in this section, by noting each question individually. For these perceptions, as 5 point Likert

Scale was used by respondents to rate the questions between one (strongly disagree) and five (strongly agree) (as shown in Appendix B).

The results for question 1 (Table 6.10) show that 40% of the subjects agreed that after using the app, autistic children with communication difficulties interacted better with teachers. On top of that, the same percentage strongly agreed while neutral was 20%. The remaining 20% disagreed and strongly disagreed.

Table 6.10

Perceived Usefulness – Question 1

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	1	10.0%
	Disagree	1	10.0%
	Neutral	2	20.0%
	Agree	4	40.0%
	Strongly Agree	2	20.0%
	Total	10	100%

With reference to Table 6.11 below, 40% for both subjects agreed and strongly agreed that after using the app autistic children with communication difficulties interacted with their peers better. The same percentage disagreed while 10% were neutral. Meanwhile, no respondents chose strongly disagree.

Table 6.11

Perceived Usefulness – Question 2

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	0	0%
	Disagree	1	10.0%
	Neutral	1	10.0%
	Agree	4	40.0%
	Strongly Agree	4	40.0%
	Total	10	100%

Information contained in Table 6.12 about question 3 showed that the percentages for neutral, agree and strongly agree were similar at 30%. Based on the results shown in the table below, after using the app, the autistic children were more able to express their needs by themselves. Meanwhile, the percentage for disagree was 10%. However, no respondents chose strongly disagree.

Table 6.12

Perceived Usefulness – Question 3

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	0	0%
	Disagree	1	10.0%
	Neutral	3	30.0%
	Agree	3	30.0%
	Strongly Agree	3	30.0%
	Total	10	100%

The results for question 4 displayed in Table 6.13 explain that the features really satisfied them in their needs. Particularly, more than half of the participants (60%) agreed that they were satisfied with the features. A low percentage (10%) for strongly disagree and disagree was recorded. However, neutral was 20% for this question. Meanwhile, no respondents chose strongly agree.

Table 6.13

Perceived Usefulness – Question 4

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	1	10.0%
	Disagree	1	10.0%
	Neutral	2	20.0%
	Agree	6	60.0%
	Strongly Agree	0	0%
	Total	10	100%

Based on the results shown in Table 6.14, the highest percentage for question five was 60% for agree. The second highest was 20% for strongly agree. This indicates that the app is acceptable for autistic children and most easily adapted to it. A low percentage (10%) for neutral and disagree was recorded. Meanwhile, no respondents chose strongly disagree.

Table 6.14

Perceived Usefulness – Question 5

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	0	0%
	Disagree	1	10.0%
	Neutral	1	10.0%
	Agree	6	60.0%
	Strongly Agree	2	20.0%
	Total	10	100%

The results for question 6 displayed in Table 6.15 show the same percentages for neutral, agree and strongly agree at around 30%. Based on the results, the ICanTalk app was successful at creating focus and servicing the basic needs of autistic children with communication difficulties. Meanwhile, the percentage for disagree was 10%. However, no respondents chose strongly disagree.

Table 6.15

Perceived Usefulness – Question 6

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	0	0%
	Disagree	1	10.0%
	Neutral	3	30.0%
	Agree	3	30.0%
	Strongly Agree	3	30.0%
	Total	10	100%

The results for question 7 in Table 6.16 show that the percentages for agree and strongly agree were similar at 40%. Based on the results, it was found that ICanTalk was highly effective to be implemented in teaching subjects and achieving important contributions, such as reducing teaching and production burdens for caregivers, enhancing learning motivation, and improving the communication ability of children with autism. Meanwhile, the percentage for neutral was 20%. However, no respondents chose strongly disagree or disagree.

Table 6.16

Perceived Usefulness – Question 7

	Scale	Frequency	Percent
Usefulness	Strongly Disagree	0	0%
	Disagree	0	0%
	Neutral	2	20.0%
	Agree	4	40.0%
	Strongly Agree	4	40.0%
	Total	10	100%

C. Perceived Easy-to-Use

The third section of the questionnaire asked how many subjects perceived ICanTalk as being Easy-to-Use. The results are discussed in this section by noting each question individually. For these perceptions, a 5 point Likert Scale was used by respondents to rate question between one (strongly disagree) and five (strongly agree) (as shown in Appendix B).

Question 1 asks precisely whether the ICanTalk is easy to use. Table 6.17 details the results for this Question. A low percentage (10%) for strongly disagree, disagree and neutral was recorded. The highest percentage for agree was 50%. Meanwhile, strongly

agree was 20% for this question. Based on the results, 70% of the subjects agreed ICanTalk was easy to use.

Table 6.17

Perceived of easy to use – Question 1

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	1	10.0%
	Disagree	1	10.0%
	Neutral	1	10.0%
	Agree	5	50.0%
	Strongly Agree	2	20.0%
	Total	10	100%

Table 6.18 presents the results obtained for question 2. The percentage for disagree, neutral, strongly agree and agree were 10%, 20%, 30% and 40%, respectively. However, no respondents choose strongly disagree for this question. Based on the results, 70% of the subjects found that ICanTalk was flexible. Particularly, 40% agreed, and 30% strongly agreed.

Table 6.18

Perceived of easy to use – Question 2

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	0	0%
	Disagree	1	10.0%
	Neutral	2	20.0%
	Agree	4	40.0%
	Strongly Agree	3	30.0%
	Total	10	100%

Besides flexibility, simplicity is another influencing feature. It engages autistic children while interacting with the ICanTalk. The results for question 3 (shown in Table 6.19), display a total percentage for neutral and strongly agree of 20%. Meanwhile, the highest percentage for agree was 80%. The results in table show that most subjects agreed, at 90% (80% agreed and 10% strongly agreed), that the ICanTalk was simple to use. However, no respondents chose strongly disagree or disagree.

Table 6.19

Perceived of easy to use – Question 3

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	0	0%
	Disagree	0	0%
	Neutral	1	10.0
	Agree	8	80.0
	Strongly Agree	1	10.0
	Total	10	100.0

Table 6.20 details the results for Question 4. A low percentage (10%) for strongly disagree and disagree was recorded for this question. The highest percentage of 30% was recorded for neutral and strongly agree. Meanwhile, agree achieved 20% for this question. Based on the results, almost 50% of the subjects agreed that ICanTalk is autistic children-friendly.

Table 6.20

Perceived of easy to use – Question 4

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	1	10.0%
	Disagree	1	10.0%
	Neutral	3	30.0%
	Agree	2	20.0%
	Strongly Agree	3	30.0%
	Total	10	100%

The results for question 5 are displayed in table 6.21. It was found that 80% agreed that autistic children could remember how to use ICanTalk. In detail, 50% agreed and 30% strongly agreed. In addition, the percentage for disagree was 20%. However, no respondents chose strongly disagree or neutral.

Table 6.21

Perceived of easy to use – Question 5

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	0	0%
	Disagree	2	20.0%
	Neutral	0	0%
	Agree	5	50.0%
	Strongly Agree	3	30.0%
	Total	10	100%

The results for question 6 are shown in Table 6.22. They explain that a low percentage (10%) was recorded for strongly disagree and disagree. The highest percentage was for agree and neutral at 30%. Meanwhile, strongly agree was 20% for this question. Based on the results, almost 50% of the subjects agreed that autistic children could use ICanTalk successfully every time.

Table 6.22

Perceived of easy to use – Question 6

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	1	10.0%
	Disagree	1	10.0%
	Neutral	3	30.0%
	Agree	3	30.0%
	Strongly Agree	2	20.0%
	Total	10	100%

The results of question 7 are shown in Table 6.23. The percentages for neutral and strongly agree were 20% and 30%, respectively. Meanwhile, the highest percentage for agree was 50%. However, no respondents chose strongly disagree or disagree. Based on the results, most subjects agreed at 80% (50% agree and 30% strongly agree). Accordingly, after using the ICanTalk app, the autistic children would want to keep on learning.

Table 6.23

Perceived of easy to use – Question 7

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	0	0%
	Disagree	0	0%
	Neutral	2	20.0%
	Agree	5	50.0%
	Strongly Agree	3	30.0%
	Total	10	100%

The results for question 8 are analysed and displayed in Table 6.24. It was found that the total percentage for agree and strongly agree was 80%. Meanwhile, the percentage for disagree was 20%. However, no respondents chose strongly disagree or neutral. The results show that, initially, most of the autistic children felt comfortable using the ICanTalk app.

Table 6.24

Perceived of easy to use – Question 8

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	0	0%
	Disagree	2	20.0%
	Neutral	0	0%
	Agree	4	40.0%
	Strongly Agree	4	40.0%
	Total	10	100%

Table 6.25 shows the percentages for strongly disagree, neutral, agree and strongly agree were 10%, 20%, 30% and 40%, respectively. However, no respondents chose disagree for this question. Based on the results, almost 70% of the subjects agreed that the respondents were satisfied with the ICanTalk app.

Table 6.25

Perceived of easy to use – Question 9

	Scale	Frequency	Percent
Easy to use	Strongly Disagree	1	10.0%
	Disagree	0	0%
	Neutral	2	20.0%
	Agree	3	30.0%
	Strongly Agree	4	40.0%
	Total	10	100%

Tables 6.26 and 6.27 present the descriptive statistics for both usefulness and easy-to-use factors. Statistics, such as Mean and Standard Deviation, are used in this study. Moreover, the Mean and Standard Deviation results for each question were reviewed and investigated. The tabulated results reveal that all questions had a high mean score that was close to, or greater than, four. Furthermore, the standard deviations were small; being either less than, or greater than, one. These scores highlight the respondents' feedback obtained from the data collected through the questionnaires. Therefore, all statements regarding the ICanTalk app in the questionnaire were approved by the subjects with a very small bias or a limited influence of other factors.

Table 6.26 shows the descriptive statistics for the usefulness measure. The answers for participation in this study about the usefulness questions show that most participant's answers about these questionnaires were between agree and strongly agree with that statement, with a mean score of M=4.20 and a Standard Deviation score of SD=.789. Meanwhile, some participants felt uncomfortable using the ICanTalk (M=3.30 and SD=1.059).

Table 6.26

Descriptive Statistics for Usefulness Measure

Measure	No. of participants	Mean	Std. Deviation
Usefulness Q1	10	3.50	1.269
Usefulness Q2	10	4.10	.994
Usefulness Q3	10	3.80	1.033
Usefulness Q4	10	3.30	1.059
Usefulness Q5	10	3.90	.876
Usefulness Q6	10	3.80	1.033
Usefulness Q7	10	4.20	.789
Valid N (listwise)	10		

For the descriptive statistics of easy-to-use measure, explained in Table 6.27 below, the participant's answers in this study about easy-to-use, shows that most answered between agree and strongly agree for that statement, with a Mean score of M=4.10 and a Standard Deviation score of SD=.738. Meanwhile, some participants felt uncomfortable using the ICanTalk (M=3.40 and SD=1.265).

Table 6.27

Descriptive Statistics for Easy to Use Measure

Measure	No. of participants	Mean	Std. Deviation
Easy to Use Q1	10	3.60	1.265
Easy to Use Q2	10	3.90	.994
Easy to Use Q3	10	4.00	.471
Easy to Use Q4	10	3.50	1.354
Easy to Use Q5	10	3.90	1.101
Easy to Use Q6	10	3.40	1.265
Easy to Use Q7	10	4.10	.738
Easy to Use Q8	10	4.00	1.155
Easy to Use Q9	10	3.90	1.287
Valid N (listwise)	10		

6.3.2.2 Reliability for Usefulness

The results of the reliability test in Table 6.28 show that the Cronbach's alpha for seven items is .881, which is greater than 0.7. Therefore, the entire items are accepted in this study.

Table 6.28

Reliability Statistics Usefulness

Cronbach's Alpha	Number of Items
.881	7

6.3.2.3 Reliability for Easy to Use

Table 6.29 presents the reliability aspects for Easy to Use in using ICanTalk app. The measurement was conducted nine items and the obtained result was .885. Thus, these measures satisfy the internal reliability criterion.

Table 6.29

Reliability Statistics Easy to Use

Cronbach's Alpha	Number of Items
.885	9

6.3.2.4 Results of Teacher's Interview

This section discusses the teacher's interview results with the researcher. Interview sessions were conducted in Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis, Malaysia. Interviews involved three teachers. The interview questions focused on the teachers' perceptions of using the ICanTalk app and understanding the children's perspective towards interacting with the app through the teacher's observations. Altogether, there were five interview questions for each interview session. The section below summarizes the results and discussions from the three respondents:

i. The first interview question; "How effective is the ICanTalk app in educating the children with Autism?" All of the teachers had good opinions about the effectiveness of the app in educating children with Autism. Each of the teachers also expressed that, although each child's learning curve differed, they saw that their learning potential and ability was growing. Following the use of ICanTalk, the children's potential for growth in the expression of their language and communications was stimulated.

ii. The second interview question; "From your perspective, how was she/he satisfied with the App?" According to the respondents, the children showed their happiness facially. They held their tablet and tried to use it repeatedly. The ICanTalk app was appealing to the children, and they enjoyed the act of clicking on the pictures on the

tablet’s screen through the ICanTalk interface. They further observed the children's attentiveness to the interface's voice feedback when it repeated the words. The children subsequently responded by repeating the words after hearing them vocalized through the ICanTalk's interface.

iii. The third interview question; “Describe any special responses exhibited by the children while using ICanTalk; and the circumstances at that time?” All of the teachers said the children liked to click on the pictures and listen to the voices. They improved their cognition and practiced their pronunciations with it. Another feature that appealed to teachers was ICanTalk's ability to store words and sentences. Teachers were able to save these words and sentences in ICanTalk, in order to enable the children to practice them later. Children could then review tasks with the saved words and sentences that the teachers wished for the children to reference in conjunction with the recorded pronunciations. Furthermore, the children were both visually and aurally stimulated as they repeated the words after the recorded sounds had finished.

iv. The fourth interview question; “Do you feel that ICanTalk's primary function consists of instruction, communication, or both? Why and how?” All of the teachers said "Both" because the app is a teaching-assistant tablet app for autistic children to teach cognitive and communication skills. Meanwhile, the app helps autistic children, in not only improving their disability, but also in obtaining a measure of their progress through assignment category.

v. The fifth interview question; “Which do you believe is the most appropriate device size to use ICanTalk: Tablet or smartphone?” According to the respondents, all were in favour of a tablet sized device; because the screen is bigger than that of smartphones.

The interviews with the teachers revealed that they were excited about the ICanTalk; especially about its content. It was suggested that the colours needed to be improved to make it more interesting. The app would be more interesting if both animations and content were incorporated into it. Furthermore, the autistic children found that the ICanTalk was easy to use due to its simplicity and friendliness. Additionally, the children were more capable of understanding and memorizing words for longer periods of time. Based on this positive feedback, the teachers hoped that ICanTalk could be utilized in school and home by the autistic children; and also by the parents in guiding their children.

Based on the interview results, it was found that ICanTalk was highly effective to be implemented in teaching subjects and achieving important contributions, such as reducing the teaching and production burden for caregivers, and also enhancing the learning motivation and improving the communication ability of children with autism. Apart from that, it was also proved that the integration of mobile technology in traditional teaching created an enjoyable learning environment.

6.4 Summary

The data from the teacher's evaluation of the prototype was acquired in this chapter. The chapter described and summarised the user's perspective relative to the app. The aspects of both functionality and usability tests were explained in detail; in terms of procedures and results. The procedures are clear and the results are reliable. The app was perceived by the respondents to be useful and easy to use, based on the results shown in this chapter. The next chapter will discuss the conclusion of this study and recommendations for future research.

CHAPTER SEVEN

CONCLUSION

7.1 Introduction

This chapter presents a discussion of the ICanTalk prototype development study and its achievement. After stating the study's objectives in Chapter 1, existing apps were then elaborated on in Chapter 2. These current apps were used as a basis for selecting the elements to propose design principles based on IxD, towards making ICanTalk usable according to the users' perception. Chapter 3 structurally details this study's whole process—from problem identification to results analysis. Design principles were subsequently proposed in Chapter 4 after the most common principles in successful apps were determined. Chapter 5 contains a description of the development of ICanTalk, the prototype of an Edutainment app designed for autistic children who have communication difficulties. In conclusion, the results are then discussed in Chapter 6.

7.2 Objectives Achievement

After carrying out the activities that were outlined in Chapter 3 and expounded on in Chapters 4 and 5, this study has accomplished all the stated objectives that were set in Chapter 1. These objectives are also discussed in the following:

Objective 1: To identify requirements of design principles for mobile edutainment game for autistic children with communication difficulties.

This study analysed the existing apps available for people suffering from Autism Spectrum Disorder, which are stated in chapter 2 (CommApp, iCanLearn, Proloquo2Go App, TapToTalk, AAC speech communicator). These apps were analysed to determine the elements of design principles applicable to the Edutainment app being studied, which were proposed based on IxD.

Objective 2: To develop mobile edutainment game based on the identify requirements of design principles for mobile edutainment game.

The ICanTalk App's design has been outlined according to derived design principles and requirements that were compiled in Chapters 4 and 5. ICanTalk is an interactive system that deals with children towards improving their communication skills; this is done through display of photographs and playing audio comments related to every photo, as well as showing the photo's main categories.

After the design has been finalised, a working prototype translation was created and elucidated in detail in Chapter 5. This is to enable the children to get through the constructed model, which was derived in Chapter 4. This step is important since, without a working prototype, the model will not be understandable to the children. All the design principles that were gathered based on IxD, as explained in Chapter 4, are incorporated in this prototype. The three categories, which are related for the children's main interface, are contained in this prototype, namely: daily special needs, safety instructions, and assignment.

Objective 3: To evaluate the edutainment game through usability study (usefulness and easy to use).

The release of the ICanTalk mobile app has transpired; it has also been tested in terms of its perceived usefulness and easy to use. Chapter 6 provides details about the assessment, where the results obtained attest that the subjects give the app high perceptions when it comes to both usefulness and easy to use. The results were not influenced by any technical effects since before the perceptions were tested; the prototype functions were first examined towards ensuring that they work well as intended.

7.3 Limitations and Recommendations for Future Studies

Although successful in many respects, the implementation and the evaluation of the ICanTalk environment has highlighted a number of critical issues. In what follows, we briefly discuss the main limitations we encountered in developing ICanTalk app as we believe that they pertain not to ICanTalk specifically but, more generally, to the design and evaluation of apps for autism. One of the major limitations is the limited literature available for review about the studied field. This study has been done in five months only. Because of this, the prototype consists of three categories only. Moreover, the prototype is focus on the daily special needs, safety instructions and assignment only because the limitation time to make on the other subject areas. There are some of the levels do not develop in this prototype such as, videos and animations.

Regarding the future work, the study has raised some ideas and suggestions for future work that can be developed in further studies. The beautiful thing about mobile apps is that improvements can still be made long after the initial release. Feedback from users is the driving force behind future updates. Five enhancements under consideration are:

- The researchers must cover more samples data to get a good result. In this study, the samples were took from Sekolah Kebangsaan Pendidikan Khas Kangar, Perlis in Malaysia, and feedback back from teachers only. In the future, the researchers can take sample from different area like rural area and they can get the requirement from instrument and teachers. Moreover, the researchers can develop the courseware prototype by using other environments.
- The scope of this study is limited for children. Thus, further developments have to be made to cover other ages of people with Autism.

- This study focused only on Malay and English language but we can apply it on any foreign language by following the same steps.
- The app would be more interesting if animations and are incorporated in.
- Allow caregivers to share the content by connecting their devices over Wi-Fi.

7.4 Summary

With confidence, this study affirms that its contributions are significant after discussing the objectives' achievement. It collects inputs from a variety of sources towards constructing a significant contribution to the body of knowledge through the proposed prototype. In the future, other researchers may utilise the proposed prototype towards further enhancement. Aside from this, the study contributes to society by means of the developed prototype in providing a new service to teachers and parents, assisting them in giving the education and care that the children need. Ultimately, this innovation will result in having children with autism reach a higher state of functionality. These children will grow up living happier and more productive lives with the whole society benefitting from their contributions. Lastly, this study has accomplished the stated objectives. As addressed in the previous section, a number of future considerations should be taken into account towards bettering this initiative.

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