HAVALL MUHSSIN MOHAMMAD

DEVELOPING A MOBILE LEARNING APPLICATION TO TEACH NUMBER CONCEPTS FOR PRIMARY SCHOOL CHILDREN

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A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES

OF

NEAR EAST UNIVERSITY

By

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In Partial Fulfillment of the Requirements for the Degree of Master of Science

in

Computer Information Systems

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name:

Signature:

Date:

To my lovely family…

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ABSTRACT

It is not an easy process to develop an application that is appropriate for young children based on modern technology using voice recognition system with a combination of e-learning resources. The aim of this study is to develop an Android based mobile application using Java programming to teach children basic Mathematics, namely app is Talk-Numbers, simple counting, addition, and subtraction with English as the second language. With the help (parents or teacher) of the developed mobile applications children can learn and improve their basic Mathematical skills while playing with mobile applications. The developed mobile application is in three levels with the difficulty level varying in ascending order. The first level is the simplest one and this level helps children to learn and identity the basic numbers. The second level tests whether or not the children can recognize the basic numbers. Finally, the last level, which is more difficult, teaches and tests the basic mathematical operations such as addition and subtraction. Currently, learning while playing using a mobile application on a mobile phone is an important field. In this Thesis the Android development studio together with SQLite database were used to create a mobile application based environment. The developed mobile application will be helpful to children, to researchers, to educational establishments, and to other people who might be interested in developing mobile phone applications for children.

Keywords: Intelligent mobile application; learning Mathematics; mobile learning; self-learning; voice recognition; mobile devices

ÖZET

Çocuklar için modern teknolojiyi kullanan ve ses tanımı yapabilen mobil uygulama geliştirmek kolay değildir. Bu çalışmanın amacı, yabancı dili İngilizce olan çocuklara temel Matematik konularından sayma, toplama ve çıkarma öğreten Android tabanlı ve Java programlama dilini kullanan Talk-Numbers isimli oyun tabanlı mobile uygulama geliştirmektir. Geliştirilmiş olan bu mobil uygulama sayesinde çocuklar ana-babalarından ya da öğretmenlerinden yardım alarak temel Matematik bilgilerini oyun oynayarak geliştirebilmektedirler. Tasarımı yapılmış olan uygulamanın zorluk derecesi giderek artan üç seviyeden oluşmaktadır. Birinci seviye en kolayı olup bu seviyede çocuklar sayıları öğrenip tanımaktadırlar. İkinci seviyede çocukların sayıları tanıyıp tanımadıkları ölçülmektedir. Sonuncu seviye daha zor olup bu seviyede çocuklar toplama ve çıkarma gibi temel Matematik işlemlerini öğrenmektedirler. Son birkaç yılda mobil cep telefonu kullanımı oldukça artmış, telefonların fonksiyonları da gelişmiş ve kullanımları da kolaylaşmıştır. Bu nedenle mobil telefonlarda çok çeşitli oyun uygulamaları geliştirilmiştir. Ancak bu uygulamaların çoğu sadece oyun odaklı olup eğitim boyutu dikkatlice ele alınmamıştır. Bu tezde Android studio ile SQLie veri tabanı kullanılarak çocuklara temel Matematik öğretmek amacı için mobil ve oyun destekli bir uygulama geliştirilmiştir. Geliştirilmiş olan bu uygulama çocuklara, araştırmacılara ve eğitim veren enstitülere ve ayrıca mobil uygulama geliştirmek isteyenlere ışık tutacaktır.

Anahtar kelimeler: Akıllı mobil uygulama; Matematik öğrenimi; mobil öğrenme; kendi başına öğrenme; ses tanımı; mobil cihazlar

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LIST OF ABBREVIATIONS

3D: Three Dimensional

CAA: Computer Assisted Assessment

CAD: Computer Aided Design

CCI: Children Computer Interaction

COTS: Commercial Off-The-Shelf

DBR: Design Based Research

HCI: Human Computer Interface

HP: Health Points

HMM: Hidden Markov Model

ICT: Information Communication Technology

IQ: Intelligent Quotient

KPs: Knowledge Points

MMO: Massively Multiplayer

MP3: Media Player Three

PC: Personal Computer

PDA: Personal Digital Assistant

RPG: Role Play Mobile Application

TTS: Text to Speech

UML: Unified Modelling language

ZPD: Zone of Proximal Development

CHAPTER 1

INTRODUCTION

This chapter presents a brief description of the modern technology that enables children to use their smartphones and computers to participate in gaming environments that encourage them to learn skills such as counting and writing.

1.1 Overview

In recent years, there has been a rapid expansion in the utilization of mobile telephones due to the continuous development of new functionalities. Furthermore, there is now a multitude of mobile applications available that have been designed for the entertainment of phone users. However, in spite of the advances in technology, phones are particularly underutilized for learning purposes. For example, children apprehension of Mathematics has been a challenging process as, even though information is available in books, it is not easily accessible. Therefore, interfacing Mathematics with under-used technology could be an innovative way of reducing the fear that children experience in relation to the subject. mobile applications are amongst the most effective mediums for instruction, particularly for the younger generation of learners (Georgiou, 2015). Children will appreciate the entertaining nature of mobile applications and will consequently participate without feeling stress. Children can easily associate with mobile applications and they are exercises that coordinate with Mathematical structures, rules and other factors. Due to the sense of familiarity that the children feel, they are connected back to the nursery. The GSM Association (2014) published a review stating that 71% of children who utilize mobile telephones connect to the Internet through their devices. This rate is continually increasing as children have increased access to modern smartphone technology. More than 50 percent of the European children aged 12 reviewed stated that they connected to the mobile web, in contrast with 26 percent in different regions of Japan. The Internet is predominantly utilized for watching videos by approximately 85 percent of the children, around 77 percent of the same sample of children stated that they access the Internet for the purpose of studying

Games are generally inclusive activities that are influential on all children, and they can address diverse learning styles and distinctive identities. Furthermore, they consist of exercises that can be repeated frequently, so the learning potential increases without the child feeling a sense of boredom. A basic mobile application can be played several times using limited language (e.g., Is it a?). Children will therefore be enthusiastic about the subject without being overwhelmed, as the mobile application has an entertainment aspect as well as a genuine informative capacity. Mobile applications are fundamentally organized exercises that can be used to teach Mathematics around the world; moreover, they are beneficial for students as they incorporate many aspects (cognitive and emotional), resultantly establishing a solid connection with the language (Chian, 2014). Some children will be enthusiastic about exploring the different avenues for creation, while others will be cautious and will require additional time to adapt. This adaption time should to be offered to the children, and they should not be forced into using the technology. Mobile applications following these fundamental rules will become vital tools that enables a language to be heard and comprehended. Consequently, children can participate in these exercises without feeling pressure. Instructive mobile applications were first introduced in 1970-1980 and were targeted at children and young people. The principle objective of these mobile applications was to augment the children logical abilities as well as their lexical and syntactic aptitudes. Unique mobile applications can be transformed into a genuine form of instruction for children, as well as for overall learning objectives (Tunjera et al., 2014). Historically, most mobile application application designers have concentrated on the Apple iPod and iPhone as the preferred platform, as this market had the greatest potential for parents purchasing applications for their children (Hssina et al., 2015). Recently, there has been a transformation in attitudes with more effective applications for children on the Android platform now available (Tunjera et al., 2014). New technology is being constantly developed and the benefits of this technology for teaching Mathematics is transmitted to parents via the teachers (Hee, 2015). Today, the Android platform commands a dominant position in the smartphone market, and many parents are purchasing applications for their devices that can be utilized by their children (GSMA, 2016). Nonetheless, there has been increasing interest in using tablets; many parents purchase tablet PCs for themselves and allow their children to utilize them. However, an increasing number of parents are choosing to purchase separate tablets for their children and there are now more reasonably priced Android devices on the market (Morphitou, 2014). There are many new applications for the Android market that are being released and these can form a solid foundation for parents who purchase new mobile technology and can install beneficial new material to assist their children learning (Paolo, 2014). In the past decade, research into Mathematics education in developed nations has reached the conclusion that the teaching of Mathematics in the United States should be more focused and cogent in order to augment the level of Mathematical ability in that country. To fulfil this promise, standards in Mathematics have been established to address the issues of a school that is one mile wide and one inch deep (Morphitou, 2014). These new benchmarks have been formed based on the highest quality Mathematical standards from different states throughout the country. Additionally, they draw on the principal universal Mathematical models for behavior, and also research and contributions from various sources, including state departments of education, professionals, research developers, professional organizations, teachers, parents and students, and individuals from the general population (Paolo, 2014). These Mathematics principles give lucidity and certain words instead of entire sentences. They endeavor to consider the actual design (Peirce, 2013), by not only considering the most important topics, but also by the constant return to the organizational principles, including the amount and details of accountability. Furthermore, all devices should meet certain Mathematical standards that enable the students to learn. Subsequently, the creation of guidelines based on research-based learning processes were the foundation for the current understanding of how children acquire Mathematical knowledge, abilities, and comprehension. Children must have a solid foundation in Mathematics to prepare them for school, their careers and their lives, as Mathematical standards are interwoven in all aspects of society (Morphitou, 2014). Contemporary approaches to mobile application-centered education focus on innovative educational content and team mobile applications, the educational principles incorporated within the mobile application, the design of educational mobile applications and simulations, the effectiveness, sources, and institutional use of the mobile application as well as the level of playability of the mobile application (Paolo, 2014). Nonetheless, these methodologies have largely focused on the school, higher education, corporate, and military sectors.

The design and methods of instruction incorporated in mobile applications for early childhood have distinct challenges that are not relevant to other mobile application genres. The overarching problem for this age group is the development of the students. The formative phase of the children can influence both the educational methods that can be utilized in addition to the learning exercise that can be implemented (Peirce, 2013). While considering the level of students' development, it is imperative to consider both the intrinsic variability of development among students as well as the various kinds of development, such as cognitive, psycho-emotional/social and psychosexual. These obstacles are exacerbated by the fact that the different forms of development can exhibit powerful interdependencies; for example, the development of psychomotor skills can influence the social and cognitive enhancement, e.g. the development of certain muscles can impact speech, which subsequently influences the ability to engage in society a positive way of motivating the utilization of Mathematical mobile applications by children is to design these applications in such a way that they will find them entertaining, which is one of the principal aims of this Thesis. One of the most effective ways of achieving this is through mobile application-based learning (GBL), which is a kind of gaming that has established learning results for children. In conclusion, mobile application-based learning is a form of instruction that is designed to provide an effective balance between the mobile application play itself and the fundamental subject matter that is being taught (in this situation, Mathematics is the focus), which enables the mobile application player to learn and apply the learning in a practical situation. Consequently, this creates a scenario where the child is learning real Mathematics in a manner that they can easily associate with in their daily lives, which will lead to a sense of enjoyment while learning.

1.2 Problem

(Tagoe and Abakah, 2014) reported that applied mobile applications are often thought to have a positive impact in the areas of learning motivation and learning outcomes. However, a limited number of studies have explored how these factors are related. Today, parents are searching for more effective and practical ways of motivating their children to study Mathematics, even when they are still very young in order to prepare them for school so that they can achieve higher levels than the other children. Consequently, there is a necessity for new technology that can assist with teaching children in a more effective and efficient manner, particularly in the light of the exponential growth in popularity of mobile applications in younger generations. Therefore, this study will attempt to fill the gap/add to the existing learning mobile applications that are currently available. The integration of information technology strengthens the educational space, and teachers can use digital mobile applications to support children during the learning process. Serious (or applied) mobile applications have shown various tendencies in various educational fields (Hee, 2015), such as Mathematics (Hssinaet al., 2015). (Tagoe and Abakah, 2014) identified that mobile application tools can help students to explore and understand the problems that exist, which can lead the user in a variety of situations. Mobile applications, including recreational mobile applications, simulations and virtual worlds can be used in schools (formal education) as well as vocational training to reinforce traditional learning. Additionally, the number of educational mobile applications with a research base, (i.e., to meet the educational needs of the use of theories), is increasing. Other research has not only studied the learning benefits that educational mobile applications provide for children, but has examined the design of these mobile applications (Hssina et al., 2015). For example, Morphitou (2014) suggested six facets of education that must be incorporated in the design of a particular mobile application learning objectives simulation domain (disciplinary knowledge or skills or the incorporation of animation); relationship with the simulation, progression and problems which problems need to be resolved in the mobile application attractiveness of the mobile application which media and script elements are engaging for the children and make the mobile application appealing and usage conditions (will the mobile application be accessible both in and out of the classroom?).

1.3 Aim of the Study

The aim of this study is to develop an Android based mobile application using Java programming to teach children basic Mathematics, namely app is Talk-Numbers, to simple counting, addition, and subtraction with English as the second language.

1.4 Significance of the Study

This study is unique with a fact that it is a voice recognition system to help children adopt to the techniques of Mathematics easily. The system which is in form of an application is done to make this aim attainable easily.

1.5 Limitations of the Study

The following limitations are associated with this study:

- The developed mobile application was designed on the Android OS.
- The Android system and functionality of the touchscreens.
- The architecture of the voice recognition system.
- The application is limited to counting the numbers between 7 and 10, including subtraction and addition.
- The children must at least English as a basic second language.

1.6 Overview of the Study

This Thesis consists of a total of six chapters:

Chapter one presents a brief summary of the modern technology that enables children to use their smartphones and computers to access mobile applications that provide the opportunity to learn numbers by counting and writing.

Chapter two presents an overview of the various research that has been conducted in the field of Mathematics to help children count to 10 as well as the use of new and innovative technology.

Chapter three comprises two sections: The first section consists of an overview of different gaming applications aimed at teaching Mathematics to children and introduces the main topic of how to teach students by using tablets and smartphones. The second section provides more in-depth details about the use of computers for children active learning of numbers.

CHAPTER 2

RELATED RESEARCH

This chapter presents an overview of different research that has been conducted in the field of Mathematics, particularly into teaching how to teach them to count to 10 along with the use of modern technology.

2.1 Mathematics Android Applications for Children

Sokolowski (2015) investigated the impact of the application of Mathematical modelling to reinforce the acquisition of Mathematical knowledge by students in high school and at university. A later moderator analysis discovered variations in the results as a result of diversification of the design models.

Shalamanoski et al. (2015) demonstrated the design and application of a 3-dimensional (3D) academic mobile application that was targeted at assisting students in enhancing their Mathematical abilities. In this scenario, the mobile application was straight forward to use and easily navigable, while the children experienced a rich gaming environment, which augmented the overall experience. In order to increase accessibility, installation of the mobile application must be elementary and the functionality of the mobile application should permit usage via any web browser.

Osifo and Radwan (2016) reported that the area of educational Mathematical mobile applications is a rapidly growing industry. Educational institutions, hospitals, organizations and the military can all benefit from the positive impact of serious mobile applications and they are necessary for their organization to learn the benefits of education. Learning designers and mobile application designers should collaborate to produce mobile applications that can provide customers with most engaging and productive learning experience. The integration of social networking and advanced Internet technology with the design of applied mobile applications enables modern employees to be more effective learners. Thus, it is possible to develop and utilize industry-standard tools, including software produced by Adobe, to produce serious mobile applications that drive radical user adoption.

Marshall et al. (2015) formed a multidisciplinary community of academics, designers, and professionals to collaborate and discuss their work. Furthermore, their objective was to investigate the interaction between play and happiness based on the interactive design of the mobile applications and the children themselves as well as to determine opportunities for further research.

Popetal (2015) determined that playing a digital Mathematics mobile application has the potential to augment a child's number sense, particularly in comparison to children that do not play mobile applications. In this study, a pre-and post-assessment was used to evaluate the number sense of two groups of third grade children who were taught by the same Mathematics teacher.

Read et al. (2015) presented a course in which the participants had the opportunity to acquire knowledge regarding about the theory and implementation of conducting research in to Human-Computer Interaction (HCI) in children. The course was split into two sessions: fundamental principles and theory, and best practices. The instructors in this course had a foundation of multiple years of experience in designing, implementing and analyzing Children-Computer Interaction (CCI) studies, in various countries, including the UK, USA, and Israel.

Tagoe and Abakah (2014) reported that serious mobile applications are often perceived to have a positive impact on learning motivation and learning outcomes. Thus, based on this assertion, they conducted an empirical study to examine the association between expected satisfaction and the disposition to play the mobile application, as well as the relationship among gaming pleasure, self-reported cognition, and motivation learning and test outcomes. In an exploratory study, 74 children from five elementary schools participated in the AWWWARE educational mobile application. Multilinear regression was used to analyze the results both before and after the test. The analysis revealed that early enjoyment is only a minor factor in determining children disposition towards playing mobile applications. For the students, it is more important that the mobile application will be easy to use and informative. The impact of level of enjoyment that the children experience is also less than anticipated. Although an association exists between the level of satisfaction and the motivation to continue participation in the mobile application, no benefits are found in the self-assessment or testing of learning gains. Consequently, this leads to the conclusion that additional factors, such as explicit learning tasks, guidance and support for inherent mobile applications or teacher supplements, could be more influential than the sense of enjoyment gleaned from the mobile application.

The GSMA (2016) reported that one of the numerous challenges experienced in urban areas is the prevalence of discarded waste in roads, pavements and public areas, which has created significant environmental problems. This situation has not only been caused by the deficiency of public regulations and urban infrastructure, but also to the lack of participation by the general population. In this context, it is mandatory that people should be educated, particularly the younger generations, who represent the society's future. Their study presented a proposal for a serious mobile application called protecting the earth, which was focused on increasing the awareness of the public on selective waste collection, recycling, as well as waste reduction and waste recycling at various stages of reuse. The methods used included systematic review, which refers to the use participatory design methods, including contextual techniques, normative and nonfunctional requirements, and the development of suitable techniques for the development of projects. Furthermore experiments were conducted with children in order to evaluate the effectiveness of the proposed tool. The results obtained from the children's' usability tests indicated that the interface needed to be refined in order to immediately improve the accessibility and the satisfaction levels of the users.

According to Osifo and Radwan (2016), in order to accelerate the development of human interaction with the real world, it was proposed that two competing intelligent systems were simultaneously introduced into the test field. One of the Intelligent Systems automatically moved using set preprogrammed behavior, while the other was remotely controlled by a human operator. The operator attempts to improve the Intelligent Systems by exploring new behavioral elements. Simultaneously, the preprogrammed behavioral group is tested using the first intelligent system. The principal concept behind this approach is that, by allowing two intelligent systems to compete with each other, the development process will consequently be accelerated. By applying this method, an intelligent educational system for children be can be developed. The study described how this approach works and how it explores and improves behavioral elements through field development. The use of intelligent systems as teaching tools is particularly compelling, because they have the potential to support collaboration, the ability to promote physical activity and have inherent attraction. Nonetheless, despite their numerous advantages, there have been few studies that have investigated the use of intelligent systems for children under the age of 6 and, furthermore, intelligent systems for these very young children do not make full use of the technology, because the designed Intelligent Systems are fixed in one place and do not promote collaborative teaching. Thus, their paper assessed the benefit of a tangible mediator Intelligent System designed for cooperative kindergarten teaching by testing it on 86 kindergarten children (aged 2-6 years). The results demonstrate the relevance of platforms proposed for children under 3 years of age and lay the foundation for developing new learning activities based on this educational technology for young children. According to Tagoe and Abakah (2014), the integration of information technology strengthens the educational environment, and teachers can use digital mobile applications to provide support for their students and as a motivational factor in the learning process. The design of mobile applications for children involves understanding the interests, behaviors and other aspects in order to determine their needs. For example, children with cochlear implants are faced with greater challenges, including literacy. Teachers use different learning strategies than for children with normal hearing, because they must follow the language acquisition process through speaking and listening. Mobile Applications can serve as a substitute for recreational and educational support materials, which will subsequently inspire children in the literacy process.

Chian (2014) identified that autistic children may experience broad and severe limitations in various aspects on limitation, such as imagination, behavior, communication and reciprocal social interaction. The use of video mobile applications by children and young people has become increasingly widespread, and this has led to interest in exploring the benefits that can be gained by incorporating these tools in the educational and social fields. Through the use of an interactive mobile application, interactivity, increased mental activity and social interaction can be promoted between different users. Serious mobile applications have been used in a variety of contexts, including education, military and health. This article described the development of a serious mobile application that can be used to improve the communication and social interaction levels of autistic children.

Morphitou (2014) investigated the benefit of a mobile application on the literacy levels of children aged 6 to 8 years old. When conducting this study, they used descriptive, *in situ*, and analytical methods. Their results suggest that experts concur that the adoption of mobile technology can facilitate children literacy process; it motivates children to develop a passion for reading and writing through various forms of text and tools, particularly those that can be accessed through tablet applications. While technology be beneficial in the enhancement of literacy processes, it is ineffective in the development of certain aspects of the writing process.

Hssina et al. (2015) investigated the expanding literature on the addiction to smartphone technology among university undergraduates in order to determine any prevalent trends. In the conducted literature review, the researchers only included original research papers and a thematic structure was applied. Furthermore, the study examined the association between smartphone addictions and the students' level of educational success. Finally, the study identified whether there were any significant differences in the addiction levels according to the students' gender, subject of study, parental educational level and family income.

Osifo and Radwan (2016) recommended three steps to augment the effectiveness of Android applications:

- A management system should be established for mobile educational applications on the Android (OS) tablets;
- The viability of the management system for mobile educational applications should be determined for Android (OS) tablets
- Educators' satisfaction levels towards the management system for mobile educational applications for Android (OS) tablets should be assessed.

Chian (2014) determined that playing digital Mathematical mobile applications can potentially enhance a child's number sense, particularly in comparison to children that do not play such mobile applications. In his study, pre- and post-tests were utilized to determine the number sense of two groups of third grade children who were taught by the same Mathematics teacher and it was discovered that a higher percentage of the children that went through the test achieved a higher IQ level after frequent use of the system.

Paolo (2014) introduced a course in which participants were able improve their understanding of the theory and implementation of research into Human Computer Interfaces (HCI) for children The course is partitioned into two sessions: fundamental theory and implementation, and best practices. The teachers in this course have a wealth of experience in planning, implementing and analyzing Child-Computer Interaction (CCI) research

Tunjera et al. (2014) introduced the design and application of a three-dimensional (3D) instructional mobile application that was targeted at enhancing students' Mathematical proficiency. The developed application was easy to utilize and simple to explore; moreover, the children appreciated the rich gaming environment, which improved the overall experience. In order to improve accessibility, the application can easily be installed and can be accessed directly through a web browser.

Osifo and Radwan (2016) conducted a study that concentrated on the viability of the heuristic evaluation method for the assessment of computer assisted assessment (CAA) frameworks and proposed a collection of CAA heuristics that can be used for assessing evaluation instruments. Resultantly, the findings of these tests demonstrated that, with minimal preparation, inexperienced evaluators can successfully perform an evaluation could, utilizing this heuristic set, distinguish actual ease of use issues related to the evaluation instrument. Consequently, educational technologists or software engineers have the capability of utilizing the developed CAA heuristic set to assist with their procurement acquirement or to guide their design process

Hee (2015) described the study of data refinement and the evaluation of a learning model for educational mobile application learning. The model is designed to be used by intelligent educational agents to improve the learning capabilities of children during the course of the mobile application. The first version of the model was designed on the basis of instructor and subjective parameters. They illustrated the improvement of the data to the model and reported on its accuracy.

In a study by Morphitou (2014), direct and intuitive pediatric interaction was developed and evaluated. Haptic and tangible interfaces are predominantly used for direct manipulation. The use of intelligent systems as educational tools has also become an increasingly popular research topic because they have the ability to capture children imagination. However, few studies have investigated the interaction between intelligent systems and children less than six years of age; hence, further research is required in order to understand the challenges, limitations, and opportunities provided by intelligent systems in the kindergarten learning environment.

Morphitou (2014) presented the findings of a study aimed at empowering young people to conduct heuristic evaluation, with their fellow students taking the role of expert evaluators. The outcomes demonstrated that the young participants found it challenging to act as the facilitator, as they experienced difficulties while attempting to clarify the heuristic assessment process as maintaining the evaluators focus. The evaluators did not discover many issues and ultimately, their attention was diverted from the assessment, with some choosing to explore other functionalities of the device rather than the mobile application that was the focus of the study.

Hssina et al. (2014) proposed a project called edugame, to the goal of which was to provide educational mobile applications that introduce children to a series of activities, such as the construction of text, letter recognition or Mathematical operations. The project commenced with a design phase using a UML approach, followed by the implementation phase using the Android platform. This allowed the researchers to make an interactive mobile application available to children aged 3 to 7 years and, by understanding the needs of the various age groups, it is possible to educate the children according to their specific retentive capabilities in order to achieve a greater level of understanding.

Tagoe and Abakah (2014) presented an assessment method using a specific case study, which was the first Mathematical application prototype to be assessed for children aged 12 to 14. The primary objective of this preliminary study was to explore the gaming experience, the first impressions and to evaluate the children thoughts and expectations for further development of other mobile applications. Their principal challenge in the evaluation activities was the selection of appropriate methodological approaches, specifically taking children as the special user group. They chose to use a different approach, primarily qualitative and exploratory, which has been reported to be beneficial in the field of human-computer interaction (HCI) for children. By introducing their own multiple approaches, particularly in the study of the steps and procedures, other researchers can take inspiration for designing activities involving children mobile applications that enable the children to feel a sense of enjoyment while simultaneously exploring new ways of learning.

Peirce (2013) reported that, during the past decade, the focus has been predominantly on early learning in education, particularly in reading and writing in terms of basic literacy. Additionally, numerous countries have concentrated more on core competencies in the information society, information and communication technology (ICT) and English literacy levels. Meyer focused on the education materials used in the pre-school environment through the development of a mobile application platform called Mingoville. The researchers at Mingoville have been researching serious gaming projects in the global marketplace (2007-11), some of which are part of a mobile application that follows the country through the classroom environment. The designers behind the Mingoville platform are currently designing a new platform version targeted at pre-school children that will be suitable for tablets, as well as computers and smart boards. Furthermore, Pierce discussed the effects of redesigning the preschool education platform as well as how using Mingoville can have an impact on the teaching of Mathematics.

Tagoe and Abakah (2014) stated that computer technologies, particularly mobile applications that can be beneficial for children with autism to develop their social skills, while a minimal number of existing tools are targeted at critical communication and emotions. Their research analyzed the emotional demands of teaching children with autism by using serious mobile applications to address their needs. Semi-structured interviews were conducted with parents and users and the findings were combined to determine the user needs. Their findings suggested that, while parents recognize the importance of educating their children emotions, effective tools are not available. The recommendation was that effective intervention tools should be customized, flexible and contextual. Serious mobile application has shown various tendencies in different educational fields (Hee, 2015), such as Mathematics (Hssinaet al., 2015), medicine (Tunjera et al., 2014), history (Paolo, 2014), among others, due to the stimulation of curiosity and their positive aspects, while seeking to develop social aspects of education and user culture.

Tagoe and Abakah (2014) reported that mobile application tools can help to explore and understand existing problems, which can lead to a variety of situations. Additionally, the number of educational mobile applications with a research base, (i.e., to meet the educational needs of the use of theories), is increasing. The potential of digital mobile applications as learning tools will increase the availability of improved underlying technology, kits, and increased interaction with the ability of the software to process data, encouraging children to use mobile devices. However, there are also obstacles to the use of entertaining and serious mobile applications as learning tools. Practical issues include licensing, support, and equipment costs. The constraints imposed by the teacher can be finding a suitable mobile application, identifying what should be learned, integrating the learning plans within other learning tools and developing evaluation techniques. Wrzesien and Raya Lopez (2010) emphasized that the use of mobile applications increased motivation and user satisfaction during the learning process.

2.2 Mathematical Mobile Applications for Children

Smartphone technology is now an integral aspect of modern life and children are frequently exposed to this technology from an early age with the delighted parents enthusiastically taking short videos or photographs for posterity. The utilization of smartphones by elementary school children and infants is also increasing exponentially as the children are granted more access to the technology by their parents (increasing global penetration of mobile technology), while educational institutions are also embracing the new advancements in technology. According to a report called zero to eight children Media Use in America 2013 published by Common Sense Media, a total of 72% of children under 8 years of age and 38% of children under the age of 2 had utilized a mobile device at some point during the previous year. Furthermore, in the previous 2 years, the percentage of children who had accessed a mobile device at least once per increased twofold from 8% to 17% Another report published in 2017 by KAVAJ claims that approximately 40% of German elementary school children have their own smartphone, while 25% have access to their parents' devices. This report examines the available applications for children 12 and under on the Apple Store as well as the Google Play Store. It examines instructive and non-instructive applications, the application costs, as well as features such as parental control, security applications and future patterns. Instructional mobile applications are designed for mobile devices, which take the form of computerized learning exercises, utilizing particular software (App Inventor). These applications are designed to assist preschool children with the process of learning Mathematics by adhering to the principles for Responsible Management Education (RME) largely concentrating on the presence of rich thematic systems related to the child's experiences. Consequently, mobile applications implemented alongside group and individual exercises that do not require the use of a tablet, including tabletop mobile applications, dice, hidden object mobile applications, among others. These types of computerized applications were selected based on the fact the previous research (Nix, 2005; Vavoula, Pachler, and Kukulska-Hulme, 2009) has demonstrated that digital instructional exercises not only appeal the children interests, but are also regarded as a form of entertainment that can simultaneously construct an innovative and engaging learning environment. Modern children will be more inclined to appreciate an educational experience that includes digital activities, because mobile applications are a primordial form of educational play and significant benefits can be gleaned by utilizing them as educational tools (Squire, 2006). In particular, 16 unique activities have been developed that encompass the four levels of Mathematical intervention mediation (ground or zero, first, second and third) in light of the RME principles for preschool instruction (Van Den Heuvel-Panhuizen, 2008; Zaranis, 2011, 2012). The purpose for the following stage of the research is to widely implement such applications and other instructional exercises in kindergarten classrooms keeping with the aim of methodically investigating the suitability and educational usability in comparison to traditional modes of education In the opinion of Van Den Heuvel-Panhuizen (2008), the existing level of knowledge of formal Mathematical ideas can vary significantly from child to child at the time of commencing kindergarten education. Moreover, some children are relative comfortable with basic counting, while other children knowledge may be deficient. In a similar manner, the degrees to which they are able to recognize the different meanings of numbers may also differ. The level of comprehension of resultative counting that children have acquired before entering kindergarten can also demonstrate wide disparities. Resultantly, the varied initial scenario in which children have different levels of Mathematical understanding when commencing their kindergarten education has been defined as the ground level. Generally, a rudimentary numerical sense is established both before and during the period of pre-school education, which has four general levels. Apart from the aforementioned ground level, the three overall levels that are developed during the period of kindergarten education can be defined as follows: First level: Context-bound counting and calculation, including basic addition and subtraction; Second level: Object-bound counting and calculation, including basic addition and subtraction in which objects are shown and then removed; Third level: Pure counting including addition and subtraction incorporating missing variables. The first level comprises context-based scenarios in which children are educated on how to count to ten, arrange numbers in the correct order as well as how to make sensible estimations or comparisons of numbers using Mathematical principles such as more than (>), less than (<) or equal to (=). Simple additional and subtraction exercises are presented at this level. In the second level, relevant object-bound counting and estimation are incorporated in problem scenarios, which concentrate primarily on quantitative aspects. As opposed to the first level, questions in the second level require the children to count and identify a given number of objects in a particular scenario, which enhances their Mathematical understanding. Nonetheless, this principle is only applicable if the questions are related to particular objects and include natural numbers. Additionally, the second level comprises exercise in which the children are capable of selecting a suitable strategy for solving basic addition and subtraction questions, in which the relevant objects are momentarily revealed before being concealed. The following questions are representative of questions that students may be asked at level 2: How many sweets are there in the box? How many chairs are there? How many individuals are there in the queue? Which box contains the most desserts? If there are seven lit candles and the wind blows out three, how many will remain? The third and final level comprises of pure counting and calculation, where students are asked questions utilizing actual numbers, as opposed to items, which concentrate on the part of a missing variable. For example, a question that could be asked is, ’what will remain if three is subtracted from seven? The process of concealing items after displaying them for a short time in level two encourages children to utilize their fingers, or other methods for increasingly challenging exercises, as the visual items were eliminated from their view. Resultantly, the children counting abilities are no longer associated with the items themselves and they develop the capability to identify physical or mental representations of the items that enable them to answer the question correctly.

CHAPTER 3

THEORETICAL FRAMEWORK

This chapter consists of two parts: the first part presents an overview of different mobile application applications aimed at assisting children to learn Mathematics and introduces the main topic of how to teach children by using tablets and smartphones. The second part provides greater detail about for the use of mobile devices by children in the process of actively learning numbers. The application is called Talk-Numbers.

3.1 Intelligent Systems

An intelligent academic system, is capable of adjusting to the educational environment through dynamic educational methodologies that are appropriate for learners' abilities. Intelligent systems are pivotal factors in education as these systems can educate learners to the required levels in order that students can gain the maximum benefit and are motivated throughout the training process. Learning abilities and learning speed can vary among individuals. Consequently, in the intelligent system designed by the author of this paper, the number of learners is determined before the learning process begins, which means that the educational process can proceed at the level that is most appropriate to the learners themselves. Consequently, the inspiration of self-learners is not impacted; hence learning can be achieved with a sense of enjoyment. However, if the level of difficulty is too challenging for the student, then he or she can rapidly lose motivation, experience stress and their level of confidence in the educational material will be diminished (Cavus, 2016).

A system is a small aspect of the universe that this Thesis is focused upon. For example, a system could be natural such as the weather, or it could be manufactured like a vehicle; furthermore, it could be an object like a machine or device, or it could be an abstract concept such as a process for choosing political hierarchy. The surroundings are defined as all other factors that connect with the system itself. In some situations, a system could be additionally subdivided into subsystems that are also interconnected. This division into subsystems is not really one of a kind and can assist with determining what the framework in question should be.

In spite of the fact that it is difficult to measure the intelligence of a particular system, it is possible to perceive the following general characterizations of an intelligent system:

(a) Low intelligence: Ordinarily, it is a basic system. It cannot function independently and requires comprehensive instructions, a low-level of control, the parameters are fixed, and it is generally mechanical in nature.

(b) High intelligence: Ordinarily, it is a complex system. It maintains a certain level of autonomy and requires minimal instruction. It can establish its own objectives, requires high-level control, shows flexibility, makes decisions and appropriate choices and is predominantly digital.

Hence, there is a continuum between these two distinct extremes and the majority of useful devices can be categorized within this spectrum. As a result of this wide definition, all control systems can be considered to have a certain level of intelligence; therefore, they have similarities in this regard. Nonetheless, intelligent systems are now capable of managing complex scenarios and have the capabilities to make more involved choices. s. As the quality of computer equipment and software is augmented, it will become increasingly plausible that intelligent systems will be designed under this definition The present study will utilize a set of techniques that have been defined as soft computing These techniques have their origins in the field of biology and are particularly effective in non-linear, complex issues.

3.2 Text-to-Speech Processor

Text-to-speech (TTS) systems can be utilized in a vast array of applications. The first practical usage of such systems was in reading applications for the visually challenged, in which the system functionality would read text from a book and transform it into speech. Although these initial systems appeared particularly mechanical they were adopted by the sight impaired because the other available options including braille or another person reading the text were frequently not practical. Today, advanced systems have been developed that enable human-computer interaction for the visually impaired, in which the TTS facilitates the user's navigation around a windows-based framework. However, the widespread adoption of TTS has been significantly restricted by the level of quality of the software. With the exception of users who have limited options (the visually impaired, for example), the general reaction from the public to classic TTS systems has been relatively negative. While the initial reaction to hearing, several sentences converted from text may be positive and enthusiastic, this sense of optimism will rapidly diminish. Nonetheless, recent technological developments have advanced the quality of the systems, with the result that TTS systems are now more frequently found in common applications. Moreover, it is evident that the primary usage of TTs is now associated with call-center automated systems, which powers software that enables customers to pay utility bills or make travel reservations by using an automatic dialogue framework. Furthermore, TTS systems can be found in applications for perusing news articles, reports on the weather, journey planning as well as a plethora of other features. It is important to note that academic research into this particular area has made valuable contributions to the general comprehension of language. Frequently, this has been represented by negative evidence, whereby a hypothesis that was previously regarded as correct was proven to be false when it was applied to a TTS system; moreover, as will be demonstrated in this study, numerous theories in the field of linguistics have been disproven when thoroughly tested in TTS systems In a more positive respect, TTS frameworks have proven to be effective testing environments for numerous models and theories, and TTS frameworks can be particularly intriguing themselves, regardless of their application or utilization. In order to demonstrate the common form of the model, it is important to demonstrate the functionality of a text-to-speech system. The first step in the process is for the input text to enter the system as an arrangement of ASCII characters, which can be formed of any length. In order to facilitate the processing of the characters, the text can be separated into distinct sentences by utilizing an algorithm for splitting the text. Although the original input may only consist of a single sentence, this will not always be clear and therefore it is essential that the process of determining sentence limits is conducted. Each sentence is further separated into a sequence of tokens, based on the existence of whitespace, punctuation and other factors. Frequently, tokens represent the encodings of individual words; however, they could also be encodings of numbers, dates and other characters. The next step is to determine the semiotic class of every token. In the case of non-normal language tokens, a different system is utilized to decipher the text into its underlying form, and then, based on established rules, this form is translated into a form of natural language with actual words. For normal language tokens, the process involves resolving any ambiguity in order to determine what the words are. The aim is to attempt a simple prosodic examination of the relevant text. Even though the situation may arise where a vast proportion of the required information is missing from the text, they system will aim to achieve optimal success using algorithms to ascertain the phraseology, the prominence of patterns and the intonation in the spoken language. This completes the text and prosodic examination stage of the process. The following phase in the process is called the synthesis phase, which commences by encoding the words found in the previous phase as phenomes. This part of the process is implemented to enable a more concise representation for the remainder of the synthesis phase. The combination of words, phonemes and phrasing constitutes the input specification for the unit choice module. Consequently, real synthesis is achieved by comparing the input specification with a pre-established database of recorded speech in order to determine a match (or as close as possible). The pre-recorded speech can be formed of database of waveform sections and, when a specific arrangement of these sections is selected, preparing system of signal processing is employed to stich them together to produce a single continuous output speech waveform. This process represents the basic functionality of current TTS systems. Each stage of the TTS process can present complexities; however, with the advancements observed in modern technology, while it is now possible to design an effective system with the aforementioned functionality, it is perhaps more challenging to produce a system that unfailingly returns high quality speech, regardless of the original input (Taylor, 2013).

3.3 Voice Recognition

Two specific concepts are related to the voice recognition process: speech comprehension and speech recognition. Speech understanding refers to the comprehension of a spoken statement with the outcome that one is capable of replying appropriately, regardless of whether all of the words in the statement have been recognized perfectly. However, speech recognition is fundamentally referring to the transcription of spoken words without the transcriber necessarily comprehending the speech. These two processes can be amalgamated; however, this section focuses purely on speech recognition. Automatic speech recognition and comprehension can be used in numerous practical situations. Inputting data into a machine is generally regarded as the generic use; however there are conditions where speech could be considered the favored or only option For example, a user that uses both hands and eyes to complete their duties, such as , a quality control inspector, employee taking inventory, cartographer, radiologist mail sorter, or airline pilot are illustrations of such situations. Another potential benefit could be in business, where it is more efficient to eliminate the problems of typing for individuals who are not proficient in that particular skill. Furthermore, innovations in this field can be particularly beneficial for persons with disabilities, who are often incapable of managing their surroundings without external assistance. Automatic speech recognition has been a complex issue for many years, with the first research papers on the subject dating back to 1950 (Denes, 2013). Subsequently, a number of approaches have been used, including for example, linear-time-scaled word-template, dynamic-time-warped word-template coordinating, phonetically motivates methods (discover the phonemes, collect into words, form into sentences), and hidden Markov models (HMM), were utilized. From all of the developed systems, HMMs are now producing the best results.

3.4 Android Design

Android is a broadly utilized operating system (OS) designed specifically for tablets and smartphones. Furthermore, it is an open source project driven by Google and it is licensed with the Apache Software License. This flexible license has enabled the OS to be accepted around the world and permits device producers free access to modification and customization. In fact, although the Android OS was originally targeted at mobile devices, it is now also utilized by other forms of technology such as televisions and cameras. Furthermore, a large community has developed around Android, who enhance its functionality and design new applications for a variety of purposes All Android applications, or apps, are created on the Android User Interface framework. In this context, the interface is the first aspect of the application that a user will communicate with. Consequently, the Android framework ensures that the user experience is constant for each application that is installed on people's mobile devices The Android system also simultaneously provides developers with the fundamental building blocks that form the basis of an advanced and reliable UI (API).

The Android User Interface is divided into three distinct categories:

- Home screen
- All apps
- Recent screen

The home screen is on the initial visual interface that users encounter after switching on the device. This interface offers advanced customizability as well as the option of selecting different themes. Furthermore, by activating so-called widgets, users have the opportunity to design and personalize their own home screen. All apps is the interface from which all applications that are installed on the device can be accessed, while the recent screen displays the applications that have been used recently Since its conception Android has experienced a significant transformation in terms of the features that it offers as well as the interfaces. Furthermore, the development of smartphone technology has enabled developers to design apps that are even more engaging. At the onset, applications using the Android platform were not consistent in terms of the user interface and the guidelines were not well structured; resultantly, each app assumed a different approach in terms of navigation and where the various buttons were located on the screen. The resulting effect was that Android users experienced confusion and this was perceived as the primary deficiency of the platform in comparison to the Apple iOS.

3.5 Touch Screen Principles

A touchscreen is a form of advanced technology that is formed of a digital visual display that has the capability of identifying both the presence and exact location of a human touch on the screen. The term predominantly alludes an individual's finger(s) or hand coming into contact with the display area. However, some touchscreens also have the capability to detect other objects, like a stylus. Today, touchscreens can frequently be found in widely-used devices such as all-in-one PCs, tablets and smartphones. Touchscreen displays can be connected to PCs or even networks via terminals. They are also key facets of advanced digital devices, including personal digital assistants (PDAs), sat-nav devices, cell phones and computer mobile applications.

The two primary properties of modern touchscreen technology are:

a) It enables direct user interaction with the information that is displayed, as opposed to indirectly through a mouse or touchpad.
b) It allows users to access conduct such activities without the necessity of using any manual intermediate devices.

The technology developed until this point has only enabled touchscreens to detect one contact location at a time, and only a limited number of devices had the functionality to detect the level of pressure that user applies. However, this situation is now transforming (Patschon, 2015).

A touchscreen is digital visual display which permits the user to control it via basic or multi-touch motions through either an object such as a stylus and/or one or more digits. Some examples of touchscreens required the user to wear normal or specially designed gloves, while others only function with a specific pen or stylus. The user has the ability to respond to the information that is displayed and can also control the manner in which it is displayed (by zooming in on text, for example). The touchscreen permits the user to directly interact with what is displayed on the screen without having to use external devices such as a mouse, touchpad or other similar instruments (apart from a stylus, which is an optional accessory for the majority of modern touchscreens) Today, touchscreens can frequently be found in technology such as video mobile application consoles, PCs, tablet PCs and smartphones. Furthermore, they can also be found in computers or in terminals connected to networks. Touchscreens are also prominent design features of various digital devices, including personal digital assistants (PDAs), sat-nav devices, cell phones, video mobile applications and even e-books.

The increasing popularity of mobile devices as well as other children of data appliances has been the driving force behind the demand and acceptance of everyday touchscreens in mobile and functional hardware. Touchscreens are now found in various sectors of society, including medicine heavy industry, automated teller machines (ATMs), automated kiosks such as in museums or automated rooms, where the traditional keyboard and mouse system do not permit the user to have intuitive, fast, or precise interaction with the displayed content (Johnson, 2013).

3.5.1 Touch screen technology

Touchscreen technology is a form of direct manipulation gesture-based technology. In this context, direct manipulation is the capability to control a digital environment within a screen without the necessity to use command prompt commands. A device that operates using touchscreen technology is now defined as a touchscreen device. A touchscreen is a digital visual display that has the capacity to distinguish and locate a touch at any point on its display screen. Touchscreens are generally sensitive to touch by human finger, hand, finger nail or objects such a stylus or specially designed pen. Through the use of the touchscreen, users have the ability to move things around the screen, scroll through text or images, and zoom in or out, among other features.

3.6 Design Based Research

Cobb et al. (2015) defined the design based research (DBR) as a set of measuring methods or techniques which stabilizes the interpretivist and optimists paradigm in order to provide a road map theory in educational practices. With learning environment it's a set of blended theoretical driven and experimental educational research model. The DBR is of utmost vital model because it provides with the understanding of why, how and when educational inventions operates in real. Brown et al. (2014) stated that the DBR techniques aim to determine the relationship that exist amongst practice, educational theory and designed artefacts. In this study design based research model was used by Easterday et al. (2014) in the developing process and they stated that the model consist of six iterative phases or stages during the designing a mobile application which consist of focus, understanding, defining, conceive, build and test.

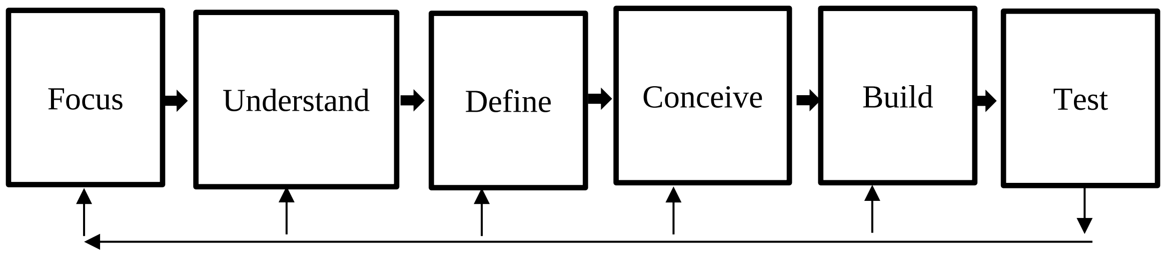


Figure 3.1: Design based research model iterative phases (Easterday et al. (2014))

- **Focus**

The focus phase is the first design based research model phase; which connect the designer with the target group, the project scope and the proposed topic. This phase define who the mobile application will serve with the inclusion of learners and other stakeholders. This phase indicates who is planning the mobile application and their purposes behind taking an interest. The phase determines the general issue the mobile application should address and how it should emerged. The degree determines the limitations and the size of the mobile application. Conclusively, this phase set a road map for the designing of the mobile application whilst guaranteeing that there is something worth outlining and the ability to succeed.

- **Understand**

The understand phase is the second design based research model phase; the learners context, existing solutions, and the domain are all examined in this phase. The understand phase examines the issue through experimental techniques and optional sources, and blends that information into a frame that can be effortlessly utilized later all the while. Experimental strategies incorporate fast human-focused procedures, for example, perception, meeting, reviews, information investigation, and so forth. Audit of optional sources concentrates on: look into that comprehends the issue, for example, models of learning and social settings; examination of current answers for comparable or related issues; and ID of plan standards.

The experimental information and research review should be combined through strategies, for example, distinguishing subjects, building graphical models and making student personas. Convincingly, this phase discover new features to add up to the proposed project.

- **Define**

The define phase is the third design based research model phase, in this phase goals and assessment are defined by changing over an uncertain problem or issue, which has no solution, into a determinate issue that can be solved. There are numerous approaches to outline an issue. For instance, assume that the originator finds that: (a) the objective students are from outsider groups, (b) their customer needs to enhance students' execution on regular center proficiency and urban training guidelines, and (c) there are crevices in inquire about writing about how to use students' social assets. The issue could be characterized as an issue of in what capacity may connect with learners in discusses about lawful status? or by what method may we instruct understudies to build video documentaries about movement approach? or in what capacity may instruct learners to dissect the political esteems in English/Spanish-dialect youth media? by finishing the sentence by what means may we? the architect chooses an objective from the unending and obscure number of objectives that could be characterized. Conclusively, this phase provide a solution to a problem which formerly has no solution.

- **Conceive**

The conceive phase is the fourth design based research model phase; designer draws an arrangement for the problem. Given a definition, the originator can design a plan proposed to achieve the objective. This includes envisioning an answer and dissecting whether it will work. In this stage, the planner has not focused on executing the outline in a given medium, yet rather makes a nonfunctional, typical or graphical portrayal that enables the designer to reasonably breaks down the arrangement by deciding the parts of the outline and how they may cooperate. Here, originators additionally create hypothetical items. The refinement between the consider and manufacture stage is between that of a theoretical arrangement compelled just by the planners learning and that of a solid model that is at any rate halfway utilitarian and obliged by a medium. Conclusively, this phase lets designer to evaluate the optimal tool to use out of many tools in which can be time consuming, difficult or even costly.

- **Build**

The build phase is the fifth design based research model phase; in this phase, the designers execute the solution accordingly. Once a plan has being conceived, the core designer can execute the outline in a shape that can be utilized. This usage can be of lower or higher devotion relying upon the phase of the venture and the inquiry that the planner needs to test, which might be about a specific part of the instructive mediation, or whether the instructive intercession as considered can accomplish its objective.

- **Test**

The test phase is the last design based research model phase, the designer assess the viability of the arrangement. Iterative client testing includes testing progressive renditions of the plan at expanding levels of constancy. Early testing of the plans created in the consider stage concentrates on inquiries of pertinence and consistency and after that later on expected reasonableness, with master surveys and walkthroughs. Testing frequently utilizes developmental assessment, which may not build up causality to the degree conceivable in controlled, randomized analyses, yet which can rapidly dismiss awful outlines. This improves the probability of finding a powerful outline that can be confirmed later through summative assessment. Some consider the limit amongst developmental and summative assessment the time when configuration look into closes and the sciences of the fake or for this situation, thorough assessments testing solid causal cases of outline standards, starts. However, substantial types of testing in DBR are considered. The testing phase is important because it gives an overall evaluation feedback of the project, to determine if the goals are achieved or not.

CHAPTER 4

DEVELOPED MOBILE APPLICATION

Mobile learning (or m-learning) refers to the ability to learn something regardless of the time or location through the use of a mobile technological device. In general, mobile learning has less structure than so-called e-learning; however, it has the capacity to significantly enhance this form of education. Furthermore, people around the world are now increasingly obsessed with performing activities rapidly, and education is no exception. Talk-Numbers developed here will be targeted at mobile learning of Mathematics and will specifically focus on assisting children to count from 7 to 10. This will be an example of a real-time application and will be simply designed to aid comprehension.

4.1 Target Groups

The goal of this application is to control the learning procedure of young children between the ages of 7 to 10 years to help them with the comprehension of basic Mathematics. Talk-Numbers will be deigned and developed in such a way, to the point that it is drawing in for the children regarding basic or essential, incorporating different inquiries, questions with an assortment of levels of difficulty with English as the second language. The idea of virtual learning is leaving on a journey of revelation, which gives imaginative adaptability, boundless assets and instructive material to children from nations around the globe. Mobile learning (or m-learning) is that the ability to be instructed wherever and at whatever point using through a compact gadget. As beforehand said, the idea of mobile learning (or m-learning) alludes to the capacity of picking up something, paying little mind to the time or area, using a mobile phone. However, mobile learning is less sorted out than e-learning, it can possibly decidedly fortify e-learning. In the current world, the worldwide populace is fixated on finishing errands rapidly, including learning. The execution of self-examine is obviously a basic part of learning. As far as subject authority, a little measure of time spent concentrate every week will essentially upgrade a child advancement. Thusly, the test introduced to teachers is the manner by which to persuade children who have chaotic existences to allot time. As the usage rates of portable or mobile technology is expanding exponentially, one arrangement is allowing the youngsters to work whenever or any area by utilizing a mobile phone or tablet. As opposed to over-burdening children with data which may hinder them, children can at first be urged to finish little and sensible homework assignments in which they can concentrate regarding the matter of Mathematics for 5-10 minutes every day. Thusly, the improvement of compelling applications will be motivational for the youngsters to learn in a portable way, which will return constructive outcomes. This will be especially engaging youngsters who fall into the high school class, as this statistic is accepted to take in more successfully in such an interactive domain or environment.

4.2 Device Specification

In order for this application to function efficiently a platform is required and in this case, the Android mobile platform will be adequate. In the modern technological era, there are numerous devices that can utilize Android applications. This application has been designed to operate on devices that support Android version 4.0.4 or above. Consequently, on the application will function effectively on any device that has the capability to support these versions of the Android operating system. The platform for the application should comprise the Android OS, v4.0.4 (Ice Cream Sandwich) or 4.3 (Jelly Bean), with a Exynos 4412 Quad chipset, and the CPU should be at a minimum Quad-core 1.4 GHz Cortex-A9 and the GPU should be at a minimum Mali-400MP4 for the application to function at a suitable speed. It is essential that it has a GSM/HSPA for information technology and should have the capacity to function with a Wi-Fi Internet connection.

4.3 Application Features

This application the capacity to operate independently without the necessity to connect to the Internet in the circumstance that the student is unable to do so. Talk-Numbers is extremely small with a raw.apk file of only 2.2. MB and installation is relatively simple and quick. The application was designed using the Android mobile application developer and therefore only functions on this particular platform.

4.4 Area Of Use

This application is targeted at facilitating the learning of Mathematics for younger students. Consequently, prior to the development of the application, it was essential that the Mathematic abilities of young children were investigated. While it was determined that the majority of children do not comprehensively understand the subject, they demonstrate the ability to be quick learners. For this reason, the application begins with relatively easy questions and progresses to more complex problems. Mathematics is taught in the educational system in this area, which means that the application will not completely replace the traditional mode of learning in the classroom, but will be a guide to assist the students' learning of the knowledge they acquire at school.

4.5 Application Database

SQLite is a C library that provides a lightweight disk-based database that does not require an isolated server process and allows the database to be opened by utilizing a non-standard alternative of the SQL query. Various applications can utilize SQLite for internal information storage. Furthermore, it is conceivable that a sample application could be created utilizing SQLite and the code could be subsequently transferred to a larger database namely Oracle or PostgreSQL.

4.6 Application Architecture

The system architecture provides in-depth information on structure as well as how all the features are interconnected. Applications that are designed for mobile learning should be relatively straightforward as they are an instrument for learning and therefore should be easily comprehended by the users.

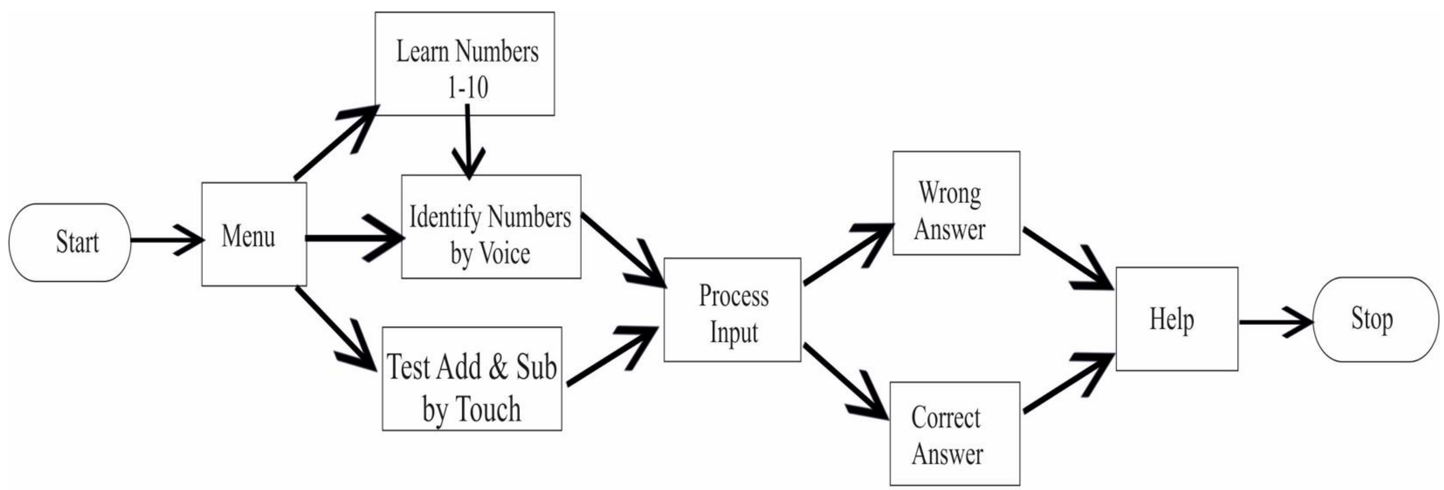


Figure 4.1: Application architecture

4.7 Applications Questions

The application questions were designed in regard to the level of comprehension of the students. The use of the application to deliver these questions to these children will facilitate their ability to understand the concepts of Mathematics.

- **Level 1:** The first level is designed to help the children to understand the basic number system from 1 to 10 as well as how to pronounce these numbers. Furthermore, a fruit is displayed to depict each of the numbers. For example, if the child is to learn the number 2, then 2 fruits will be shown on the screen to relay to the child the concept of that number. Furthermore, the applications teach the student how to pronounce the number 2, which is one of the aims of the application that is a pre-requisite for the following level
- **Level 2:** The second level includes a total of 10 questions, and each question has three possible answers. The objective of this level is to test the child's acquisition of the concepts learned in the first stage. In this stage, fruits are presented to the child and they are expected to say aloud the correct number of fruits that are displayed. For instance, if there are 4 oranges displayed, the child is expected to say the number 4 and the application will subsequently display on the screen whether the answer is correct
- **Level 3:** This level also displays 10 questions, which test the student's ability to add and subtract. The questions are displayed to the child and they are expected to select the correct answer out of the three available options. At the end of the test, the results will be displayed on the screen.

4.8 Application Description

This flow chart describes the application flow the beginning of the application to its end point. At the start of the mobile application, the child is presented with a menu option, which contains four different options. The first option is related to learning the numbers from 1 to 10. The mobile application uses the uses the mobile device's speakers to verbalize each number as the child selects them. For example, if the child presses number 1, the application will say the number 1 so that the child can clearly here it. In the second level, the child is required to verbalize the number of fruit(s) that he or she can observe. For instance, if four fruits are displayed, the child say the word four and the application will consequently utilize Google's voice recognition system using the device's in-built microphone to recognize the word that the child said, and then compare it with the items displayed on the screen. If the child answers correctly, a smiley is displayed to demonstrate to the child that they were correct; however, if the answer is incorrect, a sad face is displayed. The next level tests the child's Mathematical abilities, in which simple addition and subtraction questions are presented. For instance, the question could be a subtraction problem such as 3-2. The application also shows 3 fruits next to the number 3 and 2 fruits next to the number 2 to facilitate the child's understanding of the question. The child is required to select the answer from two options and then in a similar manner to level 2, a smiley face is displayed if the answer is correct and a sad face if incorrect. The last stage is the Help option in which the student can understand how the application functions.

4.9 Interface Design Principles

The interface of the specific application was done in a way that it will be user friendly to the children. The interface is very interactive and amicable designed. Instead of exhibiting the greater part of the accessible materials to students, insightful frameworks must be worked to build up an underlying profile of the student and present materials that will profit the particular student. As the learning framework connects with the students, it finds out about every understudy and adjusts the interface and route design as indicated by that student's style and needs. On account of the restricted display limit of m-learning gadgets, designers must utilize introduction systems to empower students to prepare the materials productively. Since working memory has constrained limit, data ought to be composed or lumped into bits of a fitting size to encourage handling. As indicated by Miller (2013), in light of the fact that people have restricted here and now memory limit, information ought to be assembled into important groupings. Information to be shown on m-learning gadgets ought to be pieced into in the vicinity of five and nine significant units to adjust for the restricted limit of here and now memory and the impediment of the show gadget.

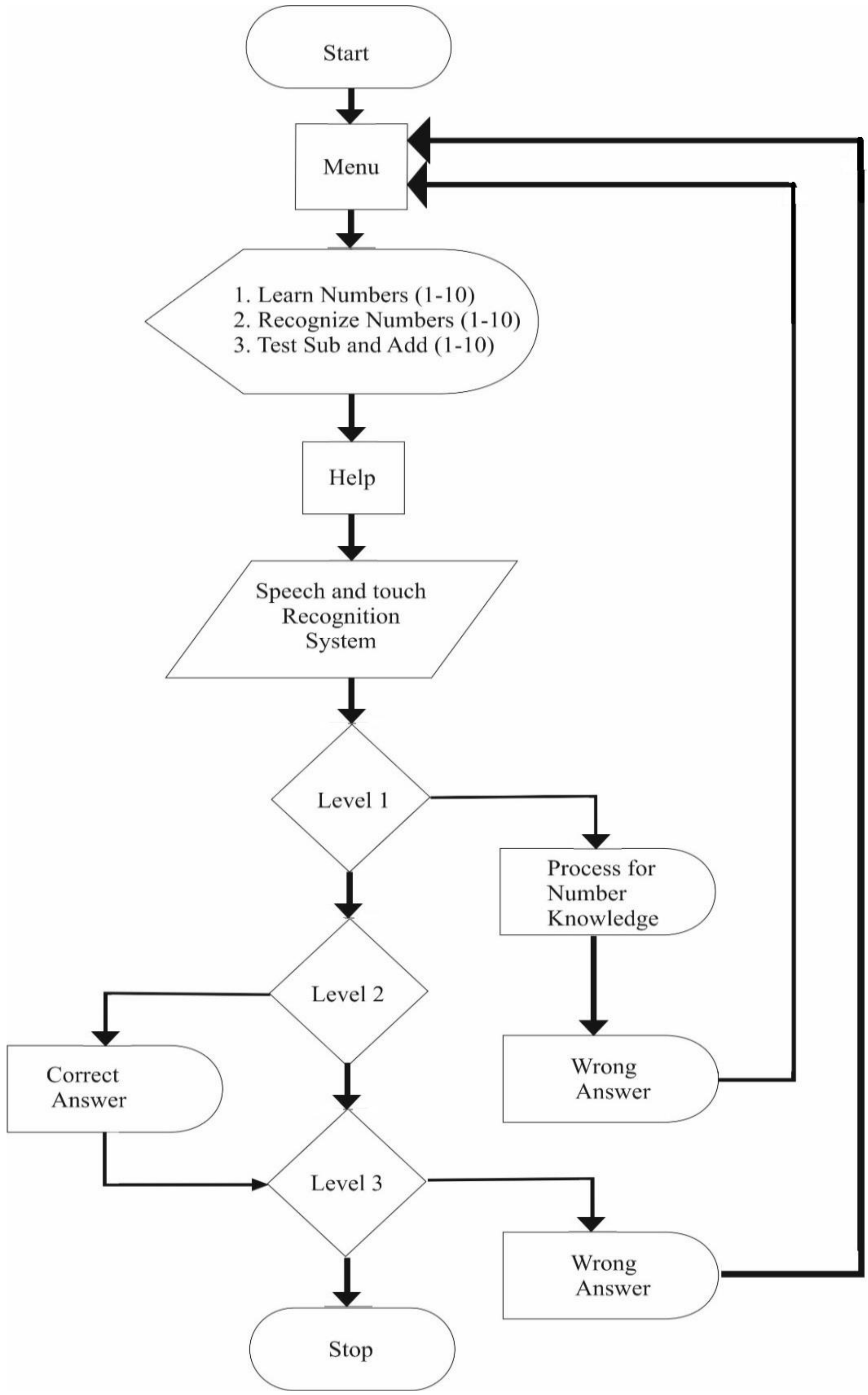


Figure 4.2: Flowchart describing the developed mobile application

CHAPTER 5

IMPLEMENTATION

The mobile application is developed to provide assistance to children who face difficulties with understanding the subject of Mathematics. This chapter offers detailed explanation on how the application has been specifically designed with simple processes to aid the understanding of children.

5.1 Start Page

This is the page displayed after successful installation of the app. It has three (3) mobile application play options:

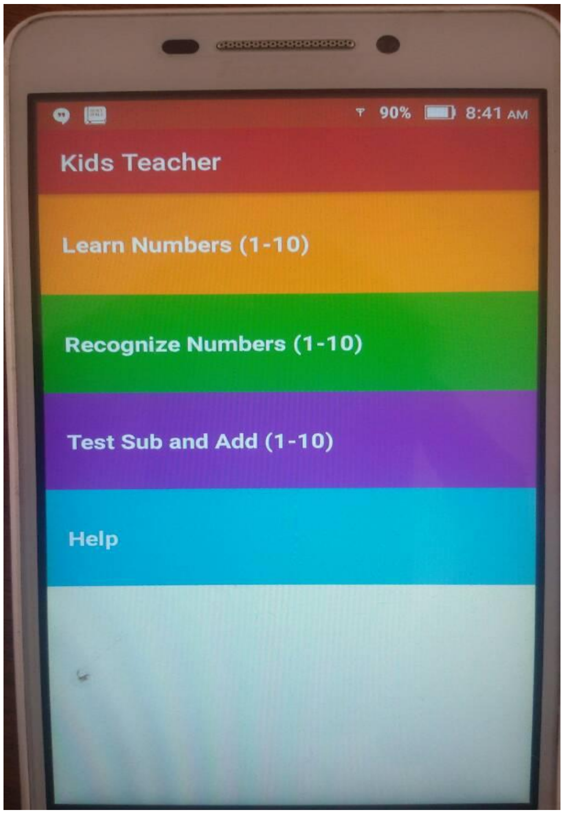


Figure 5.1: Home page

5.2 Learn Numbers (1-10)

Level 1 is designed to help children understand the number system from 1 to 10 as well as how the numbers are pronounced. It also displays fruits depicting the associated number. For instance, if the child is to learn the number 2, then two fruit will be show to visually demonstrate the number to the child. Furthermore, the applications teaches the child how to pronounce the numbers, which is a skill that will be required in the following level of the application. The only feedback given here is the voice which says exactly the number the child selected, where the child can learn pronunciations, for this purpose speech recognition system was used.

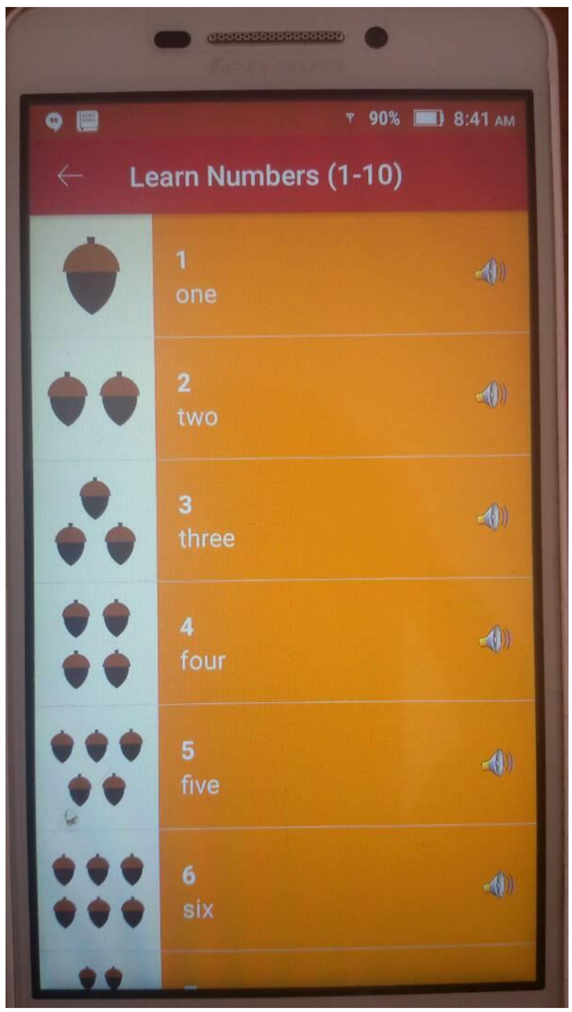
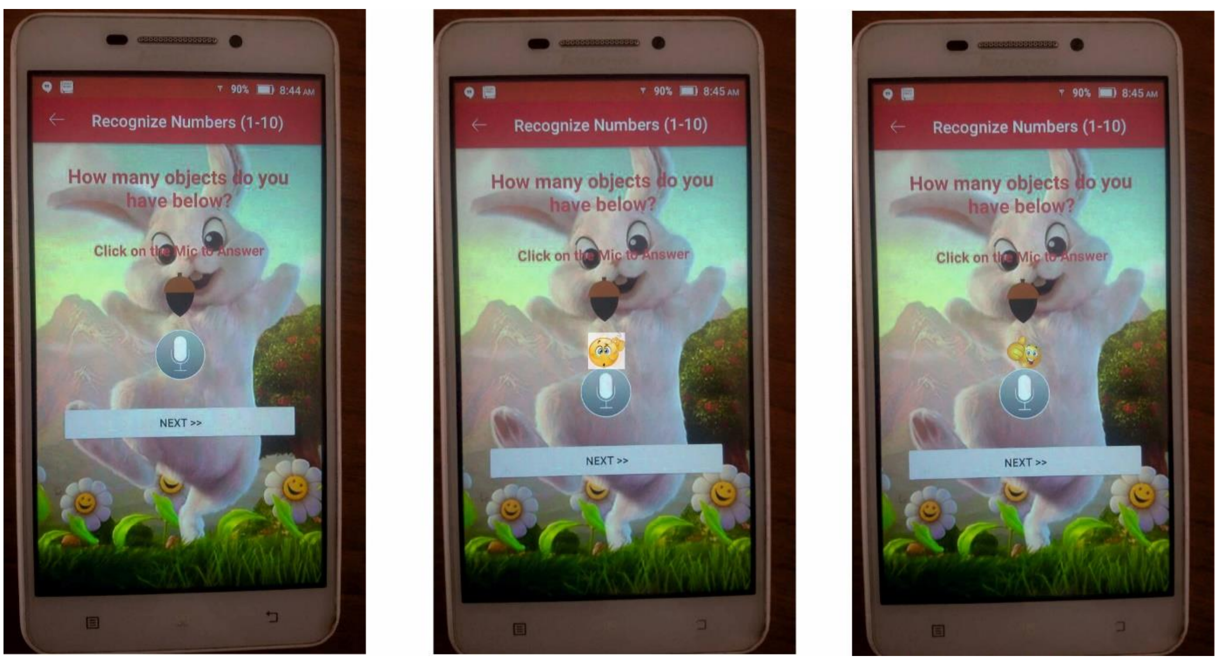


Figure 5.2: Learning numbers (1-10)

5.2.1 Test of knowledge of numbers by Voice (1-10)

Level 2 includes ten questions and each question has three options to choose from. The aim of this level is to test the level of comprehension from the previous level. In this stage, fruits are presented to the child and they are expected to verbalize the correct number of fruit. For instance, if four oranges are displayed, the child is expected to say the number four and the application will display on the screen whether the answer is correct or incorrect. If child answers incorrectly, the application displays to the child the wrong answer and then displays what he or she should have said. In this case, feedback was shown to the child to show if the answer was given correctly or wrong. Speech recognition happens to be the originality of this level.



(a) Say the number of fruits displayed

(b) Feedback if answer is incorrect

(c) Feedback if answer is correct

Figure 5.3: Snapshot of level 2 of the mobile application

5.3 Test Subtraction and Addition (1-10)

This level also has 10 questions which test the child's understanding of addition and subtraction. The questions are displayed to the child and he or she is expected to select the correct answer from the two displayed options. At the end of the test, the results will be displayed on the screen. The originality of this level is to test the child ability in adding and subtracting numbers which is done by touch (tapping the correct option from the 2 options displayed).

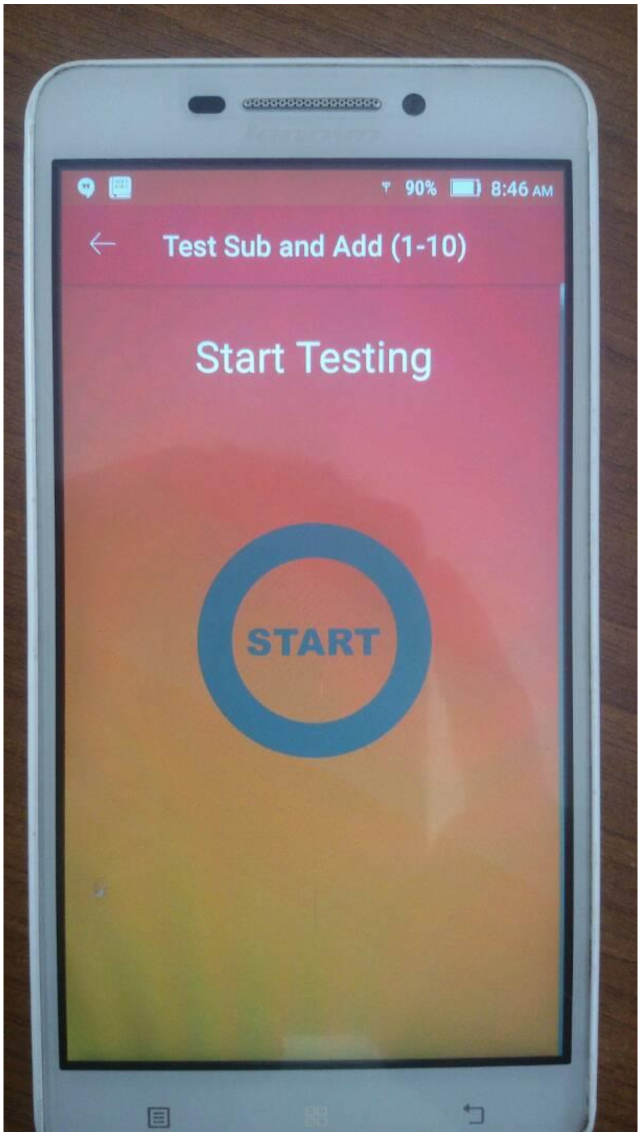
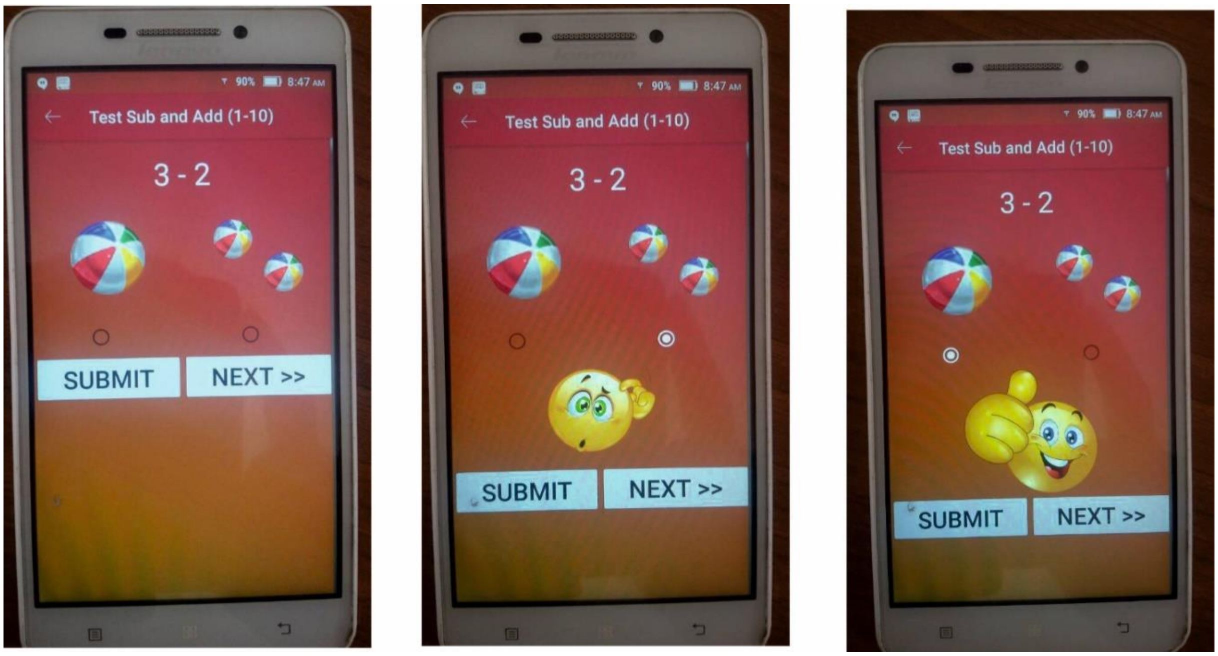


Figure 5.4: Test subtraction and addition start page



(a) Tap the correct answer

(b) Feedback if answer is incorrect

(c) Feedback if answer is correct

Figure 5.5: Snapshot of Level 3 of the mobile application

5.4 Help

This section presents the application instructions and can be a guide to advise parents and teachers on how they can assist the children with using the application and the children themselves can understand the application functionality. For example, it can demonstrate how to perform simple addition and subtraction.

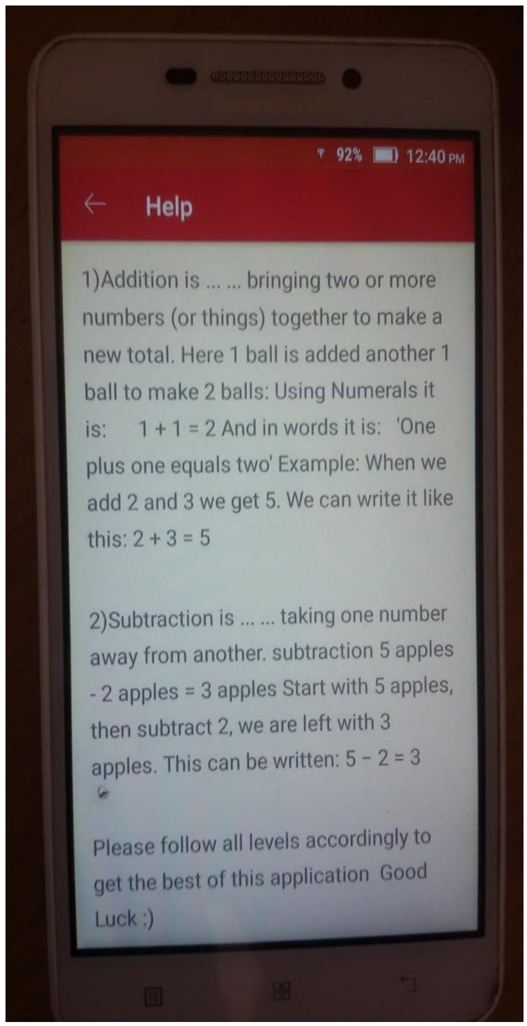


Figure 5.6: Help section

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

It is not an easy process to develop an application that is appropriate for young children based on modern technology using Google’s voice recognition system with a combination of e-learning resources. In this study, a mobile application has been developed and described to facilitate children learning of basic Mathematics both inside and outside the classrooms, in order make the learning of Mathematics more interesting and interactive for the children. It application is an educational tool which can be used by both teachers and parents in helping the child learn Mathematics speedily. The developed mobile application is an educational tool that can teach Mathematics attractively as well as making it enjoyable, which means that the fear of the subject experience by children will be decreased. Therefore, this study will aid to fill the gap/add to the existing learning mobile applications that currently exist. The developed mobile application will be helpful to children, to researchers, to educational establishments, and to other people who might be interested in developing mobile phone applications for children.

6.2 Recommendations

The following are recommended for more effective research and development of mobile application.

6.2.1 Recommendations for schools, teachers and parents

- It is recommended that the developed mobile application should be incorporated into the school’s curriculum to encourage it to be used at different levels of education.

- Teachers should encourage their students to utilize the application because it will be instrumental in the process of acquiring Mathematical knowledge.

- Teachers should be advised and educated on how they can make effective use of the application by monitoring the children progress and understanding the kinds of questions that they should be given.

6.2.2 Recommendations for mobile application developers

- The questions could be expanded to other subjects like chemistry and current affairs.

- The delivery of grades could be upgraded to the level of sending text messages directly to the parents' phone numbers.

- More questions could be added to each of the levels to increase amount of interactive time spent on the app.

- Age groups could be increased to cover children of different ages, and the app can also offer a section for adults.

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APPENDICES

APPENDIX 1

LEVEL 1: LEARNING TO IDENTIFY NUMBERS AND LEARN THE PRONOUNCIATIOS

Level 1 is designed to help Children understand the number system from 1 to 10 as well as how the numbers are pronounced. It also displays fruits depicting the associated number. For instance, if the child is to learn the number 2, then two fruit will be show to visually demonstrate the number to the child. Furthermore, the applications teaches the child how to pronounce the numbers, which is a skill that will be required in the following level of the application. The only feedback given here is the voice which says exactly the number the child selected, where the child can learn pronunciations.


```xml
<?xml version="1.0" encoding="UTF-8"?>
<project version="4">
  <component name="AndroidLayouts">
    <shared>
      <config />
    </shared>
  </component>
  <component name="AndroidLogFilters">
    <option name="TOOL_WINDOW_CONFIGURED_FILTER" value="Show only selected
application" />
  </component>
  <component name="ChangeListManager">
    <list default="true" id="cdb71adf-58a4-42b9-98fc-b0e378115d76" name="Default"
comment="" />
    <ignored path="Kids Teacher.iws" />
    <ignored path=".idea/workspace.xml" />
    <option name="EXCLUDED_CONVERTED_TO_IGNORED" value="true" />
    <option name="TRACKING_ENABLED" value="true" />
    <option name="SHOW_DIALOG" value="false" />
    <option name="HIGHLIGHT_CONFLICTS" value="true" />
    <option name="HIGHLIGHT_NON_ACTIVE_CHANGELIST" value="false" />
    <option name="LAST_RESOLUTION" value="IGNORE" />
  </component>
  <component name="CreatePatchCommitExecutor">
    <option name="PATCH_PATH" value="" />
  </component>
  <component name="ExecutionTargetManager" SELECTED_TARGET="default_target" />
  <component name="ExternalProjectsData">
    <projectState path="$PROJECT_DIR$">
```

```
      <ProjectState />
    </projectState>
  </component>
  <component name="ExternalProjectsManager">
    <system id="GRADLE">
      <state>
        <projects_view />
      </state>
    </system>
  </component>
  <component name="FavoritesManager">
    <favorites_list name="Kids Teacher" />
  </component>
  <component name="FileEditorManager">
    <leaf>
      <file leaf-file-name="MainActivity.java" pinned="false" current-in-tab="false">
        <entry
file="file://$PROJECT_DIR$/app/src/main/java/com/mobolade/kidsteacher/MainActivity.java
">
          <provider selected="true" editor-type-id="text-editor">
            <state relative-caret-position="270">
              <caret line="20" column="41" selection-start-line="20" selection-start-column="41"
selection-end-line="20" selection-end-column="41" />
              <folding>
                <element signature="imports" expanded="true" />
                <element signature="e#893#1145#0" expanded="true" />
                <element signature="e#1144#1145#0" expanded="true" />
                <element signature="e#1243#1498#0" expanded="true" />
                <element signature="e#1497#1498#0" expanded="true" />
                <element signature="e#1595#1845#0" expanded="true" />
                <element signature="e#1844#1845#0" expanded="true" />
              </folding>
            </state>
          </provider>
        </entry>
      </file>
      <file leaf-file-name="ColorsActivity.java" pinned="false" current-in-tab="false">
        <entry
file="file://$PROJECT_DIR$/app/src/main/java/com/mobolade/kidsteacher/ColorsActivity.ja
va">
          <provider selected="true" editor-type-id="text-editor">
            <state relative-caret-position="450">
              <caret line="59" column="82" selection-start-line="59" selection-start-column="46"
selection-end-line="59" selection-end-column="82" />
              <folding>
```

<element signature="imports" expanded="true" />
<element signature="e#1507#2613#0" expanded="true" />
<element signature="e#2163#2587#0" expanded="true" />
<element signature="e#2586#2587#0" expanded="true" />
<element signature="e#2612#2613#0" expanded="true" />
</folding>

APPENDIX 2

LEVEL 2: LEARNING TO IDENTIFY NUMBERS AND LEARN THE PRONOUNCIATIOS BY VOICE RECOGNITION

Level 2 includes ten questions and each question has three options to choose from. The aim of this level is to test the level of comprehension from the previous level. In this stage, fruits are presented to the child and they are expected to verbalize the correct number of fruit. For instance, if four oranges are displayed, the child is expected to say the number “four” and the application will display on the screen whether the answer is correct or incorrect. If child answers incorrectly, the application displays to the child the wrong answer and then displays what he or she should have said. In This case, feedback was shown to the child to show if the answer was given correctly or wrong. Speech recognition happens to be the originality of this level.

```
  <configuration default="true" type="TestNGTestDiscovery" factoryName="TestNG Test
Discovery" changeList="All">
    <extension name="coverage" enabled="false" merge="false" sample_coverage="true"
runner="idea" />
    <module name="" />
    <option name="ALTERNATIVE_JRE_PATH_ENABLED" value="false" />
    <option name="ALTERNATIVE_JRE_PATH" />
    <option name="SUITE_NAME" />
    <option name="PACKAGE_NAME" />
    <option name="MAIN_CLASS_NAME" />
    <option name="METHOD_NAME" />
    <option name="GROUP_NAME" />
    <option name="TEST_OBJECT" value="CLASS" />
    <option name="VM_PARAMETERS" />
    <option name="PARAMETERS" />
    <option name="WORKING_DIRECTORY" />
    <option name="OUTPUT_DIRECTORY" />
    <option name="ANNOTATION_TYPE" />
    <option name="ENV_VARIABLES" />
    <option name="PASS_PARENT_ENVS" value="true" />
    <option name="TEST_SEARCH_SCOPE">
      <value defaultName="singleModule" />
    </option>
    <option name="USE_DEFAULT_REPORTERS" value="false" />
    <option name="PROPERTIES_FILE" />
    <envs />
```

```
      <properties />
      <listeners />
      <method />
    </configuration>
    <configuration default="false" name="app" type="AndroidRunConfigurationType"
factoryName="Android App" activateToolWindowBeforeRun="false">
      <module name="app" />
      <option name="DEPLOY" value="true" />
      <option name="ARTIFACT_NAME" value="" />
      <option name="PM_INSTALL_OPTIONS" value="" />
      <option name="ACTIVITY_EXTRA_FLAGS" value="" />
      <option name="MODE" value="default_activity" />
      <option name="PREFERRED_AVD" value="" />
      <option name="CLEAR_LOGCAT" value="false" />
      <option name="SHOW_LOGCAT_AUTOMATICALLY" value="true" />
      <option name="SKIP_NOOP_APK_INSTALLATIONS" value="true" />
      <option name="FORCE_STOP_RUNNING_APP" value="true" />
      <option name="TARGET_SELECTION_MODE" value="SHOW_DIALOG" />
      <option name="USE_LAST_SELECTED_DEVICE" value="true" />
      <option name="PREFERRED_AVD" value="" />
      <option name="SELECTED_CLOUD_MATRIX_CONFIGURATION_ID" value="-1" />
      <option name="SELECTED_CLOUD_MATRIX_PROJECT_ID" value="" />
      <option name="DEBUGGER_TYPE" value="Auto" />
      <Auto>
        <option name="USE_JAVA_AWARE_DEBUGGER" value="false" />
        <option name="SHOW_STATIC_VARS" value="true" />
        <option name="WORKING_DIR" value="" />
        <option name="TARGET_LOGGING_CHANNELS" value="lldb process:gdb-remote
packets" />
        <option name="SHOW_OPTIMIZED_WARNING" value="true" />
      </Auto>
      <Hybrid>
        <option name="USE_JAVA_AWARE_DEBUGGER" value="false" />
        <option name="SHOW_STATIC_VARS" value="true" />
        <option name="WORKING_DIR" value="" />
        <option name="TARGET_LOGGING_CHANNELS" value="lldb process:gdb-remote
packets" />
        <option name="SHOW_OPTIMIZED_WARNING" value="true" />
      </Hybrid>
      <Java />
      <Native>
        <option name="USE_JAVA_AWARE_DEBUGGER" value="false" />
        <option name="SHOW_STATIC_VARS" value="true" />
        <option name="WORKING_DIR" value="" />
```

```
    <option name="TARGET_LOGGING_CHANNELS" value="lldb process:gdb-remote
packets" />
    <option name="SHOW_OPTIMIZED_WARNING" value="true" />
  </Native>
  <Profilers>
    <option name="ENABLE_ADVANCED_PROFILING" value="false" />
    <option name="SUPPORT_LIB_ENABLED" value="true" />
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  </Profilers>
  <option name="DEEP_LINK" value="" />
  <option name="ACTIVITY_CLASS" value="" />
```

APPENDIX 3

LEVEL 3: FEEDBACK BY TAPPING THE CORRECT ANSWERS

This level also has 10 questions which test the child’s understanding of addition and subtraction. The questions are displayed to the child and he or she is expected to select the correct answer from the two displayed options. At the end of the test, the results will be displayed on the screen. The originality of this level is to test the child’s ability in adding and subtracting numbers which is done by touch (tapping the correct option from the 2 options displayed).

```
  </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
            <option name="name" value="generateReleaseSources" />
          </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
            <option name="name"
value="incrementalReleaseUnitTestJavaCompilationSafeguard" />
          </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
            <option name="name" value="preReleaseBuild" />
          </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="description" value="Assembles all variants of all applications and
secondary packages." />
            <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
            <option name="name" value="assemble" />
          </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
            <option name="name"
value="incrementalDebugUnitTestJavaCompilationSafeguard" />
          </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
            <option name="name" value="incrementalReleaseJavaCompilationSafeguard" />
          </ExternalTaskPojo>
          <ExternalTaskPojo>
            <option name="description" value="Displays a help message." />
```

```
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="help" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="compileReleaseUnitTestSources" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="description" value="Installs the android (on device) tests for the
Debug build." />
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="installDebugAndroidTest" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="mergeDebugAssets" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="javaPreCompileReleaseUnitTest" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="description" value="Prepare com.android.support:support-core-
ui:25.3.1" />
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name"
value="prepareComAndroidSupportSupportCoreUi2531Library" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="javaPreCompileRelease" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="description" value="Runs all device checks on currently connected
devices." />
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="connectedCheck" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
        <option name="description" value="Installs and runs the tests for debug on
connected devices." />
        <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
        <option name="name" value="connectedDebugAndroidTest" />
      </ExternalTaskPojo>
      <ExternalTaskPojo>
```

```
  <option name="description" value="Uninstall all applications." />
  <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
  <option name="name" value="uninstallAll" />
</ExternalTaskPojo>
<ExternalTaskPojo>
  <option name="linkedExternalProjectPath" value="$PROJECT_DIR$" />
  <option name="name" value="transformNativeLibsWithMergeJniLibsForDebug" />
```