INTERACTIVE MOBILE LEARNING ENVIRONMENT FOR SCHOOL CHILDREN

MS Thesis Dissertation

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(2012)

1- Software reliability

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Dated: August 15, 2012

FINAL APPROVAL

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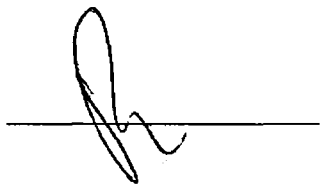

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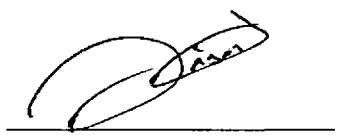

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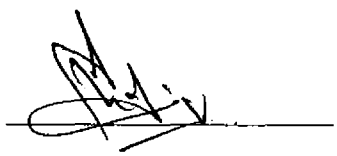

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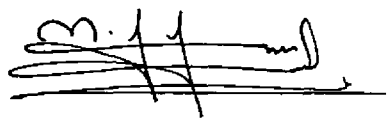

DECLARATION

I, hereby, declare that this thesis, neither as a whole nor as a part, thereof, has been copied out from any source. It is further declared that I have prepared this thesis entirely on the basis of my personal effort made under the kind and sincere guidance of my supervisors.

No portion of the work, presented in this thesis, has been submitted in support of any application for any degree or qualification of this or any other university or institute of learning.

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IN THE NAME OF

ALLAH,

THE MOST MERCIFUL AND BENEFICIENT

Dedication

"To my great parents who nourished me and guided me to the right path, what I am today is only due to their relentless efforts for my sake"

ACKNOWLEDGMENT

All praises are attributed to the sole creator of the universe "Almighty Allah", the Compassionate, the Merciful, the Source of all knowledge and wisdom, Who bestowed upon me health, thoughts, talented, sincere and cooperative teachers, friendly brothers, helping friends and Who gave me the strong courage and endurance to complete this thesis.

I express my deepest and sincere gratitude to my honorable and dignified supervisors **Mr. Shafiq-ur-Rehman** (Assistant Professor) Department of Computer Science, National Univesity of Computer and Emerging Sciences (FAST) and **Mr. Muhammad Imran Saeed** (Assistant Professor) Department of Computer Science and Software Engineering, International Islamic University (IIUI), for his inspiring guidance and continuous encouragement during the course of this research study.

I am also grateful to my all those friends specially Mr. Jahangir Khan who support me in data colloection, experimentation, reviewing and evaluation of my research work.

I am also grateful to Dr. Abdul Rauf, Mr. Shahbaz Ahmad who endowed their valuable time for my kind support.

Ghulam Murtaza

ABSTRACT

Based on the theories presented in Literature Review, it has been concluded from various viewpoints of the research community that mobile-based technology can be utilized in the education system successfully. In the light of this concept, researchers' community is increasingly involved to utilize the mobile technology for learning purposes in accordance with their own cultural and educational domains. At this point, the various differences in respect of culture, educational systems, and levels of education, have impacts on providing solutions using mobile technology for learning environment. Literature review concludes that the existing learning methods devised at primary education levels lack the mobile-based learning (mBL) methods in the perspective of Pakistan Education System. This research effort discussed the same scenario as a case study to adapt and implement for Pakistan Education System. The aim of this research work is to integrate mBL with CLS, and to see that how mBL affect the CLS in terms of Learnability in the perspective of Pakistan learning environment. This case study was meant to be conducted at Primary education level.

For the case study conduction and reporting in the field of software engineering, this research work followed the guidelines and the recommended practices provided by P. Runeson et al. The case study process was held in the five major steps. In the first step the objectives were defined and the case study was initially planned. Objective enlists the overall expected goals to be achieved from the study. In the second step, the procedures and protocols for data collection were defined. The procedures for data collection and data analysis were defined in *Case Study Protocol* (i.e., Field Procedures). In the third step, execution was made with data collection on the studied case. In the fourth step, the collected data was analyzed. Finally, in the fifth step, the report was placed.

Further, in order to validate the hypothesis and its resulting effectiveness, a prototype "1Paki mBL" was developed using Objective C in X-Code framework, which accommodates with the learning methods of Primary Education system in Pakistan. The formally designed pre-tests, post-tests, questionnaires, and interviews helped in evaluating the effectiveness of the prototype. The prototype "1Paki mBL" is evaluated with Heuristic Evaluation Strategy to analyze the Learnability aspect. The strategy adapted helped in preparing open-ended and close-ended questionnaires in conformance to the components described for the Learnability aspect to interview the educators.

The instruments Pre-tests and Post-tests, 1Paki mBL (prototype), Open-ended and Close-ended questionnaire were carefully designed in teamwork in order to keep the consistency of the various viewpoints of the stakeholders involved during the initial planning of the case study. The team was comprised of three Senior Education Specialists, one psychologist, one Software Ergonomic Expert, and one Software Programmer.

The various viewpoints which were taken into consideration to see the various impacts of integrating mBL with CLS are Interesting, Learnability, Exciting, Quick Learn, Helpful, Like, Difficult (cross question), User-friendly, mBL Environment, mBL Suitability. .

Based on merging individual and summarized data, systematic quantitative analysis was performed on the data to further analyze, discuss, and draw conclusion to the case study in the form of reports. The hypothesis generation was initially predicted from the literature review which was further made cleared from the collected data. The techniques used for the purpose was *constant comparisons.* This technique was utilized on both post-tests and pre-tests comparisons and open-ended and close-ended questionnaire comparisons. The analyzed units in the case study gave a blurred picture of the hypothesis initially. The hypotheses confirmation was made initially after generating the results i.e., on finding out the mobile-based learning environment suitability in Pakistan education system. This was further confirmed with further analysis on generated statistical results in tabular and graphical form. This analysis was made by the reviewers and the initial planners in team. At this stage, the blurred picture of hypothesis was made further cleared on the basis of information consolidation. The success rate and effectiveness of the proposed approach was described with the help of results based on the data analysis of interview processes and tests. The study results showed that various prescribed components for the Learnability aspect in mobile-based learning (mBL) environment is found more effective than conventional learning system (CLS). Further, the various viewpoints reports indicated, that it should be more effective to integrate mBL with CLS in the perspective of Pakistan educational system.

Keywords: mBL, 1Paki mBL, CLS, Nursery, Kindergarten, Primary, Pre-Tests and Post-Tests.

Contents

CHAPTER 1

INTRODUCTION

1.1 Mobile Learning

Handheld computers provide best opportunities and they also suit teaching and learning environment. The devices with touch screen seem likely to use faster than those of PCs with mouse. Because of its easy handling mobile nature, the children learn quickly from the touch-screen handheld devices. [1]

Nowadays, media customers wish to become active participants rather than passive observers of information. This is actually visible in the internet usage. Earlier net was assumed as a source of information only but today the virtual network environment with social and communal nature is recognized, also. The information is constructed online with the sharing of opinions and images. Further, user understands the power of their virtual environment and one can act as producer and consumer as well. [4]

Today, the communication technologies have started meeting our living aspects. The communication technology is not only changing the ways we communicate, it does alter the ways we receive and deliver trainings. The improvements and advances in the technology of wireless network empower mobile phones for sharing videos, text and animations any where - any time. The mobile devices are now increasingly becoming affordable and are available with sophisticated versions, the reason why it is in use of ordinary customers. The result is that later or sooner we will see that software engineering community would begin to look for new ways of activating learners in making use of this technology. [8]

In developing countries, mobile phones have large infiltration rate as compared to laptop and desktop type computers. [12]

Mobile technologies provide possibilities to implant learning facilities within natural environment. For the people working part time or full time, mobility provides opportunity to maximize their learning time with the help of its anywhere-anytime embedded nature. Mobile technology is becoming meaningful contribution for the increase in learning performance of learners. [19]

1.2 Mobile Game Based Learning

Today computer games are becoming an important part as a whole of our cultural lives and more specifically an important part of children's leisure time lives as well. Videos and computer

games are increasingly becoming popular since 2002. People including all levels of ages play these games and especially children are dedicating long time in concentration towards these games. Also, gaming helps in solving complex problems, builds up social networks for interactions among each other. In future, games are increasingly becoming an important part as a learning environment and teaching method. With this trend, the software engineering community has been involved in converting gaming environment into a meaningful and motivating learning environment. The researchers and teachers are little bit speculate about that either this technology could be used within learning environment. One of the main advantages of games software is its power to motivate people. [3]

Various feedback found in literature suggested that the simulated nature of gaming environment produces positive results on learning environment. [4]

In those regions where exists lack to structural support, for example, instructors, schooling environment, literate parents etc, mobile learning with playfulness aspect may be an ideal or suitable option for learning. For the purpose to proceduralize the decoding skills and to understand which letter corresponds to which object sound, children need considerable practice. But they can perfectly practice only when the materials are easily available for them and also provides them fun. The only solution to make this happen is the mobile learning technology. [9]

As long as mobile phones are becoming increasingly famous, the researchers are using these devices for various teaching and learning purposes. For young ones mobile learning environment can be provided depending on their abilities in terms of technical, learning, and language proficiency. [13]

Literature suggests that both learning and gaming environments can be merged to develop and implement the required mobile applications successfully. The underlying issue is to merge the game theories and designs with the instructional design of learning environment. [15]

It has been observed from the literature that Mobile Game Based learning provides fun and attractions for the children. Due to the exiting and interesting environment provided by the mobile-based learning, children finds a change in their learning setup which gets them not bored. Moreover, Mobile game based learning allows the user to anytime and everywhere access of the game, thereby, increasing the learning time for children. At the same time, the development

community continuously involves in providing better and better environments from usability aspect. [16]

1.3 Specificity of the Situation and Cultural Sensitivity with Using Mobile Technology

The learning solutions with mobile devices cannot be formulated in accordance with the pre-existing penalizing matrices and also with learning design principles, but these solutions must be done related to practical problems, specific to the learners' circumstances. Even the latest learning principles of mobile devices, those validated by practical studies and learning environment obtainable to the indigenous children in the developed countries, may be inapplicable to this population. According to Murphy (2006), it is necessary to consider and concentrate on the cultural and societal factors during designing the mobile learning solutions. In the field of reading growth, researchers have unveiled in some of mysteries that how child significantly learns to read and provides significant guidance for the flourishing readings programs. In the light of this concept, we need to create the learning contents in such a way that is pedagogically valuable and culturally suitable for the indigenous children. One thing is universally applicable in all circumstances and cultural aspects, that learning should provide fun, satisfaction, and gratifying. Playfulness aspect is the key feature that needs to be integrated into these mobile applications for young children with maintaining the right balance.

The discussion concludes as, those mutually necessary elements, for example, specificity of situation, the sensitivity of culture, practical usability aspect, economical scalability aspect, and viable sustainability aspect, along with other learning needs of children must be considered to develop a valuable learning model. [9]

1.4 Benefits

In [8], following are some of the benefits of educational game based learning that actually occur due to its mobility nature:

- improving literacy and numeric types of abilities
- recognizing their exiting types of skills
- promoting independent and collaborative types of learning experiences
- identifying where they need support and assistance

- removing their existing formalities from conventional learning environment
- building their abilities to concentrate for long time of periods
- raising self-worth and self-assurance

1.5 Research Objectives

The main aim of this research is to improve children's learning environment using mobile technology. For the purpose we came up with the following objectives:

1. To keep the research focus on Primary levels of education system in Pakistan (i.e., Nursery, KG, and initial primary)
2. To see the impact of mBL over conventional learning system in terms of "Learnability"
3. To devise such a scenario which fits best to our assumptions and help us in drawing conclusions
4. To analyze the resulting impacts of mBL technology for discussing further implementation level issues on mBL fitness or to devise alternate methods in case of mBL unfitness and/or to bring improvements (if possible) to the conventional learning system as well

1.6 Problem Statement

Due to ubiquitous nature of mobile technology, literature suggests that this technology can be utilized within learning environment. In the light of this concept, researchers' community is increasingly involved to utilize the mobile technology for learning purposes in accordance with their own cultural and educational domains. At this point, it has been observed that various differences lying in terms of culture, educational systems, and levels of education, are having its impacts on providing software solutions while using mobile technology for learning environment. Literature review concludes that the existing learning methods devised at primary education levels lack the mobile-based learning (mBL) methods in the perspective of Pakistan Education System.

1.7 Research Question

RQ. How the mobile based learning technology affect the conventional learning methods in terms of Learnability aspect in the perspective of Primary education system in Pakistan?

1.8 Expected Outcomes

- This research provides a base-line for using mobile technology at Educational System in Pakistan
- This research provides help for the development community to develop mobile learning applications as per the requirements of the prevailing primary education system in Pakistan
- This research helps children to enjoy the exciting and fast learning environment of mBL
- This research attracts the development community to take a start with providing more attractive platforms for mBL
- This research diverts the thinking level of educationists with the mBL technology in mind during their further research and solutions provision in accordance with the children's interests

1.9 Thesis Structure

This thesis consists of 6 chapters. Chapter 2 presents the literature review. Chapter 3 describes the proposed solution. Chapter 4 describes the research methodology adapted to solve the research problem. The results of case study performed in research are presented in Chapter 5. Finally, Chapter 6 discusses concluding remarks of the study, research limitations, and future work of this research effort.

CHAPTER 2

LITERATURE REVIEW

2.1 Mathematics Teaching for Kindergarten's Using mLearning

A research study [1] was held to develop a game for geometry learning keeping track of user's behavior. The game was meant for six years old pre-school pupils in Finland. Although the adaptive system was simple with simple observed behavior, the results achieved were of good learning among the pupils who were tested. Finally, the results proved fruitful with the usage of a handheld platform and such adaptive system. In this study, a geometry type learning game was developed for handheld devices. The game was actually developed for six year old pre-school children. Both the observed behavior was very simple and limited. The study results showed that learning through this kind of device is more lenient.

2.2 MObile-Based Interactive Learning Environment (MOBILE)

The wireless learning environment was set up in making use of Mobile Learning Server and Mobile Learning Tools, which facilitates the elementary students in Taiwan to have their interactions with the teacher and among themselves. Finally, the researchers performed some posts tests to compare traditional learning system with mobile learning environment. The final results determined that learning sessions using mobile application were healthier than that of traditional learning system. [2]

2.3 Mobile Learning System Adaptation based on Cultural Differences

In [5], the author suggested and proposed a learning system comprised of mobile devices and other learning contents. Tablet PC and Group Scribble (GS) tools were adapted to discover new useful learning scenarios and classroom actions supported by mobile technologies. The benefits and potential of such a proposed system were observed. The speedy increase in the network technologies including mobile technologies changed the learning behavior of students in the same year. An English learning environment was created containing two scenarios for learning English grammar, i.e., English Sentence Recombination and English Paragraph Recombination. The feedback in terms of **"Learning Activity"** reflected that the activity had drawn the following impacts on students:

- It helped in providing and developing their learning interest and motivation
- It enhanced their confidence toward learning
- It raised their interest

- It produced frequent interactions between the teacher and the students
- It was more challenging content than before

The feedback in terms of **"English Learning"** reflected that the activity had drawn the following impacts on students:

- It reduced their difficulties in English learning
- It encouraged them to learn English

The feedback in terms of **"Collaborative Learning"** reflected that the activity had drawn the following impacts on students:

- It promoted them to convey their ideas and build interactions with their partner
- It promoted the convenience and progress of CL effectively

Based on the above feedbacks, the project team was involved in further improvement accordingly.

2.4 Designing a Groupware Learning Environment Using Handheld Devices

In [6], a learning scenario has been created in groupware in order to facilitate learning activity for elementary school students in Taiwan to learn arithmetic word problem. The teacher had to monitor using laptop while students own PDAs. For the purpose to appropriate the semi-situated learning concept, 4-frame comic was embedded in the handheld device. The comic acts as a catalyst to invoke students in creating a theme according to content of the 4-grame comic. The teacher monitors the performance of the students through server (laptop) of the groupware.

2.5 Interactive Game Platform

The author developed an interactive type gaming platform for the purpose to make easy learning system. The design of software system was composed of two major parts as game engine which handles high level type of game logic and Nebule2 kernel which dealt with small types of functions. For the purpose to demonstrate the viability of their proposal, they used Nebula2 kernel to build interactive game prototype which itself contains several mini game rooms that could be accessed either through pocket PCs or through windows based desktop. During prototype implementation, the authors built three types of mini game rooms within the virtual campus. In general each room tries to highlight an appropriate subject in ICT (Information and

Communication Technology) for engineering students. The three relevant subjects for the three mini game rooms were Basic Organization of Computer, Structure of Microcomputers and Application Programming on Computers. During playing the game, groups of students were formed where each group contained 2 to 3 students including a team leader as well. Each student individually login into the game by using network PC and then enters into the room of game for the purpose to perform some selected tasks. In order to encourage team work and making any early decision, each team member was allowed to communicate with other by using peer-to-peer session. Each team was assigned some score depending on their accuracy and overall performance including time. The score was then added to their overall score and awarding the team with highest scores as winning team. [7]

2.6 Guidelines for the Conduction and Reporting of Case study in Software Engineering

In [10], suitable research methodology within the field of software engineering is the case study because the purpose of a case study is to study the current phenomenon within its natural context. This paper presents guidelines, for the help of those researchers who are conducting case studies and for the help of those readers, who are studying reports of these studies, also presents introduction of case study methodology.

The conduction of a case study is held through iterations over a rest of phases. The first phase is the design phase, where objectives are determined and the case is to be defined. Objective enlists the overall expected goals to be achieved from the study. There is one possibility of generating a hypothesis on conclusion which also needs to be included in the objective part.

In the second step, the procedures and protocols for data collection are defined. The procedures for data collection and data analysis are defined in *Case Study Protocol* (i.e., Field Procedures).

In the third step, execution is made with data collection on the studied case. In the fourth step, the collected data is analyzed. Finally, in the fifth step, the report is placed.

This research article discusses some of the terminologies, used during conducting a case study methodology, and these terminologies are presented here.

There are four types of research methodologies in nature and they all serve differently because one type of research methodology does not fit for different kinds of purposes.

- Exploratory – The purpose of this research methodology type is, to find 'What is happening', to generate new thoughts, to seek new insights and theories for new research
- Descriptive – The purpose of this research methodology type is the portraying of any situation or phenomenon
- Explanatory – Mostly, the purpose of this research methodology type is to seek an explanation for a location or dilemma except in the causal type relationship, where it is not necessary.
- Improving – The purpose of this type is a trial to bring improvement to a certain aspect of the phenomenon under study.

There are three levels classification of data collection techniques as:

Direct -- also known as *First Degree* of data collection technique, where the researchers are in direct interaction with their subjects understudy and the data are collected during the real time. Some examples of *Direct* data collection technique are interviews, Delphi surveys, observations and focus groups.

Indirect – also known as *Second Degree* of data collection technique, where the researchers collect unrefined data directly, without the actual interaction with their subjects understudy. For example, case where the usage of software engineering tools is auto-monitored and observed by using video recording.

Independent -- also known as *Third Degree* of data collection technique, where independent type analysis of work artifacts is done and already existing type data is used. This type of data collection technique is kept out of the scope of this research work.

The *Context* is the *domain* of the study, where the *Case* to be studied. In the field of software engineering, software development project is considered as a *Case* for the study. The *Case* may be anything, for example, a technology, an individual, a group of people, a product, a process, or a policy etc. Different terms may constitue a *Unit of Analysis* wihtin a *Case,* for example, an individual, group of people etc.

There are two types of case studies in nature, *Holistic* and *Embedded* case study. In *Holistic* case study type, a *Case* is studied as whole i.e the *Case* itself perform a role as one *Unit of*

Analysis. In *Embedded* case study type, there exists multiple *Unit of Analysis* and all these *Units of Analysis* are studied within one singal *Case.* Fig. 2.2, depicts both the *Holistic (a)* and *Embedded (b)* case study types.

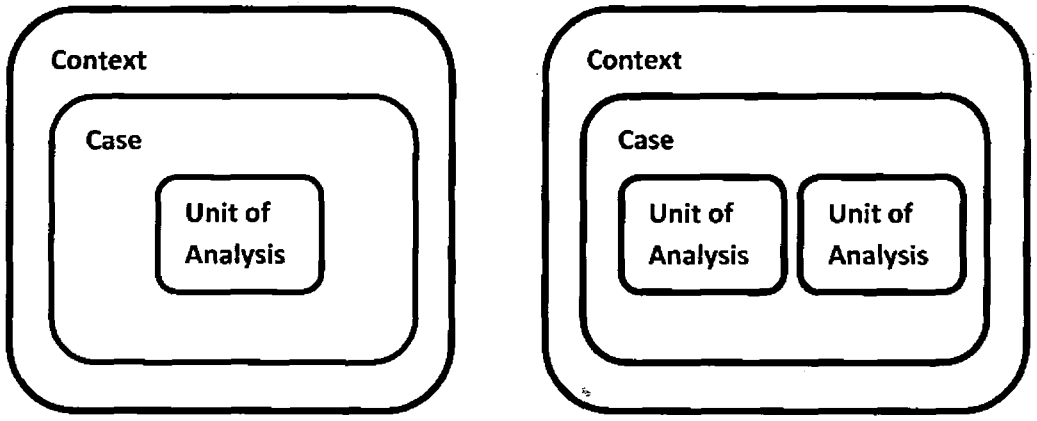


Fig. 2.2 (a) Holistic Case Study (b) Embedded Case Study

2.7 Mobile Learning Model

In another article [11], an mGBL engineering model has been proposed with certain defined steps as guidelines for mGBL applications development. In order to furnish the development process model for mGBL, firstly, the list of steps was proposed based on the initial study analysis. Secondly, the steps were classified in three phases, i.e., pre-production, production, and post-production. The study was having its focus on development steps and not on the components specification to be included in the model which was suggested for future research work. The initial components proposed were mGBL learning content, Learning Model, Game Characteristics, and Instructional Design Model and Theories.

2.8 Live Mobile Learning System

Research presented in [12] shows the results of a project, a mobile live video learning system implemented at Shanghai Jiao Tong University. It streams live lectures to the mobile devices owned by students. By compressing the normal conducting lecture videos and audio files, the data is efficiently prepared for live streaming along with the high quality of the lecture slides. Due to the live nature, the students could interact with the teacher during the normal course of lecture, using pre-programmed interactions. Finally, the evaluations were made at large-scale

which show that the system was beneficial for students and is more convenient and cost-effective way having the data accessible to large number of students. A detail discussion regarding technology related issues were discussed in terms of mobile usability, client platform, GPRS network, Video/Audio codecs and slide compression.

In another research, a Mobile Learning Prototype was developed using JCreator LE and Sun Wireless Toolkit 2.5.2 platform software, for the children of ages between 10 to 12 years old. The prototype consists of learning material from the science subjects that is taught in all primary schools of Malaysia. The researchers used such application as a revision aid so that it complements the use of textbooks and workbooks of the classroom's syllabus. The prototype consists of three parts i.e., 'Read notes', 'Exercise' and 'Get help'. The prototype was evaluated using heuristic evaluation technique with five ergonomic experts and the refinements of design issues were discussed before its real world implementation. [13]

2.9 Heuristic Evaluation Strategy

For the purpose of assessing mobile game-based learning (mGBL), the researchers formalized and conducted Heuristics Evaluation Strategy. Their strategy consists of four main aspects including Usability, Mobility, Game Play and Learning. Each of the aspect focuses on measuring the usability of mobile learning applications in terms of usefulness and efficiency for users. They define the usability with regards to game's simplicity and user's proficiency in using mGBL application. The "usability" component is significant with respect to user viewpoint and in addition the quality "usability" guarantees user's attention. "Mobility" means that how easily a user enters the game and how easily one can access the game at anytime and anywhere. The "game play" component means that how much the game is interesting and not tedious to player. The last one is the "learning" component which means that how much the game is clear. Heuristics evaluation is a usability engineering technique that is more efficient and best for the evaluations of design phase. The goal of these heuristics is to find design issues or to measure the usability from different aspects. For implementing the strategy, mGBL prototype was developed. The game prototype 1M'sia was created into two game plays, simple quiz and mix-and-match. Their findings suggest that such strategy can be implemented for similar mobile applications. Fig 2.3 depicts the Learning Contents Components of this Heuristics Evaluation Strategy. [14]

Fig 2.3 Learning Contents Components

No	**The Components of learning Contents**
LC1	Capabilities of learning ease
LC2	Learning Content Provisions
LC3	Objectives Oriented
LC4	Understandability

2.10 Implementation of Mobile-based Educational Technology

Philippines researchers developed a video game for mobile devices that cover Grade 6, Philippines Educational System. They developed three types of games as Layer of Earth Game, Layer of Atmosphere Game and Natural Disaster Mitigation Game Collection, which was taken from International Strategy for Disaster Reduction ISDR. The first game makes the user learn about the characteristics of layers of earth in term of thickness, temperature and composition. The second game makes the user to learn about the characteristics of atmosphere and the third game is to make the students learn about reducing the number of casualties that occur due to natural hazards. The main aim of this research was gaining students preferences to further augment what they have learned inside the classroom and also be able to use it in practical applications. Another aim was to know about the student's motivation and engagement about the computer games. [16]

2.11 Mobility Integration in Existing Learning Flow

In another article [17], a general model had been proposed to integrate portable game devices into the pre-existing e-Learning systems. It was possible for the instructor to track down the activities of each student individually. The major observed benefit was that it enhanced the attractiveness for learning, which masked up the boring learning environment of science and engineering subjects. The proposed architecture was exemplified with an instance based on the Nintendo DS™ and Moodle™, which characterized its scalability to other kind of handheld terminals like mobile phones, PDAs with fine communication and computing capabilities. The model was facilitated with semi-automatic way of creating interactive exercises, tests and other events, while helping the students in building up their concepts and skills. This was an approach

which was tested successfully with the future plans to put the training module into practice in a real learning environment.

It was difficult for students to take a grip of mathematics subject in the Caribbean countries. So a personalized game based mobile learning application was developed to assist secondary school students to improve their algebraic skills. The involvement of mobile technology was made for the purpose to motivate and encourage the students to practice mathematics. The MobileMath application was equipped with personalization techniques to recommend to the learners, the learning activities as they desire and navigate around. [18]

2.12 Chapter Summary

In the Literature Review, details are finding out regarding the growing potential and acceptance ratio of the implementation and usage of mBL technology in various countries, to adopt at various levels of education as learning systems. Throughout the world many researchers are agreed upon using mobile technology for learning different subjects including science, English, mathematics etc. within different domain and contexts. Using mobile technology they proved their ideas by developing various types of video games, applications, tools etc.

Although some of the drawbacks including small screen size etc, still their results indicated that mobile technology is efficient and proving mobile as a valuable tool in learning environment.

CHAPTER 3

PROPOSED SOLUTION

3.1 Input Instrumentation for Case Study Conduction

For the purpose of furnishing the research effort, the research devised a case study as research methodology, the detail flow of which is presented in Chapter 4. This chapter provides details of the planning session conducted in the case study. The required input instruments are discussed, which were designed and used for the collection of data during the case study conduction. The instruments were designed on the basis of answering to the question "How to achieve?" of the case study planning part.

The below enlisted instruments were carefully designed in a teamwork in order to keep the consistency of the various viewpoints of the stakeholders involved during the initial planning of case study. The team was comprised of three Senior Education Specialists, one psychologist, one Software Ergonomic Expert, and one Software Programmer.

3.2 Pre-tests and Post-tests

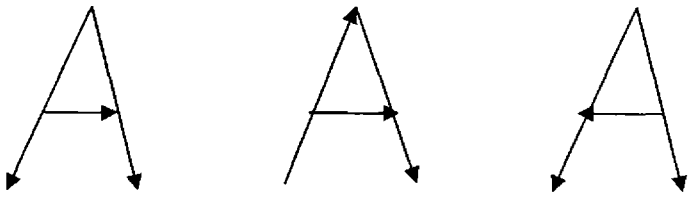
These two instruments were designed for the purpose to evaluate the children's performance. Pre-tests were designed to be conducted prior to the integration of mBL with CLS. The objective is to observe the impacts of integrating mBL with the Conventional Learning System (CLS). The tests were closely matching the CLS environment and the learning techniques were adapted from the currently prevailing teaching methods in schools. Pre-tests were paper-based while the Post-tests were designed for inclusion in the 1Paki mBL, the developed mobile application as a prototype. The tests were separately designed for all three levels keeping in view the child's normal level of understanding, by taking the help of Senior Education Specialists and psychologist of the team. The writing skill test was meant for Nursery level, Pronunciation skill test for Kindergarten level, and Spelling skill test for initial Primary level children. These tests were conducted in accordance with the currently implemented setup of CLS. The testing materials were got confirmed with all respect from the instructors of schools under study to make sure that the children have already gone through the said skill building sessions. Keeping the medium of instruction intact, the English was a selected as a choice for conducting our case study. The schooling system in Pakistan put focus from the very initial stage upon learning English language and the already implemented learning techniques are up to the mark. The most difficult part during the case study initial planning was the choice of skill to get tested, which

could be considered the necessary / mostly taught skill in schools of Pakistan. As suggested by our education specialists, the testing materials for Nursery was writing tactic of capital letters, for Kindergarten it was Pronunciation building skill, and for initial Primary it was spelling building skill. The samples of all these three tests are given below

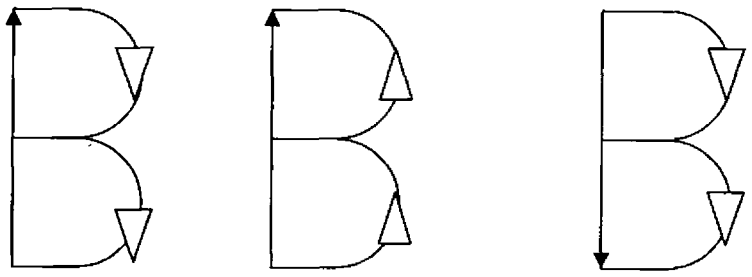
3.2.1 Nursery Level Test

Q.NO1: Choose the correct way of writing an English letter

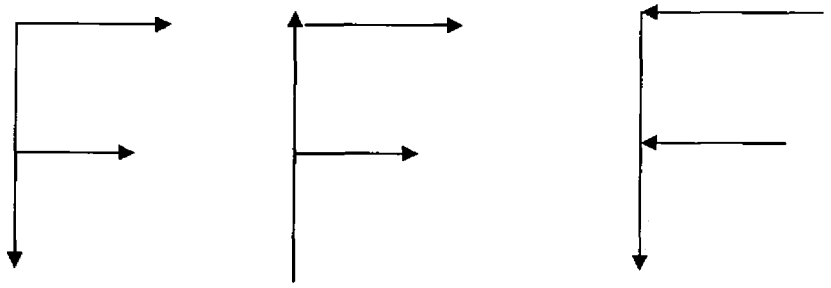
1) Letter A:



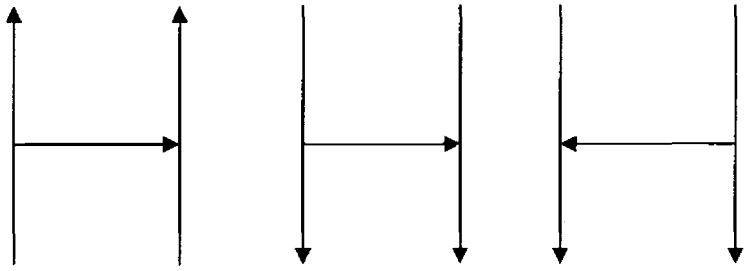
2) Letter B:



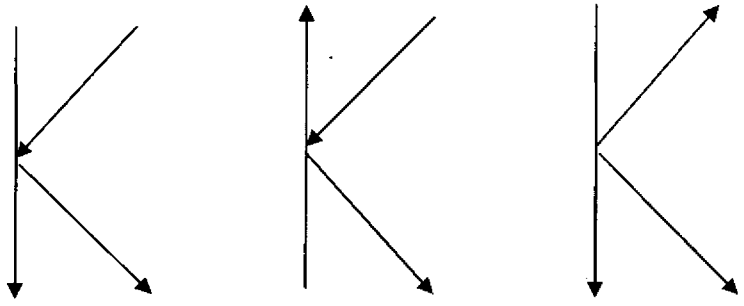
3) Letter F:



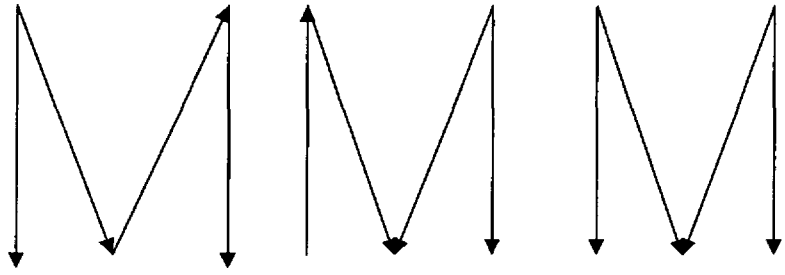
4) Letter H:



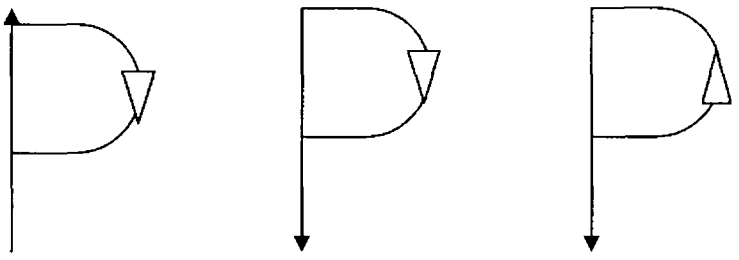
1) Letter K:



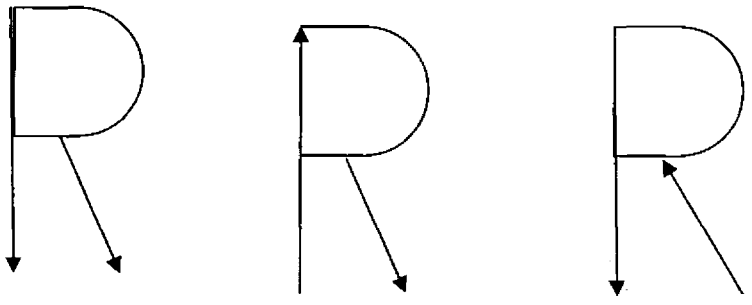
2) Letter M:



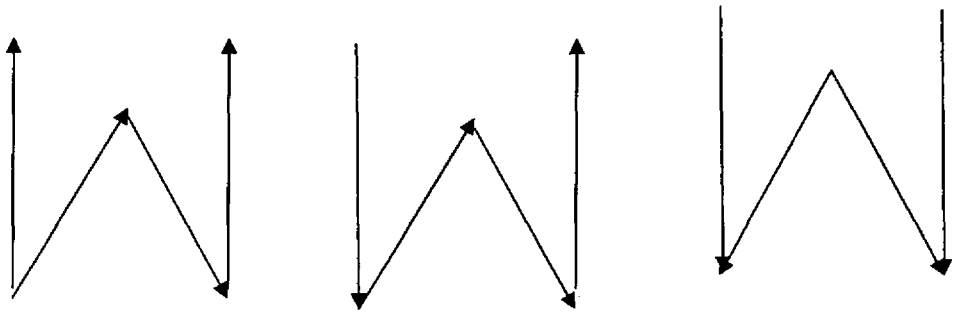
3) Letter P:



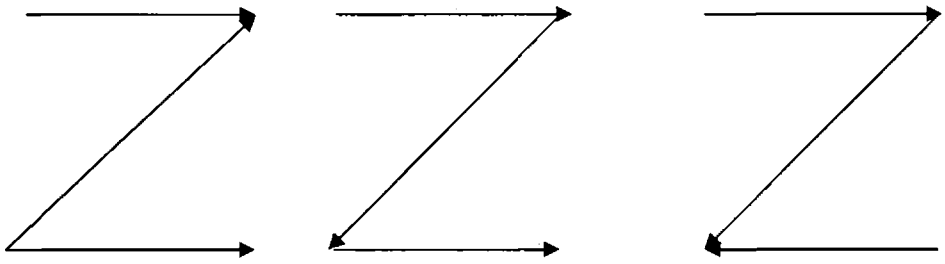
4) Letter R:



1) Letter W:

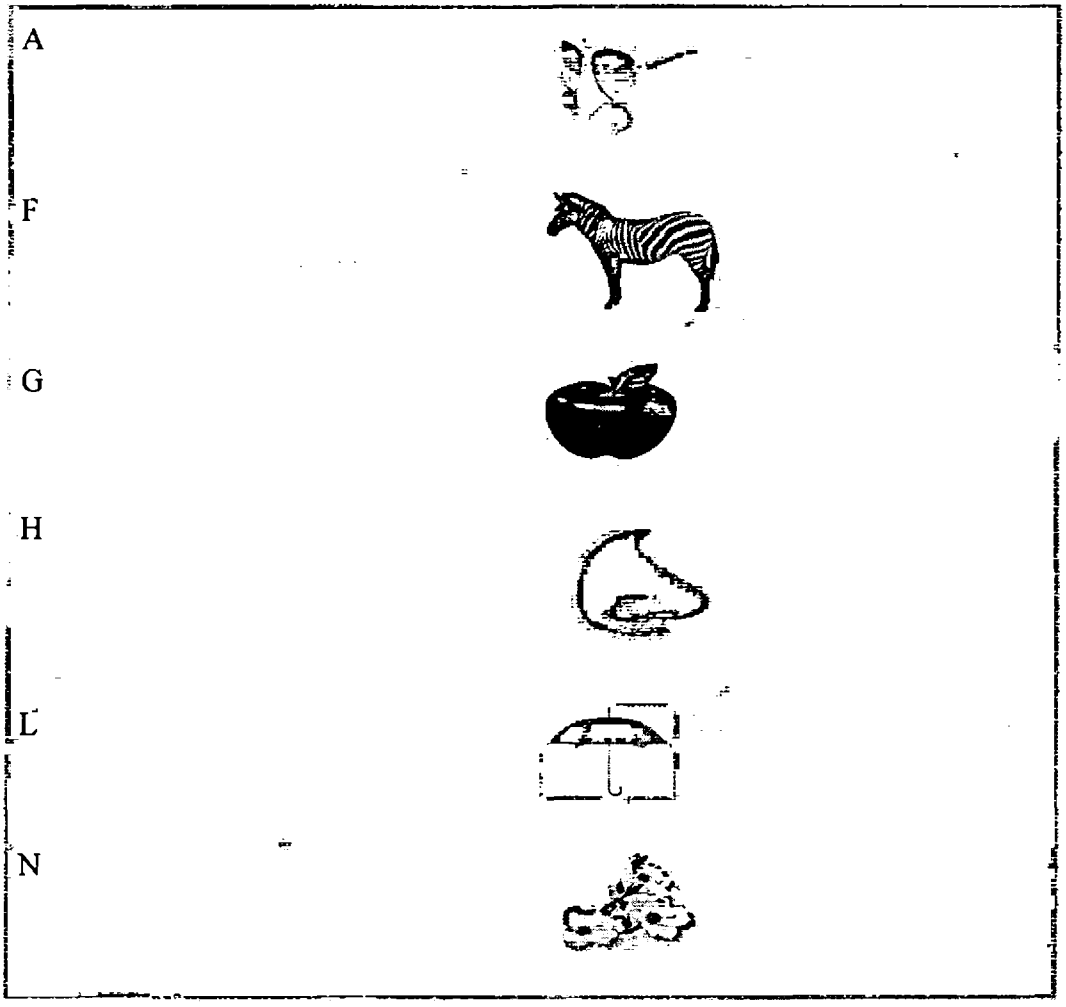


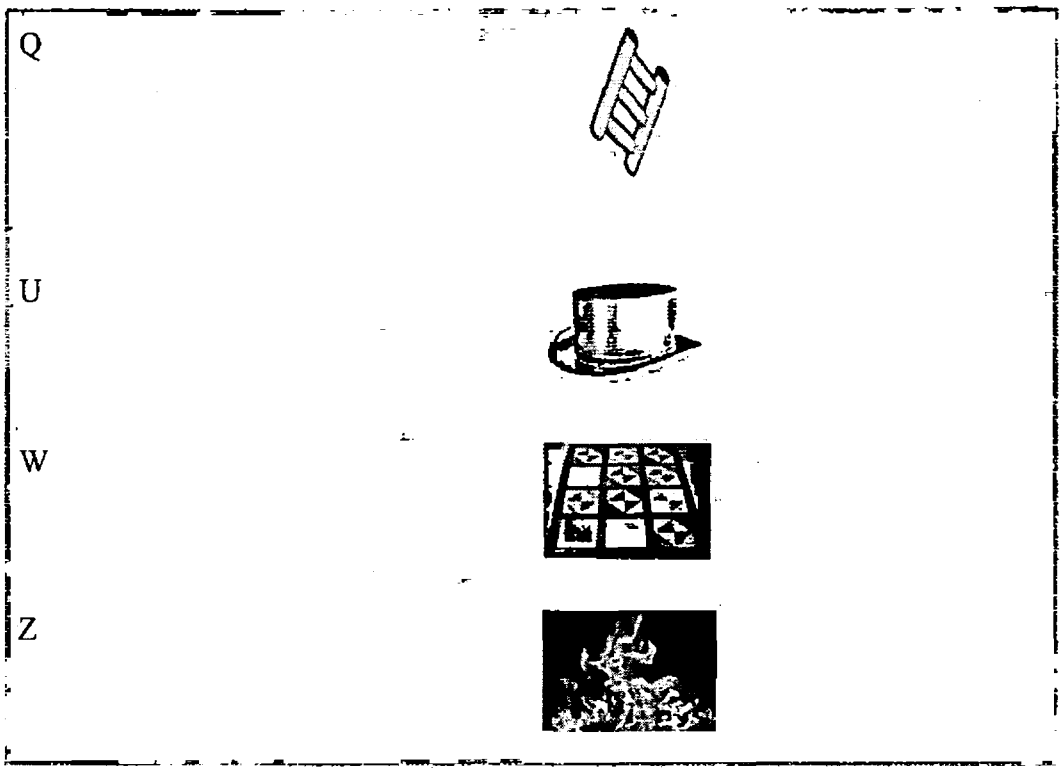
2) Letter Z:



3.2.2 Kindergarten Level Test

Match for the correct pronunciation





3.2.3 Primary Level Test

Choose the correct spelling for an object

i) Aple ii) Appel iii) Apple

i) Flower ii) Flawer iii) Flowar

i) Glasess ii) Glases iii) Glasses

i) Juic ii) Juice iii) Jouce

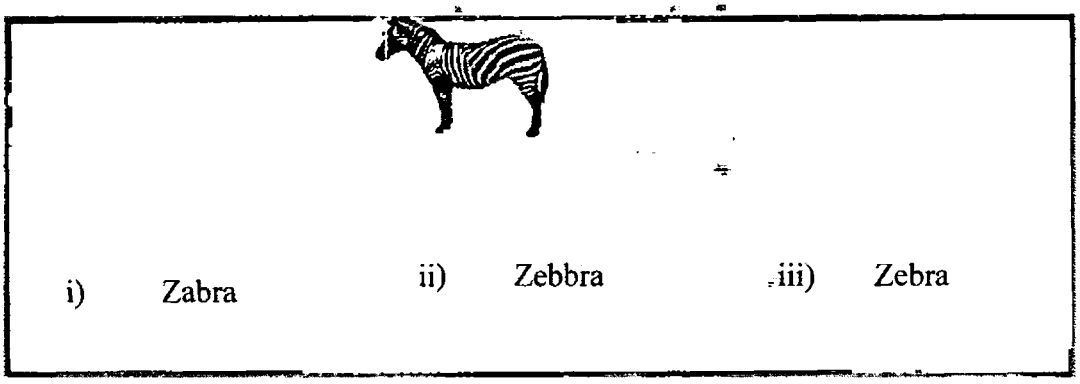
i) Icecream ii) Icecreame iii) Isecream

i) Rabit ii) Rabbet iii) Rabbit

i) Shoes ii) Shoese iii) Shose

i) Umberela ii) Umberella iii) Umberalla

i) Worm ii) Warm iii) Worrm



Also all the three tests are included in Appendix – A which were designed with the mutual consent of team members and other stakeholders and were made available for conduction of our Pre-tests and Post-tests sessions as a part of our case study execution.

3.3 1Paki mBL

In order to validate the hypothesis and its resulting effectiveness, a prototype "1Paki mBL" was developed using Objective C in X-Code framework. The objective of designing this input instrument is to provide training materials and practice which were suggested and formulated during planning phase of case study. The prototype was designed by the team members including programmer and ergonomic expert. It was developed and evaluated by utilizing the heuristic evaluation strategy, keeping in view the components categorized in the four aspects. These aspects and its components are described in Section 2.9 of the literature review. The main focus of this study is on the Learnability aspect and its four components described for it. These four components relate to the capabilities of learning ease, learning content provision, objective-oriented, and understandability. These components with its defined capabilities were to be injected in the prototype 1Paki mBL to achieve the accuracy in later on results. The prototype 1Paki mBL employs the currently implemented conventional learning methods of Primary Education system in Pakistan.

Figure 3.1 shows the architecture of 1Paki mBL prototype, the main goal of which was to observe and evaluate the impacts of mBL on its integration with CLS. This prototype consists of three main categories: Nursery, Kindergarten and initial Primary. Main menu is the first screen to make a choice of level of education.

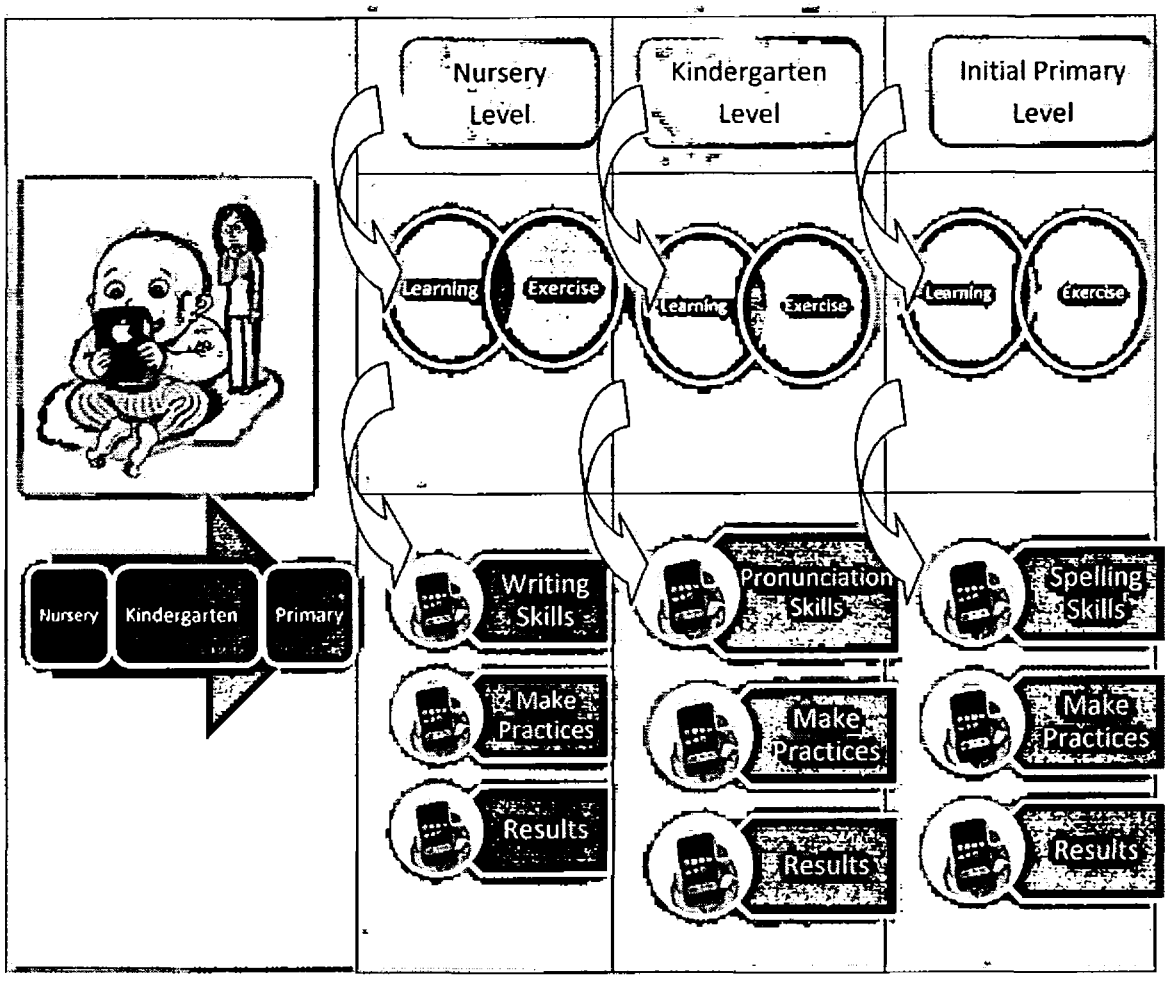


Figure 3.1 1Paki mBL Architecture

The main menu is the first screen which provides the list of options for education level selection as shown in Figure 3.2. The levels are categorized for Nursery, Kindergarten and initial Primary. On choosing the relevant category of choice, the next screen provides an option to choose either Learning session or Exercise, as shown in Figure 3.3, for the associated skill learning according to the previously selected level. The learning part help children to improve their associated skill while the exercise part helps them as a revision aid of the classroom work. Skill learning and practice activities are: Writing skills for Primary, Pronunciation skills for Kindergarten, and Spelling skills for initial Primary.

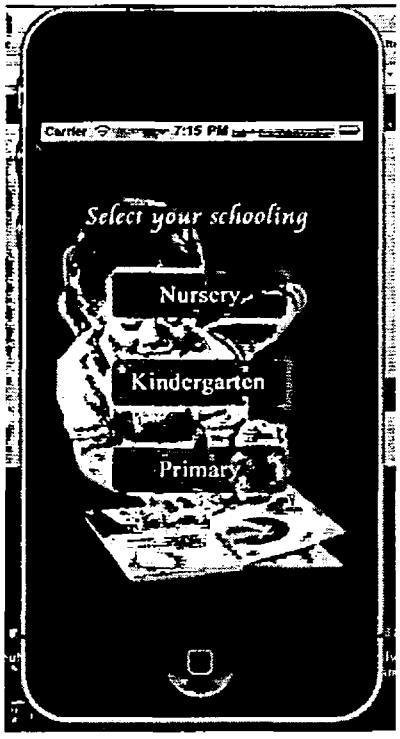


Figure 3.2 Main Menu

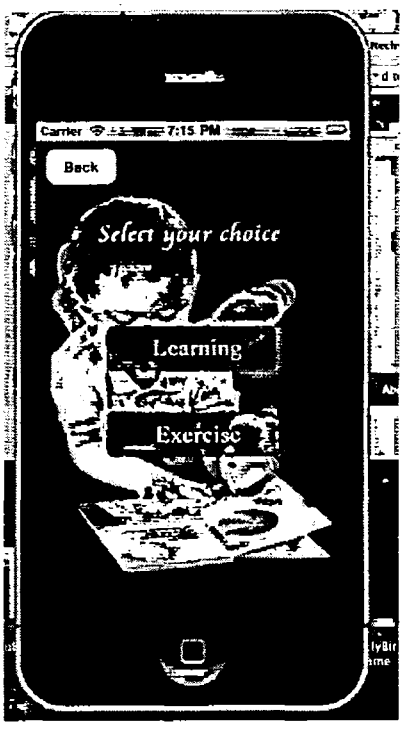
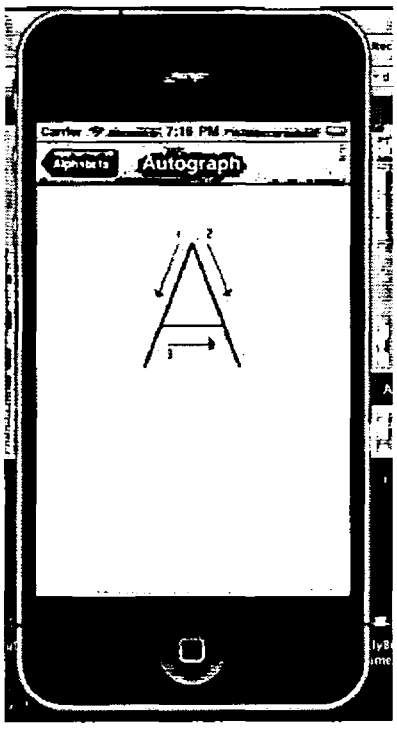


Figure 3.3 Sub Menu

The writing skill building activity using 1Paki mBL is specifically designed for Nursery students. It helps children in improving their very initial writing skills. In order to facilitate children, the device is with its touch screen capability to display the image with a single touch of a particular alphabet. In learning part of writing skill building activity, the arrow keys and labels surrounding an alphabet's outline makes the user learn how to draw it on the same screen along with finger or pointing device. A screenshot depicts the same and is shown in Figure 3.4 (a).

The 'Exercise' part for writing skill building activity consists of logical true false options to choose from, as shown in Figure 3.4 (b). The purpose is to revise and learn from mistakes. Selecting the correct option, student is awarded with "True" voice message otherwise the voice message "OOPS ... You have selected wrong option" executes and is displayed.



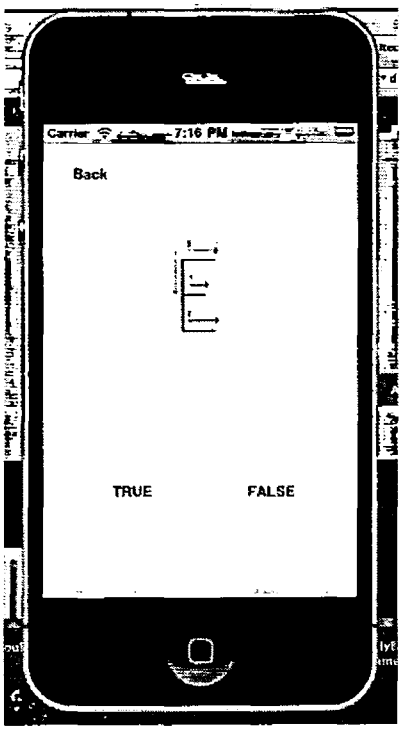
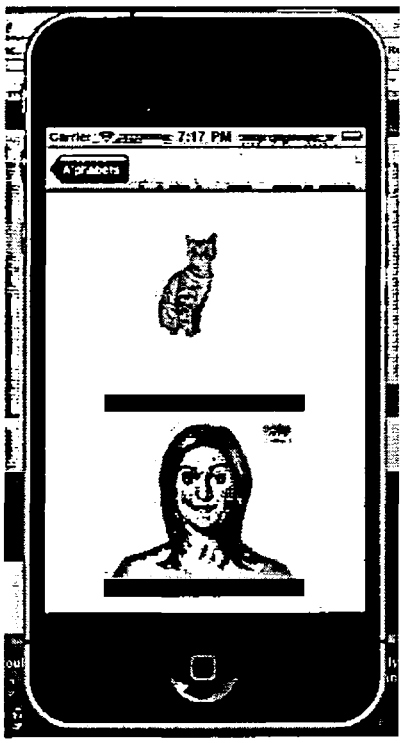


Figure 3.4 (a) Writing Learning Activity (b) Writing Exercise Activity

The pronunciation skill building activity using 1Paki mBL is specifically designed for Kindergarten students. It helps children in improving their very initial pronunciation skills. In order to facilitate children, a single touch on a certain alphabet runs an audio-video file. In learning part of pronunciation skill building activity, a virtual instructor pronounces an alphabet along with an English word starting with it. The figure against the word pronounced is also displayed which improves the vocabulary against each alphabet as well. Figure 3.5 (a) depicts, the virtual instructor pronouncing the word "C for Cat" along with the displayed image of cat.

In the 'Exercise' part for pronunciation skill building activity, an object along with a keypad is displayed on the screen and the student has to choose an alphabet, the name of the object it starts with, as shown in Figure 3.5 (b). Again, the purpose is to revise and learn from mistakes. Selecting the correct alphabet, student is awarded with "True" voice message otherwise the voice message "FALSE" executes. It continues until the correct alphabet is chosen and then the next object is displayed.



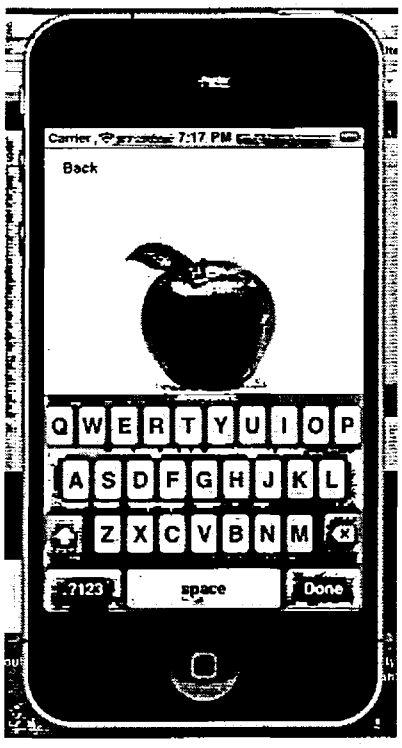


Figure 3.5 (a) Pronunciation Learning Activity (b) Pronunciation Exercise Activity

The spelling skill building activity using 1Paki mBL is specifically designed for initial Primary students. It helps children in improving their very initial spelling skills. In order to facilitate children, a single touch on a certain object image displays the spelling of that object in animated form. The student touches any single word from the list which spells out the same word on display by pronouncing it letter by letter. A screenshot depicts the same and is shown in Figure 3.6 (a).

In the 'Exercise' part for spelling skill building activity, an object along with a keypad is displayed on the screen and the student has to choose the combination of alphabets to spell the name of the object correctly, as shown in Figure 3.6 (b). Again, the purpose is to revise and learn from mistakes. Choosing the correct sequence of alphabets for the particular displayed object, student is awarded with "True" voice message otherwise the voice message "FALSE" executes. It continues until the object is correctly spelled out and then the next object is displayed for exercise.

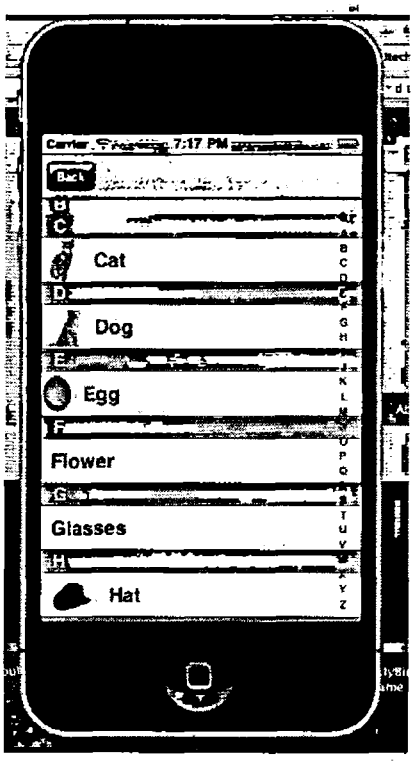
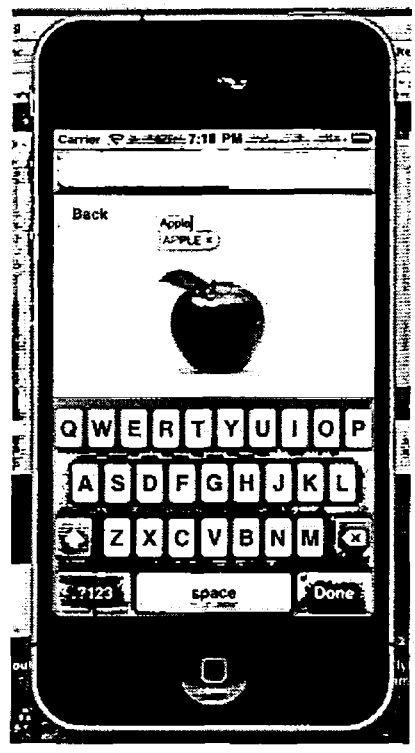


Figure 3.6 (a) Spelling Learning Activity



(b) Spelling Exercise Activity

3.4 Open-Ended Questionnaire and Close-Ended Questionnaire

In order to extract the various impacts due to the integration of mobile based learning with the conventional learning system, these input instruments were designed during the case study planning phase which were to be applied after the conduction of pre-test and post-test sessions. In the light of the results generated from the pre-test and post-test conduction, the concerned teacher of English subject was provided with these instruments to put comments on free-form as well as single-choice selection form. This session of the case study was held in all three education levels at every school under study. The psychologist of the team has presented various viewpoints which were taken into consideration to see the various impacts of integrating the two learning systems. For the purpose, the open-ended and close-ended questionnaires were prepared in terms of the following viewpoints in order to evaluate mBL whether suitable or not for integration with CLS:

1. **Interesting** -- in the views of students
2. **Learnability** – in terms of improvement
3. **Exciting** – for students
4. **Quick learn** – in terms of tendency to learn
5. **Helpful** – expectation even beyond the boundaries of school environment
6. **Like** – in the view of teachers
7. **Difficult** – to use in the view of teacher
8. **User-friendly** – in the view of teacher
9. **mBL Environment** – as a whole in the view of teacher
10. **mBL Suitability** – as a whole to integrate with CLS

Both the open-ended and closed-ended questionnaire is included in Appendix-B. In closed-ended questionnaire, for each viewpoint (Question) five likert scales from 1-5 are chosen and they varies from 0-100% selection in ascending order.

The above viewpoints were reformed into close-ended questionnaire, intended to be asked from teachers and to collect their views. Open-ended questionnaire helped us in understanding the correctness of the close-ended questionnaire as both were to be filled up by each concerned teacher of the school under study. So the open-ended questionnaire consists of cross-questions towards the above sequence of viewpoints and was put in view for building the relationship between the two input instruments as shown in Table 3.2.

Table 3.2 Relationship between Open-ended and Close-ended Questionnaires

Open-ended Questionnaire	**Close-ended Questionnaire**
Question No.	**Asks About**
1	Learnability – Quick Learn
2	Like
3	Interesting
4	Helpful
5	Helpful (Cross-question)
6	Learnability – Exciting
7	Difficult
8	mBL Suitability
9	mBL Environment
10	User-friendly

3.5 Chapter Summary

In the Literature Review, details are finding out regarding the growing potential and acceptance ratio of the implementation and usage of mBL technology in various countries, to adopt at various levels of education as learning systems. Still there were some issues of worth notice to take into consideration in the perspective of Pakistan Primary Education System. For the purpose, the input instruments for the case study conduction must be capable of ingesting those issues in order to avoid the cultural differences lying in education system of Pakistan from the rest of the world. As this research effort is to see the impacts associated with the integration of mBL with CLS in Pakistan, the levels of education chosen were of initial stages to avoid any complexities of the system at higher level of education.

Case Study was chosen as the appropriate research methodology for answering the devised research question. In this chapter, details have been provided regarding the planning session conducted in the case study. The following required input instruments are discussed, which were designed and used for the collection of data during the case study conduction:

1. Pre-tests and Post-tests
2. 1Paki mBL (a mobile learning software or prototype)
3. Open-ended and Close-ended Questionnaires

The above mentioned input instruments were carefully designed in teamwork in order to keep the consistency of the various viewpoints of the stakeholders involved during the initial planning of the case study. The team was comprised of:

- Three Senior Education Specialists
- one psychologist
- one Software Ergonomic Expert, and
- one Software Engineer

These input instruments were designed on the basis of answering to the question "How to achieve?" of the case study planning part.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Case Study

This research work has followed the guidelines and the recommended practices provided by P. Runeson et al in [10] for case study conduction and reporting in the field of software engineering. In this chapter, the same guidelines were followed and the steps as mentioned were executed. Before the execution, the initial planning steps for designing the input instruments are discussed in Chapter 3. Based on the execution of the case study, analysis reports were generated, which are explained in chapter 5.

In accordance with the phenomenon, this research focuses on improving the CLS environment by using mBL technology such that the learning techniques and syllabus of CLS were injected into this technology. So, in order to comply with the classification of various research methodologies, the purpose of this case study is that of "Improving" type. Improving type of purpose for research is a trial to bring improvement to a certain aspect of the phenomenon under study. The other types are explained in Section 2.6. So here the *Context* of the study was *"Education System in Pakistan, Conventional Learning System"* or CLS, the term used throughout the chapters of the thesis. The *Case* to be studied was the *"Integration of mBL with CLS* or *mBL Suitability"* in order to see the impacts of applying mBL to the existing CLS.

The study was planned to be conducted in the real world settings of the Primary Education System and its CLS environment in Pakistan, which was the *Context* of this case study. On injecting the mBL technology to the existing CLS becomes the *Case* to be conducted for this study.

"Embedded case study" was considered for conduction according to the prescribed context, which includes more than one unit of analysis. The holistic type case study is explained in section 2.6, which was not suitable according to this research phenomenon. For the choice to be made among the two case study types, its dependency is on the context and goals defined during the planning phase, i.e., questions like "What to know?" and "What to achieve?". Four units of analysis were chosen, i.e., Nursery, Kindergarten, Initial Primary, and Instructors (English Language Teachers). Respective data was collected, and on the basis of its analysis, the conclusion was drawn.

4.2 Case Study Execution

The case study process was held in the five major steps. In the first step the objectives were defined and the case study was initially planned. Objective enlists the overall expected goals to be achieved from the study. The objectives were refined in accordance with the Research Question been put up in Section 1.7. There was one possibility of generating a hypothesis on conclusion which was also included in the objective as well. The *Context* of the study is "Education System in Pakistan, Conventional Learning System (CLS)". The *Case* to be studied is the "Integration of mBL with CLS or mBL Suitability" in order to see the impacts of applying mBL to the existing CLS. The case contains four *Units of Analysis* or *Subjects* of the case study, which are the education levels and School Teachers. Those are i) Nursery, ii) Kindergarten, iii) Initial Primary, and iv) School Teachers. *Data* was collected from the *Subjects*. The collected Data was both *qualitative* and *quantitative*.

In the second step, the procedures and protocols for data collection were defined. The procedures for data collection and data analysis were defined in *Case Study Protocol* (i.e., Field Procedures). In the third step, execution was made with data collection on the studied case. In the fourth step, the collected data was analyzed. Finally, in the fifth step, the report was placed.

4.2.1 Case Study Design and Planning

In the case study, the *Case* was defined prior to design decisions placed for the case study protocol. It also included the ethical considerations before data collection process. The *Case* was defined by arguing and formulating the questions to undertake in the study. Each question was pointing to an element which describes a dimension of the case under study.

At the very first place, the question "What is to achieve?" was corresponding to the element "Objective" of the case study, although it was being evolved during the case study process. The major seek from the case study was to see the impact of integrating mBL with the CLS, in the context of improving the education system in Pakistan. This scenario depicted that the case study was of "Improving" type in order to bring an improvement to a current system. So, the *Case* is "mBL suitability, which became the major objective to be achieved.

The next question raised "What is studied?" was corresponding to the element "*Case*" of the study. The case to be studied was "mBL suitability", which was possible only by conducting this

study in accordance with the proposed scheme of its integration and comparison with the existing environment under the defined protocol.

Due to the distinguishing nature of the case study, the type "Embedded case study" was planned and designed for conduction according to the prescribed context. This type of case study comprises more than one unit of analysis and is contrary to the "Holistic case study", which is to be conducted on a single unit of analysis.

This case study was to be executed for the purpose of collecting the correct results to see the impact of integrating mBL technology with the already implemented CLS in Pakistan in the given context. For the choice to be made among the two case study types, its dependency is on the context and goals defined during the planning phase, i.e., questions like "What to know?" and "What to achieve?".

In accordance with the embedded case study, the following units of analysis were chosen:

1. Nursery Level
2. Kindergarten Level
3. Initial Primary Level
4. Instructors (English Language Teachers)

In order to achieve the correct results from the case study, limited units of analysis were chosen to avoid the complexities of the higher level of education systems which would rather need more facilities to be included in the 1Paki mBL prototype. The input instruments were then designed in the planning phase, which were applied to the four units for analyzing the results and seeing the later on effects of integration. The following figure 4.1 depicts this Case Study having the Context as Education System of Pakistan, the Case as mBL Suitability and four Units of Analysis as Nursery, Kindergarten, Initial Primary and Teachers.

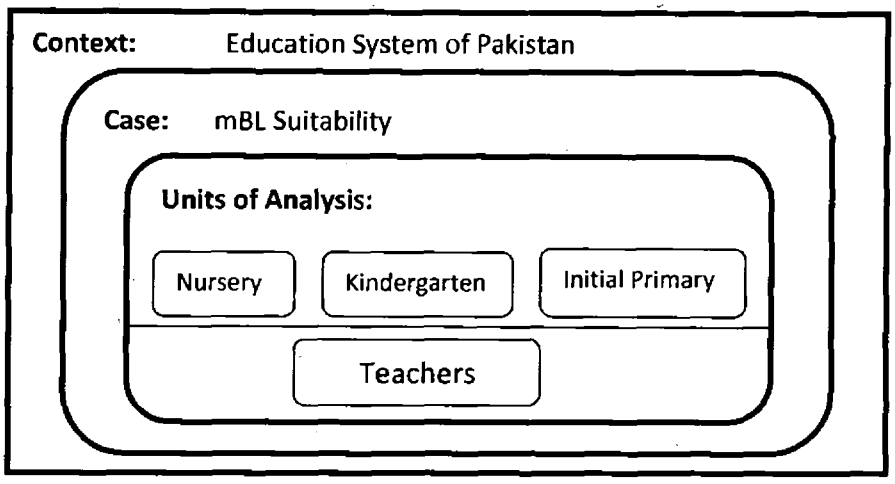


Figure 4.1 Case Study

Based on the theories presented in the Chapter 2 – Literature Review, which has already been investigated, it has been concluded from various viewpoints of the research community that mobile-based technology can be utilized in the education system successfully. In the light of those applied theories, further analysis was required to see the impact of cultural differences on utilizing this technology in the existing education system in Pakistan. This has also been argued and agreed upon by the team members that culture matters when adopting any technology or process. The heuristic evaluation was adapted, prescribing four aspects, as described in Section 2.9. The focus was made on the "Learnability" aspect as the research question was focusing on seeing the impact of the technology adaptation in Pakistan education culture and so, the contents pertaining to Learnability were evaluated to achieve the desired results.

The next question "What to know?" was corresponding to the element "Research Question" of the case study. It was straight forward and compact which asked "How the mobile based learning technology affects the conventional learning methods in terms of Learnability in the perspective of Primary education system in Pakistan?"

The question "How to collect data?" was corresponding to the element "Methods" of the case study. The detailed decisions regarding this question were achieved while preparing case study protocol described in section 4.2.2, and later on, during the design of input instruments for case study execution, described in Chapter 3. As described in the Section 2.6, three categories of methods are defined: Direct, Indirect, and Independent. In the case study, Direct methods involve Open-ended and Close-ended questionnaires, Indirect methods involve input tools

instrumentation, i.e., pre-tests, post-tests, 1Paki mBL. These two methods were designed for the purpose of collecting data and the details of which are available in Chapter 3.

The question "Where to seek data?" was corresponding to the element "Selection strategy" of the case study. This strategy has also been put in place while defining the case study protocol according to the selected units of analysis. Although, there exist different education systems, education standards, and education cultures in Pakistan, but those had been neglected to build the focus on the mBL suitability and were considered out of the scope of this research effort.

4.2.2 Case Study Protocol

Case study protocol is a part of the planning and design phase of the case study. The purpose of the case study protocol is to place all the design decisions as well as field procedures well-defined for the case study conduction. Although these design decisions and field procedures were updated time to time due to the flexible nature of case study behavior, but keeping all versions of records were beneficial for later on analysis over the collected data. It served as a guideline for case study execution, intending not to make missing during its conduction. Keeping track of all the versions of the case study protocol make it possible for the other researchers in the future to review the changes made to it due to the various circumstances and help them in formulating their own work flows for further research.

The initial guidelines for data analysis and document storage were formulated. There was a separate file arrangement for each unit of analysis containing each of the activity. The activities include Process modeling (work flows), Simulation modeling (1Paki mBL), Research instrumentation, Time reporting, Failure reporting, Results collection procedure, Data collection, Data Analysis guidelines, Analyzed results, and Analysis reports. These activities were meant to change during the case study execution and needed to get separately managed in soft and hard files with its updated version get always placed on top.

The procedures were formulated in accordance with the unit of analysis under the defined case and context for the case study. All the procedures were put in place for each activity to be conducted with details on contacts and timing.

The template letter to invite participants was carefully designed which was to be issued along with the questionnaires during case study conduction on devised schedule and is included in Appendix - B.

4.2.2.1 Ethical Considerations

For the safe side and preventing from any pitfalls, law abiding steps were taken as ethical considerations. The approvals were made at the first place from the concerned supervisors, chairman of the department, and dean of faculty. The trust was built up between all the participants and the matters of confidentiality were properly discussed in agreements before the case study execution, e.g., How to code and identify the collected data, Which documents to get published, What kind of analysis to be disclosed, and How to handle sensitive results? Matters like these were explicitly agreed upon by the mutual consent among all the participants. The following elements were made clear, read out and signed by all the participants:

- Name of Principal Researcher and contact information
- Purpose of case study
- Procedures for case study conduction
- Text stating the voluntarily participation of all the participants
- Benefits of case study execution
- Confidentiality assurance
- Approvals from the review board
- Documents duly signed by the Research team and the Participants (excluding children who were evaluated during pre-tests and post-tests conduction)
- Feedback by the teachers over the analysis

4.2.3 Collecting Data

The data was to be collected from multiple sources, i.e., data triangulation using multiple methods, i.e., methods triangulation. There are three levels classification of data collection techniques as described in Section 2.6. During the case study implementation, there was a direct and indirect interaction with the subjects under study through pre- / post-tests conduction from students and through questionnaires from teachers. So the case study was that of the *First Degree*

and *Second Degree* including *Direct and Indirect methods*. The pre-tests, post-tests, and questionnaires were *Fully Structured* and were applied as input instruments for data collection. The post-tests were conducted using software application, named 1Paki mBL as described in Section 3.3

The observations were conducted for investigating the participants to note their interactions. The understanding and awareness at a particular time during data collection was of importance and must be made clear crystal. The data collection made through the questionnaires was both of quantitative and qualitative nature for analysis. The reason why close-ended and open-ended questionnaires were designed during the input instrumentation and are explained in Section 3.4 The purpose of collecting both qualitative and quantitative was to make the comparison for authenticity and validity of the results in order to get analyzed effectively. Cross-questions brought further improvement to the validity of the results. On finding any ambiguity or differentiation of results in the raw data was returned back for review to the concerned participant. While conducting pre-tests and post-tests, the role of the researcher was that of an external examiner in the view of students. This increased the serious attitude of students' participation while attempting pre-tests and post-tests. During the interaction with the teachers, researcher made friendly environment with the teachers to achieve better results.

During the whole case study conduction period, the archival data was properly managed according the prescribed protocol and was filed accordingly for each step included in the work flow.

The individual data collected through pre-tests, post-tests, and questionnaires conduction was kept confidential due to the signed agreement and keeping defined ethical considerations explained in Section 4.2.2.1

Figure 4.2 depicts, the implementation model of the case study, where pre-tests and post-tests are applied to Nursery, Kindergarten and Initial Primary (Units of Analysis), for the comparison of mBL with CLS, whereas the mBL Suitability is evaluated by applying open-ended and closed-ended questionnaire to the Teachers (a unit of analysis).

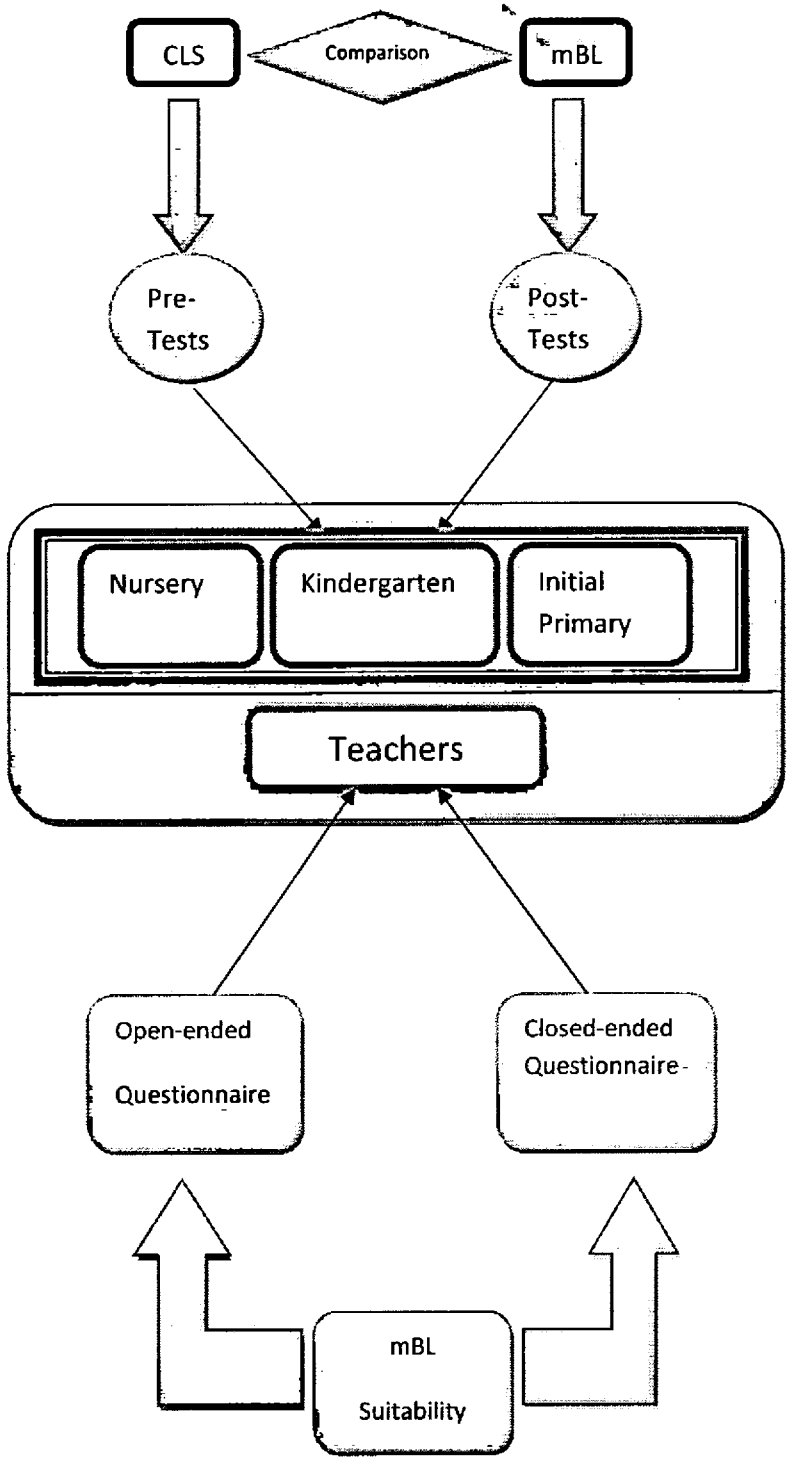


Figure 4.2 Case Study Implementation Model

4.2.4 Data Analysis

Data analysis was conducted for both quantitative and qualitative data. Descriptive statistics was used to understand the collected data and was evaluated in finding mean values, frequencies, valid data, SD (Standard Deviation), and by displaying its bar graphs for describing each data element.

Correlation analysis was conducted for the purpose of measuring and relating the later process activity (i.e., post-test) with the earlier process measurement (i.e., pre-test) for each education level separately.

As far as the data collected through open-ended questionnaires was concerned, it was used only for results validation gathered via close-ended questionnaires for bias reduction by individual participants and researcher. So only the close-ended questionnaire results were analyzed, which were quantifiable.

Based on merging individual and summarized data, systematic quantitative analysis was performed on the data to further analyze, discuss, and draw conclusion to the case study in the form of reports.

The results and reports are presented in chapter 5, which has been further assessed for reporting and the conclusions are made on the analyzed data in chapter 6.

4.2.5 Reporting

The hypothesis generation was initially predicted from the literature review which was further made cleared from the collected data. The techniques used for the purpose was *constant comparisons.* This technique was utilized on both post-tests and pre-tests comparisons and open-ended and close-ended questionnaire comparisons. The analyzed units in the case study gave a blurred picture of the hypothesis initially.

The hypotheses confirmation was made initially after generating the results i.e., on finding out the mobile-based learning environment suitability in Pakistan education system. This was further confirmed with further analysis on generated statistical results in tabular and graphical form. This analysis was made by the reviewers and the initial planners in team. At this stage, the blurred picture of hypothesis was made further cleared on the basis of information consolidation. These analysis discussions are explored in chapter 6.

4.3 Chapter Summary

In order to comply with the classification of various research methodologies, the purpose of this case study is that of "Improving" type. The study was planned to be conducted in the real world settings of the Primary Education System and its CLS environment in Pakistan, which was the *Context* of this case study. On injecting the mBL technology to the existing CLS becomes the *Case* to be conducted for this study. "Embedded case study" was considered for conduction according to the prescribed context, which includes more than one unit of analysis. Four units of analysis were chosen, i.e., Nursery, Kindergarten, Initial Primary, and Instructors (English Language Teachers). In order to achieve the correct results from the case study, limited units of analysis were chosen to avoid the complexities of the higher level of education systems. The case study process was held in the five major steps. In the first step the objectives were defined and the case study was initially planned and designed. In the second step, the procedures and protocols for data collection were defined. The case study protocol include activities comprised of Process modeling (work flows), Simulation modeling (1Paki mBL), Research instrumentation, Time reporting, Failure reporting, Results collection procedure, Data collection, Data Analysis guidelines, Analyzed results, and Analysis reports. In the third step, execution was made with data collection on the studied case. The pre-tests, post-tests, and questionnaires were *Fully Structured* and were applied as input instruments for data collection. The post-tests were conducted using software application, named 1Paki mBL. In the fourth step, the collected data was analyzed. Data analysis was conducted for both quantitative and qualitative data. Correlation analysis was conducted for the purpose of measuring and relating the later process activity (i.e., post-test) with the earlier process measurement (i.e., pre-test) for each education level separately. The open-ended questionnaires were meant for validating the close-ended questionnaires. Finally, in the fifth step, the report was placed. The systematic quantitative analysis was performed on the data to further analyze, discuss, and draw conclusion to the case study in the form of reports. The focus was made on the *Learnability* aspect as the research question was focusing on seeing the impact of the technology adaptation in Pakistan education system and so, the contents pertaining to Learnability were evaluated to answer the research question and helped the researcher in hypothesis generation and confirmation.

CHAPTER 5

EXPERIMENTAL RESULTS

5.1 Pre-tests and Post-tests Reporting

Pre-tests and post-tests instrumentation was explained in Section 3.2. The individual data collected through pre-tests and post-tests conduction was kept confidential due to the signed agreement and keeping defined ethical considerations explained in Section 4.2.2.1. The results generated are shown as follows:

5.1.1 Written Test Report

Total 47 numbers of students attempted the written test. The experimental results indicated that mBL is more effective than CLS in terms of Learnability, and once integrated with CLS brings improvements to the learning system of Pakistan primary education.

Table 5.1 presents the report of this test, where the mean of the pre-test (CLS) is 6.43 marks out of 10 marks, whereas the mean of post-test (mBL) is 8.17 marks out of 10 marks. The same story is depicted in Figure 5.1 by bar chart.

Table 5.1 Written Test Report

Written Test Report					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	6.43	47	1.426	.208
	Post Test	8.17	47	1.551	.226

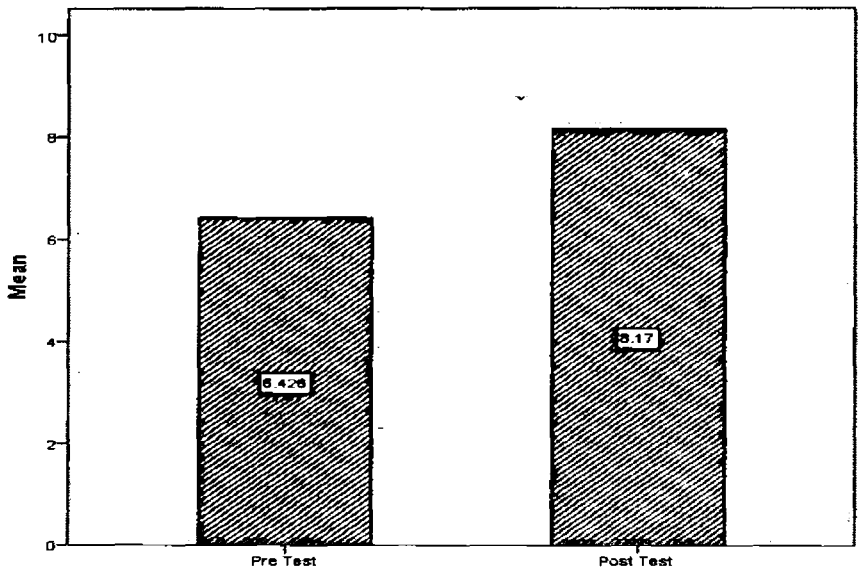


Figure 5.1 Written Test Report

5.1.2 Pronunciation Test Report

Total 35 numbers of students attempted the pronunciation test. The experimental results indicated that mBL is more effective than CLS in terms of Learnability, and once integrated with CLS brings improvements to the learning system of Pakistan primary education.

Table 5.2 presents the report of this test, where the mean of the pre-test (CLS) is 5.77 marks out of 10 marks, whereas the mean of post-test (mBL) is 9.03 marks out of 10 marks. The same story is depicted in Figure 5.2 by bar chart.

Table 5.2 Pronunciation Test Report

Pronunciation Test Report					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	5.77	35	1.592	.269
	Post Test	9.03	35	1.124	.190

Figure 5.2 Pronunciation Test Report

5.1.3 Spelling Test Report

Total 38 numbers of students attempted the pronunciation test. The experimental results indicated that mBL is more effective than CLS in terms of Learnability, and once integrated with CLS brings improvements to the learning system of Pakistan primary education.

Table 5.3 presents the report of this test, where the mean of the pre-test (CLS) is 4.39 marks out of 10 marks, whereas the mean of post-test (mBL) is 6.76 marks out of 10 marks. The same story is depicted in Figure 5.3 by bar chart.

Table 5.3 Spelling Test Report

Spelling Test Report					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	4.39	38	1.366	.222
	Post Test	6.76	38	1.550	.251

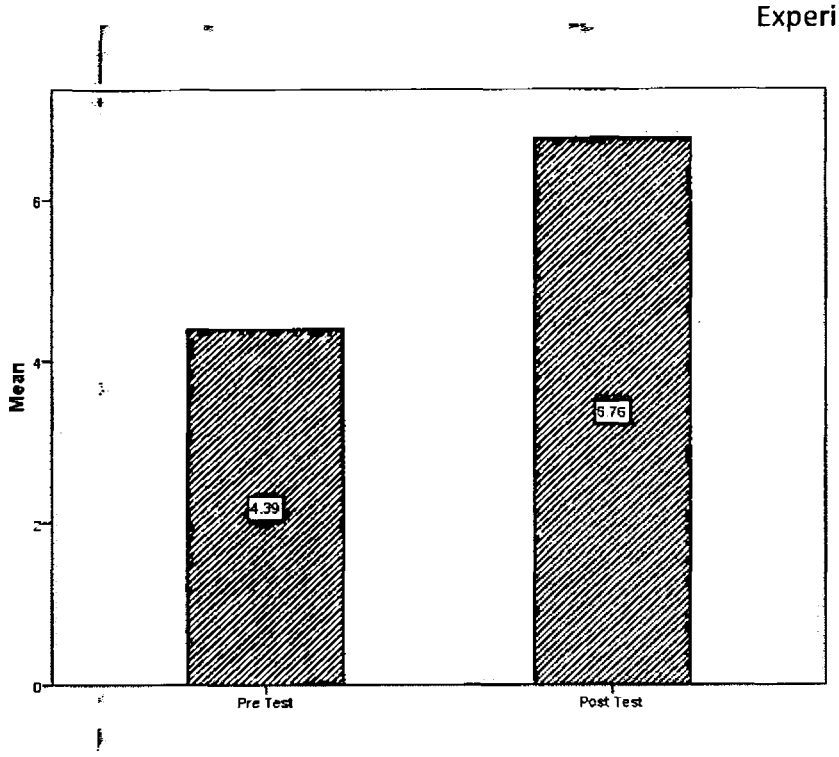


Figure 5.3 Spelling Test Report

5.2 Open-Ended Questionnaire Report

Q No.1

On presenting their comments against this question, teachers said that the successful integration of mBL with CLS provides us an effective learning environment in future. Some teachers of phonic school systems present suggestions for the development of mBL prototypes such that they suits the reading materials learned at these campuses. Typically, this question is asked in the perspective of Learnability viewpoint.

Q No.2

Teachers carefully observed the children during attempting the tests, and liked this mBL based environment for children learning. On presenting their comments against this question, teachers said that children's showed more interest in learning with using the application. Typically, this question is asked in the perspective of Like viewpoint.

Q No.3

On presenting their comments against this question, teachers said that in our point of view, interesting is basically one of the major advantage of mBL due to which children are showing attentiveness in leaning. This advantage is also established in the literature even for all situations and cultural aspects. Typically, this question is asked in the perspective of Interesting viewpoint.

Q No.4

On presenting their comments against this question, teachers are agreed upon, on using this technology outside the schooling environment for children and said that this technology helps children at everyplace. Typically, this question is asked in the perspective of Helpful viewpoint.

Q No.5

On presenting their comments against this question, teachers said that interest is one thing that is necessary for utilizing time and this mBL technology produces children interest, so definitely utilize their time for learning. Typically, this question is the cross question to question 4.

Q No.6

On presenting their comments against this question, teachers said that they observed the children carefully, where they found these children not only as learners but enjoyable as well i.e. children learned and enjoyed in parallel with using this mBL technology. Typically, this question is asked in the perspective of both Learnability and Exciting viewpoint.

Q No.7

On presenting their comments against this question, teachers said that there is no negative consequence of this mBL technology. Typically, this question is asked in the perspective of Difficult viewpoint.

Q No.8

On presenting their comments against this question, teachers suggests that this is one innovative idea for learning and children showed lot of interest in using the mBL technology for learning, so must be adopted in education systems in integration with CLS to get effective results. Typically, this question is asked in the perspective of mBL Suitability viewpoint.

Q No.9

On presenting their comments against this question, teachers voted for the mBL technology to be adopted for higher classes as well. Typically, this question is asked in the perspective of mBL Environment viewpoint.

Q No1.0

On presenting comments against this question, teachers found this mBL prototype user friendly. After careful observations of children, they said that children gets achievements with soft use of touch screen facility and other user friendly interfaces. Typically, this question is asked in the perspective of User Friendly viewpoint.

5.3 Closed-Ended Questionnaire Report

The total numbers of teachers who fulfill this questionnaire were 30. Their insights and suggestions against integrating mBL with CLS are discussed in Section 5.2. This Section gives the quantitative measurement to their insights, and presents the report against each viewpoint as discussed in Section 3.4.

5.3.1 Interesting

As discussed, interesting is basically one of the major advantages of mBL due to which children are showing attentiveness in leaning. This advantage is also established in the literature even for all situations and cultural aspects. Table 5.4 illustrates the report against the interesting viewpoint where 19 teachers selected the Likert Scale 5 (81-100%) while the remaining 11 selected the scale 4 (61-80%). Figure 5.4 depicts the said report by bar chart.

Table 5.4 Interesting Report

Interesting Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	11	36.7	36.7	36.7
	5	19	63.3	63.3	100.0
	Total	30	100.0	100.0	

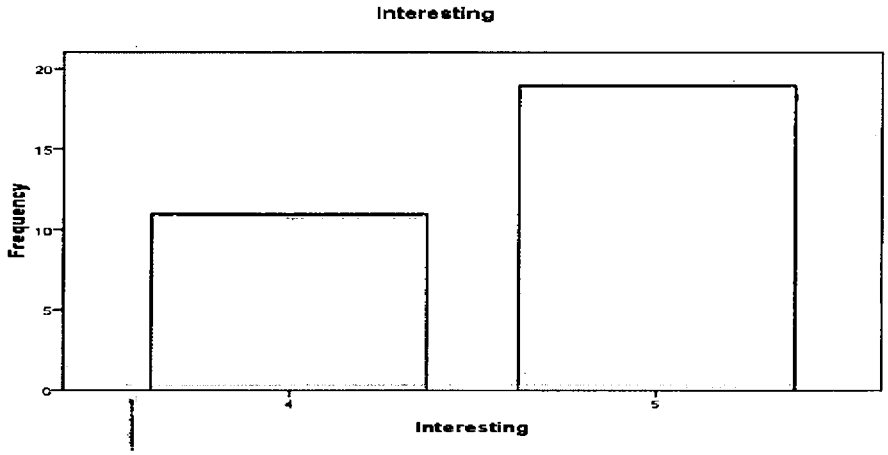


Figure 5.4 Graph of Interesting Report

5.3.2 Learnability

Table 5.5 illustrates the report against the Learnability viewpoint where 21 teachers selected the Likert Scale 4 (61-80%) while the remaining 9 teachers selected different scales i.e. the mode for Learnability aspect is coming on scale 4. Figure 5.5 depicts the said report by bar chart.

Table 5.5 Learnability Report

Learnability Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	10.0	10.0	10.0
	3	4	13.3	13.3	23.3
	4	21	70.0	70.0	93.3
	5	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

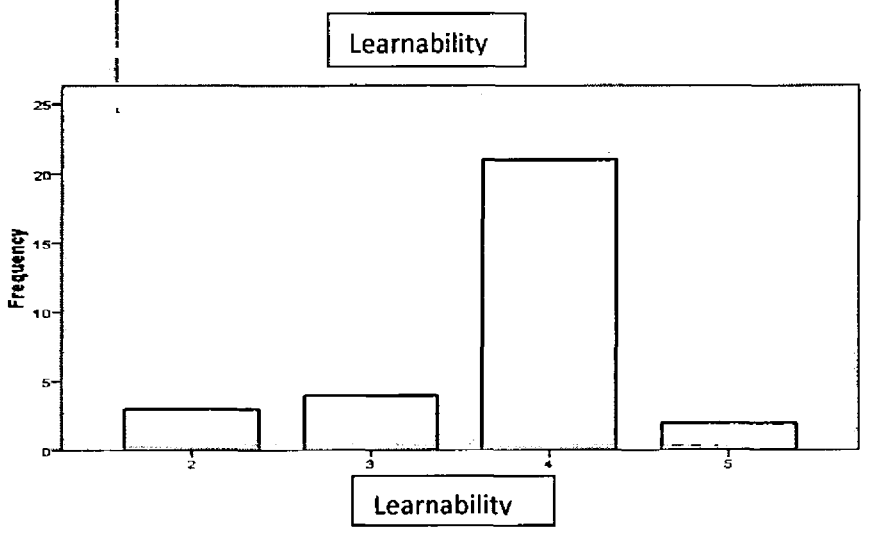


Figure 5.5 Graph of Learnability Report

5.3.3 Exciting

Table 5.6 illustrates the report against the Exciting viewpoint where 24 teachers selected the Likert Scale 5 (81-100%) while the remaining 6 teachers selected the scale 4 i.e. the mode for Exciting aspect is coming on scale 5. Figure 5.6 depicts the said report by bar chart.

Table 5.6 Exciting Report

Exciting Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	6	20.0	20.0	20.0
	5	24	80.0	80.0	100.0
	Total	30	100.0	100.0	

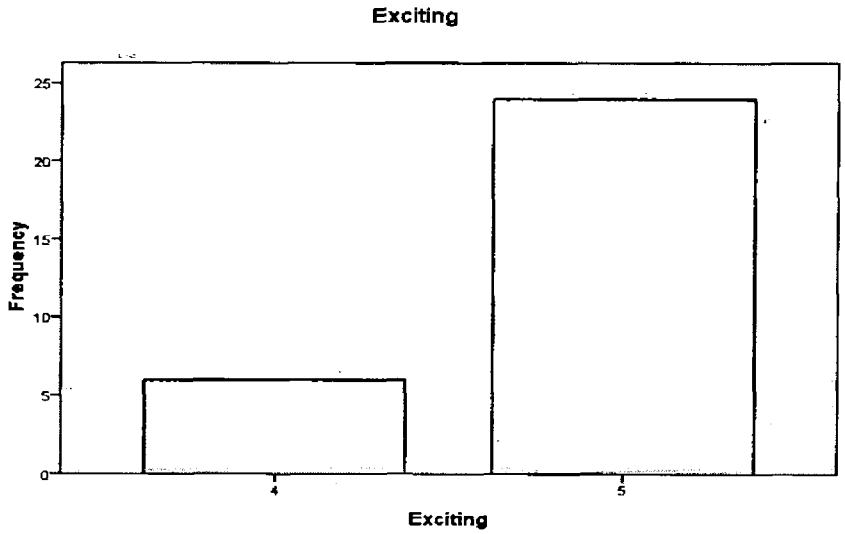


Figure 5.6 Graph of Exciting Report

5.3.4 Quick Learn

Table 5.7 illustrates the report against the Quick Learn viewpoint where 15 teachers selected the Likert Scale 3 (41-60%) while the remaining 15 teachers selected different scales i.e. the mode for Quick Learn aspect is coming on scale 3. Figure 5.7 depicts the said report by bar chart.

Table 5.7 Quick Learn Report

Quick Learn Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	10.0	10.0	10.0
	3	15	50.0	50.0	60.0
	4	6	20.0	20.0	80.0
	5	6	20.0	20.0	100.0
	Total	30	100.0	100.0	

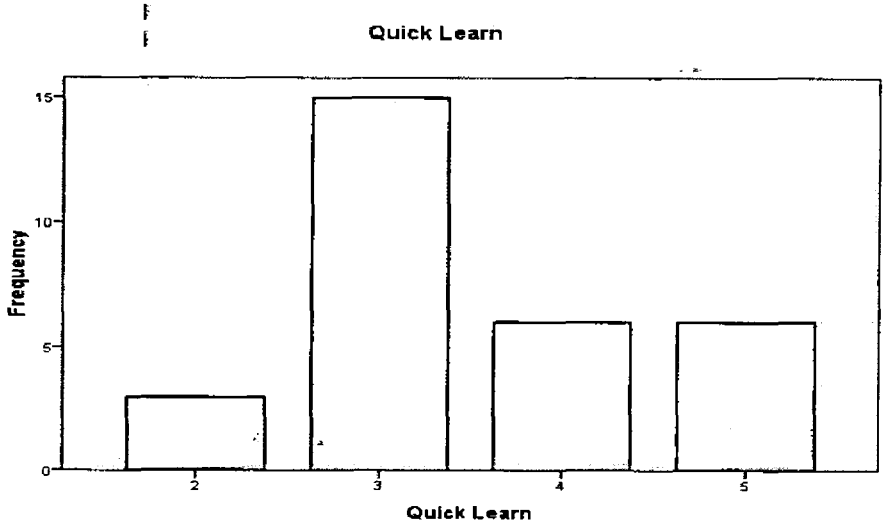


Figure 5.7 Graph for Quick Learn Report

5.3.5 Helpful

Table 5.8 illustrates the report against the Helpful viewpoint where 17 teachers selected the Likert Scale 4 (61-80%) while the remaining 13 teachers selected different scales i.e. the mode for Helpful aspect is coming on scale 4. Figure 5.8 depicts the said report by bar chart.

Table 5.8 Helpful Report

Helpful Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	6	20.0	20.0	20.0
	4	17	56.7	56.7	76.7
	5	7	23.3	23.3	100.0
	Total	30	100.0	100.0	

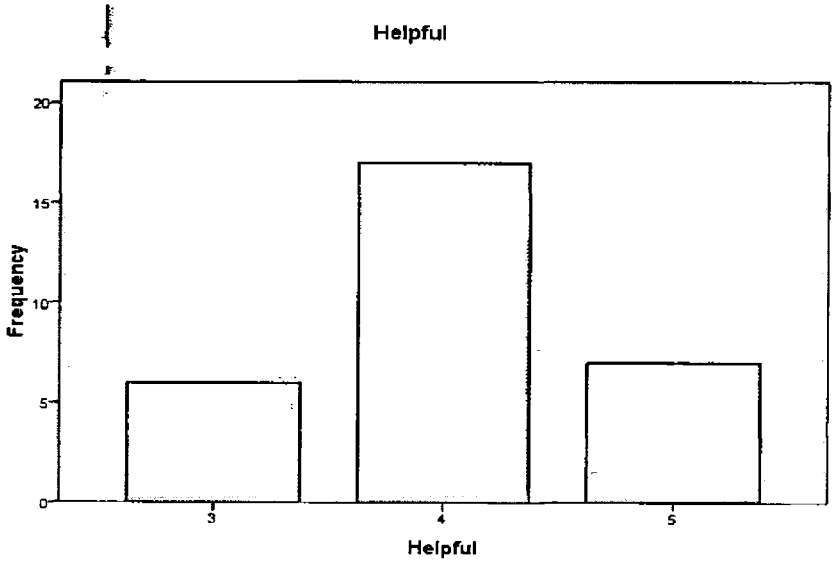


Figure 5.8 Graph of Helpful Report

5.3.6 Like

Table 5.9 illustrates the report against the Like viewpoint where 17 teachers selected the Likert Scale 5 (81-100%) while the remaining 13 teachers selected different scales i.e. the mode for Like aspect is coming on scale 5. Figure 5.9 depicts the said report by bar chart.

Table 5.9 Like Report

Like Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	6.7	6.7	6.7
	3	1	3.3	3.3	10.0
	4	10	33.3	33.3	43.3
	5	17	56.7	56.7	100.0
	Total	30	100.0	100.0	

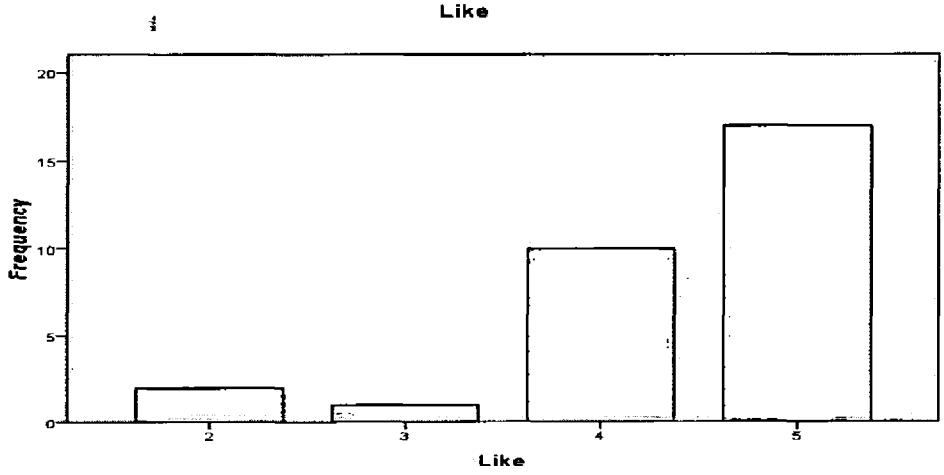


Figure 5.9 Graph of Like Report

5.3.7 Difficult

Table 5.10 illustrates the report against the Difficult viewpoint where 10 teachers selected the Likert Scale 2 (21-40%) while the remaining 20 teachers selected different scales i.e. the mode for Difficult aspect is coming nearly on scale 2. Figure 5.10 depicts the said report by bar chart.

Table 5.10 Difficult Report

Difficult Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	10	33.3	33.3	33.3
	2	10	33.3	33.3	66.7
	3	6	20.0	20.0	86.7
	4	4	13.3	13.3	100.0
	Total	30	100.0	100.0	

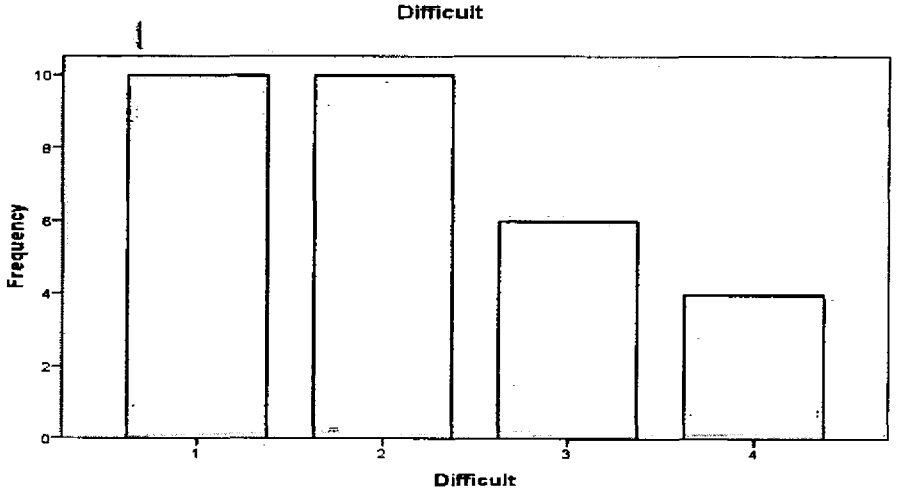


Figure 5.10 Graph of Difficult Report

5.3.8 User Friendly

Table 5.11 illustrates the report against the User Friendly viewpoint where 25 teachers selected the Likert Scale 4 (61-80%) while the remaining 5 teachers selected different scales i.e. the mode for User Friendly aspect is coming on scale 4. Figure 5.11 depicts the said report by bar chart.

Table 5.11 User Friendly Report

User Friendly Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	4	13.3	13.3	13.3
	4	25	83.3	83.3	96.7
	5	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

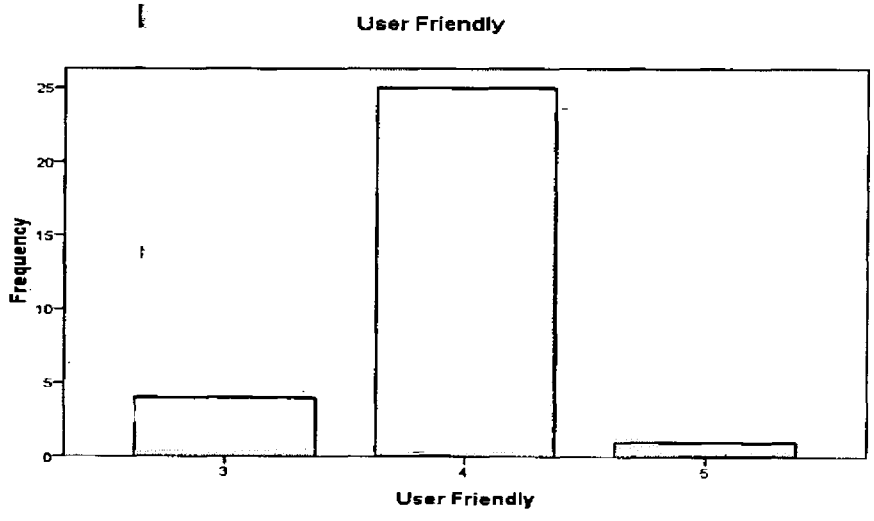


Figure 5.11 Graph of User Friendly Report

5.3.9 mBL Environment

Table 5.12 illustrates the report against the mBL Environment viewpoint where 14 teachers selected the Likert Scale 4 (61-80%), another 14 teachers selected the Likert Scale 5 (81-100%) and the remaining 2 teachers selected the Scale 3 (41-60%) i.e. the mode for User Friendly aspect is coming on Scales 4 and 5. Figure 5.12 depicts the said report by bar chart.

Table 5.12 mBL Environment Report

mBL Environment Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	6.7	6.7	6.7
	4	14	46.7	46.7	53.3
	5	14	46.7	46.7	100.0
	Total	30	100.0	100.0	

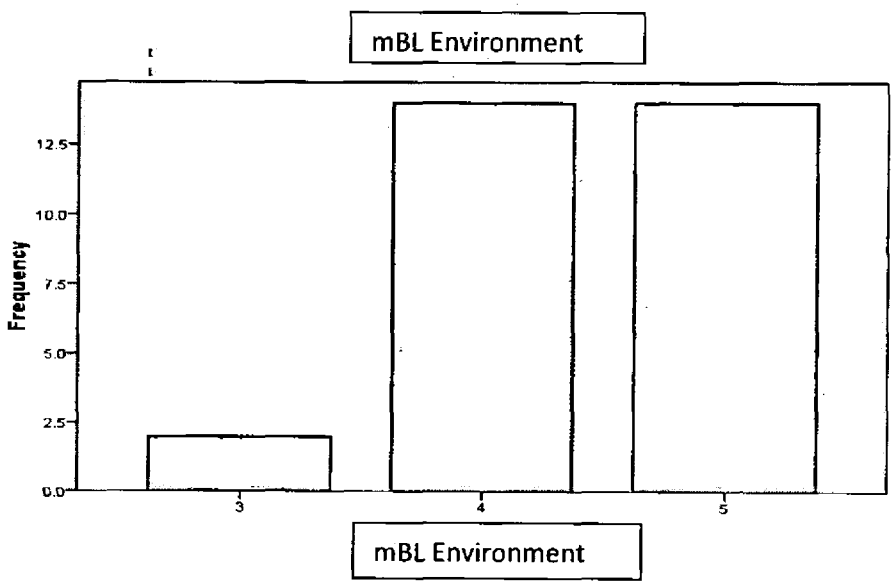


Figure 5.12 Graph of mBL Environment Report

5.3.10 mBL Suitability for Learning Environment

Table 5.13 illustrates the report against the mBL Suitability viewpoint where 19 teachers selected the Likert Scale 5 (81-100%), 10 teachers selected the Likert Scale 4 (61-80%) and 1 teacher selected the Scale 3 (41-60%) i.e. the mode for User Friendly aspect is coming on Scales 4 and 5. Figure 5.13 depicts the said report by bar chart.

Table 5.13 mBL Suitability Report

mBL Suitability Report					
	Likert Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	1	3.3	3.3	3.3
	4	10	33.3	33.3	36.7
	5	19	63.3	63.3	100.0
	Total	30	100.0	100.0	

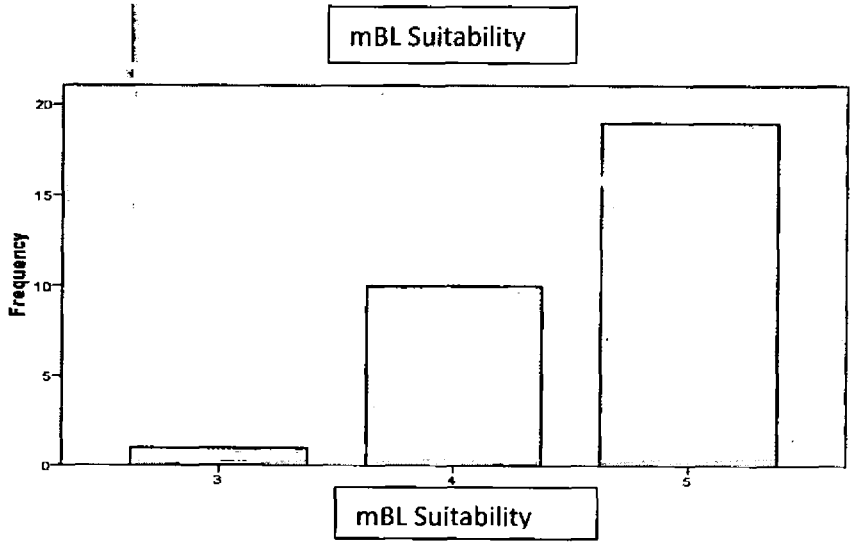


Figure 5.13 Graph of mBL Suitability Report

5.4 Summarizing mBL Suitability Report

Table 5.14, illustrates the summarizing report of these viewpoints which corresponds to mBL Suitability. Each viewpoint is clearly indicated by its mean and standard deviation, a statistical term, where the mean is extracted from the five likert scale selection. N is the total numbers of teacher, who fulfill this questionnaire. Figure 5.14 depicts the said report of Table 5.14, by bar chart.

Table 5.14 Summarizing mBL Suitability Report

Summarizing mBL Suitability Report			
	Mean	Std. Deviation	N
Interesting	4.63	.490	30
Efficient	3.73	.740	30
Exciting	4.80	.407	30
Quick Learn	3.50	.938	30
Helpful	4.03	.669	30
Like	4.40	.855	30
Difficult	2.13	1.042	30
User Friendly	3.90	.403	30
mBL Suitability	4.40	.621	30
mBL Environment	4.60	.563	30

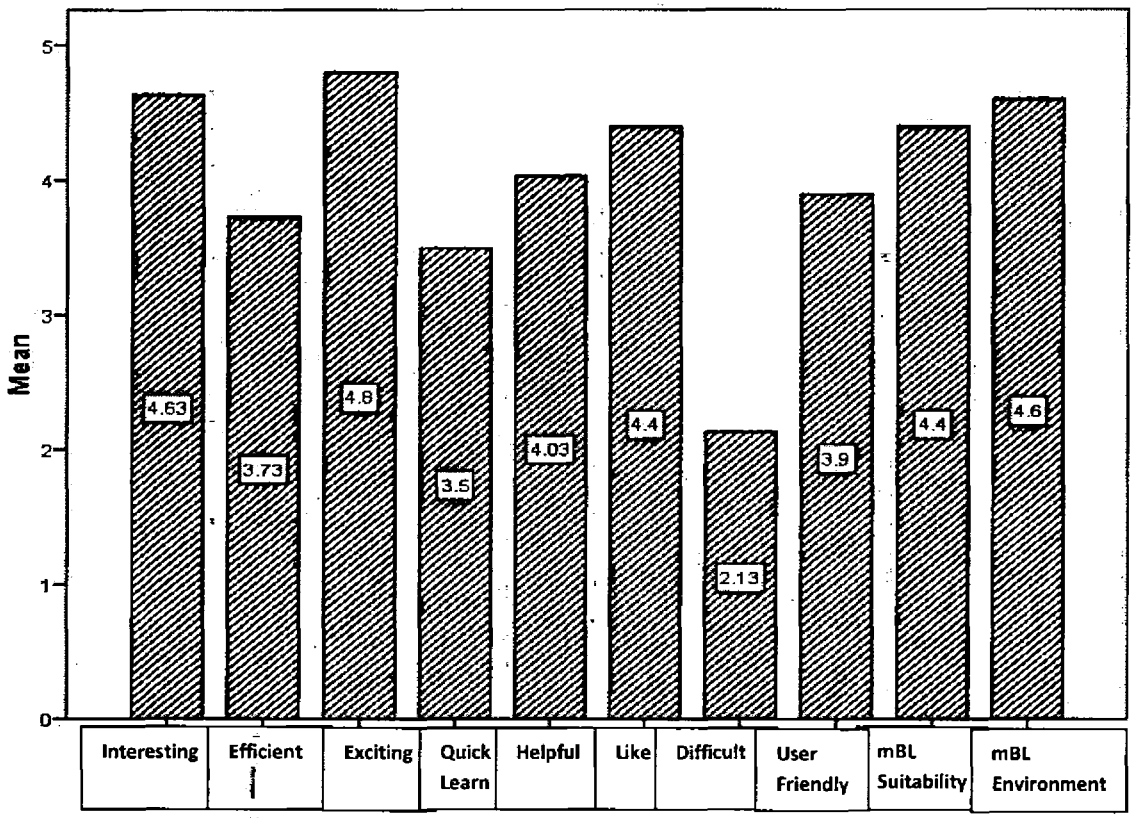


Figure 5.14 Graph of Summarizing mBL Suitability Report

5.5 Chapter Summary

This chapter gives the statistical analysis results of the case study, conducted for the purpose to integrate mBL with CLS and to see the suitability of mBL in the perspective of Pakistan education system. As discussed in section 3.4, the open-ended and close-ended questionnaires were prepared in terms of some viewpoints in order to evaluate mBL whether suitable or not for integration with CLS. These viewpoints consists of Interesting, Efficient, Exciting, Quick Lean, Helpful, Like, Difficult, User Friendly, mBL Suitability and mBL Environment. Section 5.1, provides the pre-tests (mBL) and post-test (CLS) reports, where they both are compared in the terms of Learnability, correlation analysis was performed. In Section 5.2, teacher comments, according to the above view points, are discussed. In Section 5.3, the teachers' comments about the mBL suitability are quantitatively measured and graphically represented by bar charts.

CHAPTER 6

CONCLUSIONS

6.1 Research Summary

Based on the theories presented in Literature Review, which has already been investigated, it has been concluded from various viewpoints of the research community that mobile-based technology can be utilized in the education system successfully. In the light of this concept, researchers' community is increasingly involved to utilize the mobile technology for learning purposes in accordance with their own cultural and educational domains. At this point, the various differences in respect of culture, educational systems, and levels of education, have impacts on providing solutions using mobile technology for learning environment. Literature review concludes that the existing learning methods devised at primary education levels lack the mobile-based learning (mBL) methods in the perspective of Pakistan Education System. This research effort discussed the same scenario as a case study to adapt and implement for Pakistan Education System. This case study was meant to be conducted at Primary education level. The aim of this research work is to integrate mBL with CLS, and to see that how mBL effect the CLS in terms of Learnability in the perspective of Pakistan learning environment.

For the case study conduction and reporting in the field of software engineering, this research work has followed the guidelines and the recommended practices provided by P. Runeson et al [10]. The case study process was held in the five major steps. In the first step the objectives were defined and the case study was initially planned. Objective enlists the overall expected goals to be achieved from the study. In the second step, the procedures and protocols for data collection were defined. The procedures for data collection and data analysis were defined in *Case Study Protocol* (i.e., Field Procedures). In the third step, execution was made with data collection on the studied case. In the fourth step, the collected data was analyzed. Finally, in the fifth step, the report was placed.

Further, in order to validate the hypothesis and its resulting effectiveness, a prototype "1Paki mBL" was developed using Objective C in X-Code framework, which accommodates with the learning methods of Primary Education system in Pakistan. The formally designed pre-tests, post-tests, questionnaires, and interviews helped in evaluating the effectiveness of the prototype. The prototype "1Paki mBL" is evaluated with Heuristic Evaluation Strategy to analyze the Learnability aspect. The strategy adapted helped in preparing open-ended and close-ended

questionnaires in conformance to the components described for the Learnability aspect to interview the educators.

The instruments Pre-tests and Post-tests, 1Paki mBL (prototype), Open-ended and Close-ended questionnaire were carefully designed in teamwork in order to keep the consistency of the various viewpoints of the stakeholders involved during the initial planning of the case study. The team was comprised of three Senior Education Specialists, one psychologist, one Software Ergonomic Expert, and one Software Programmer.

The various viewpoints which were taken into consideration to see the various impacts of integrating mBL with CLS are Interesting, Learnability, Exciting, Quick Learn, Helpful, Like, Difficult (cross question), User-friendly, mBL Environment, mBL Suitability. .

There was a separate file arrangement for each unit of analysis containing each of the activity. The activities include Process modeling (work flows), Simulation modeling (1Paki mBL), Research instrumentation, Time reporting, Failure reporting, Results collection procedure, Data collection, Data Analysis guidelines, Analyzed results, and Analysis reports. For the safe side and preventing from any pitfalls, law abiding steps were taken as ethical considerations Data analysis was conducted for both quantitative and qualitative data. Descriptive statistics was used to understand the collected data and was evaluated in finding mean values, frequencies, valid data, SD (Standard Deviation), and by displaying its bar graphs for describing each data element. Correlation analysis was conducted for the purpose of measuring and relating the later process activity (i.e., post-test) with the earlier process measurement (i.e., pre-test) for each education level separately. As far as the data collected through open-ended questionnaires was concerned, it was used only for results validation gathered via close-ended questionnaires for bias reduction by individual participants and researcher. So only the close-ended questionnaire results were analyzed, which were quantifiable.

Based on merging individual and summarized data, systematic quantitative analysis was performed on the data to further analyze, discuss, and draw conclusion to the case study in the form of reports. The hypothesis generation was initially predicted from the literature review which was further made cleared from the collected data. The techniques used for the purpose was *constant comparisons.* This technique was utilized on both post-tests and pre-tests comparisons

and open-ended and close-ended questionnaire comparisons. The analyzed units in the case study gave a blurred picture of the hypothesis initially. The hypotheses confirmation was made initially after generating the results i.e., on finding out the mobile-based learning environment suitability in Pakistan education system. This was further confirmed with further analysis on generated statistical results in tabular and graphical form. This analysis was made by the reviewers and the initial planners in team. At this stage, the blurred picture of hypothesis was made further cleared on the basis of information consolidation.

The success rate and effectiveness of the proposed approach was described with the help of results based on the data analysis of interview processes and tests. The study results showed that various prescribed components for the Learnability aspect in mobile-based learning (mBL) environment is found more effective than conventional learning system (CLS). Further, the various viewpoints reports indicated, that it is suitable to integrate mBL with CLS in the perspective of Pakistan educational system and whenever they both are integrated, brings effective learning environment.

6.2 Contribution

1. Development of prototype 1Paki mBL using Objective C in X-Code framework

The prototype was developed as an input artifact to validate the hypothesis and its resulting effectiveness which was evaluated with Heuristic Evaluation Strategy to analyze the Learnability aspect. This activity of prototype attracts the researchers in education field to devise methods in the light of mobile-based learning environment. The same is true in creating an open channel for the developers' community to bring further enhancement to such type of tools at Pakistan level.

2. Performed modified Heuristic Evaluation Strategy

Heuristic evaluation strategy is adapted from [14], which suits perfectly for this case study. The prior conventional heuristic evaluations were more focusing on applications design as "Usability" concern rather than "Learnability" aspect. In accordance with the metrics defined for the components in this research at Pakistan level, "Learnability" aspect was considered on top priority.

3. **Designing the other input artifacts: Pre-tests, Post-tests, and Questionnaires in accordance with the components defined for Learnability aspect**

The same Heuristic evaluation strategy helped in conducting the rest of the case study procedure keeping in view the "Learnability" aspect. The results of this research show greater achievements in the induction of mobile-based learning environment in Pakistan Education system.

4. **Case Study conducted at primary level schools utilizing the input artifacts**

The defined activities of the proposed solution were conducted in following the defined steps involved in the case study. Although the scope of research is at primary level schools but with the successful induction of mBL system, the same could be derived for the higher levels of education system as well.

5. **Comparison of mBL with conventional learning system (with Pre-tests & Post-tests conduction)**

Conducting and analyzing the pre-tests and post-tests conduction proved that the success rate of inducting mBL in Pakistan education environment is higher and more suitable than the conventional learning system. The same is true with the results drawn from open-ended and close-ended questionnaires data.

6. **mBL Data Analysis in terms of Learnability aspect**

   a. mBL and CLS comparison (Pre-tests & Post-tests)

   b. mBL Suitability Analysis (Questionnaires)

As discussed in Section 5.2 and 5.3, the data analysis was summarized and discussed in terms of "Learnability" aspect with the narrow-down approach to various components-level.

6.3 Limitations and Future Work

This research work is limited to focus only on the primary education system of Pakistan, although, there exist different education systems, education standards, and education cultures, but those had been neglected to build the focus on the mBL suitability and were considered out of the scope of this research effort.

In future, further research studies could be conducted for higher level education system of Pakistan, to build focus on the mBL suitability.

The prototype "1Paki mBL" accommodates English subject that is thought in primary education of Pakistan. Further the prototype "1Paki mBL" needs enhancement in accordance with components described under each of the four aspects of Heuristic Evaluation Strategy, described in [14].

The prototype "1Paki mBL" is only implementable on IOS (I-phone) operating system but in future same type of prototype could be developed for Android Operating System.

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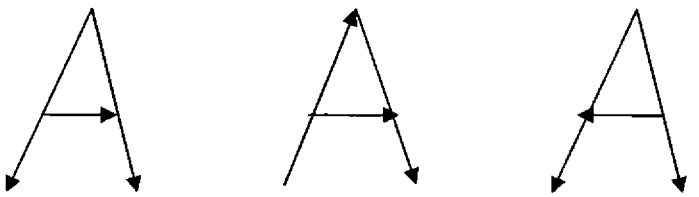
8.1 APPENDIX -A: Associated information

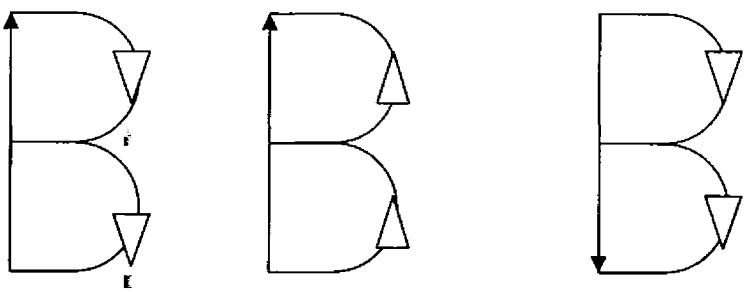
8.1.1 Nursery Level Test

Q.NO1: Choose the correct way of writing an English letter

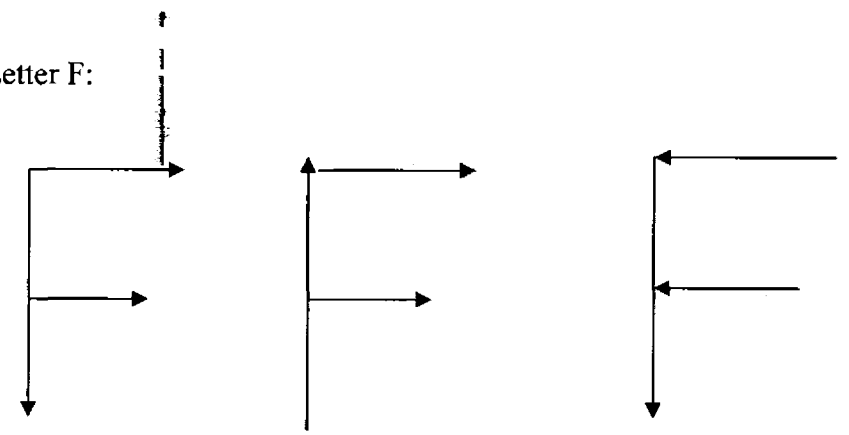
5) Letter A:



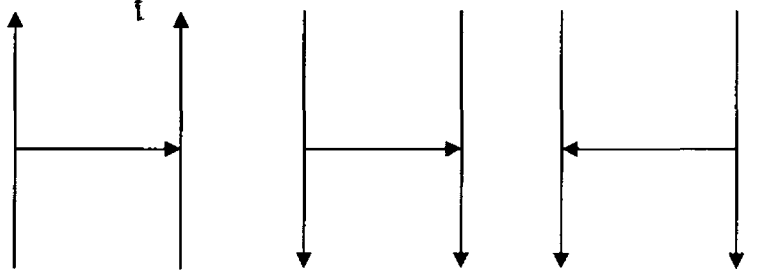
6) Letter B:



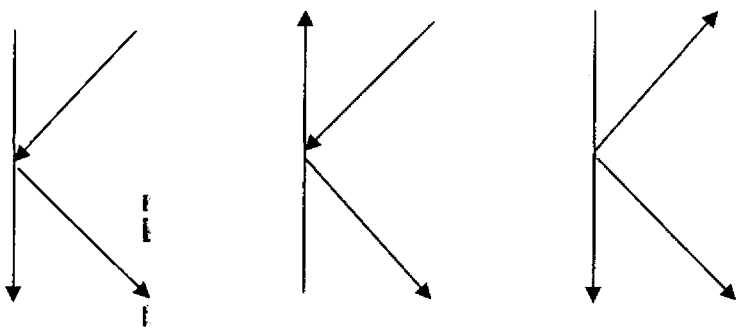
7) Letter F:



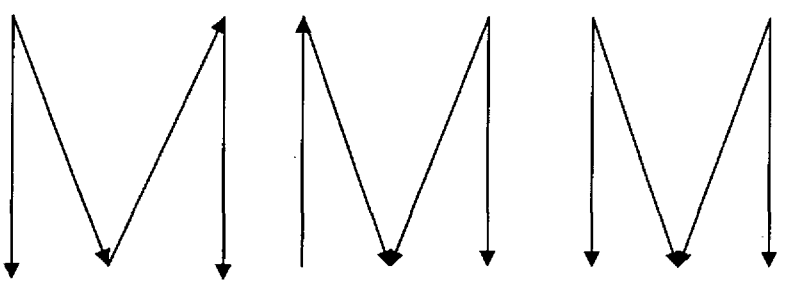
8) Letter H:



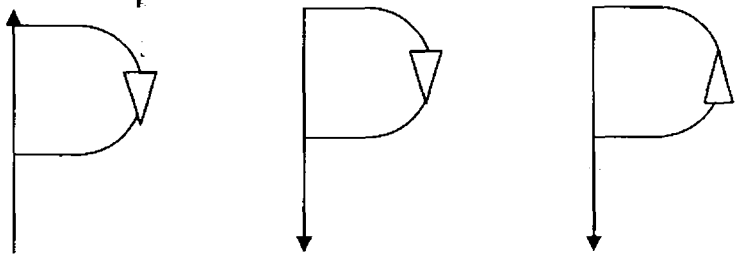
5) Letter K:



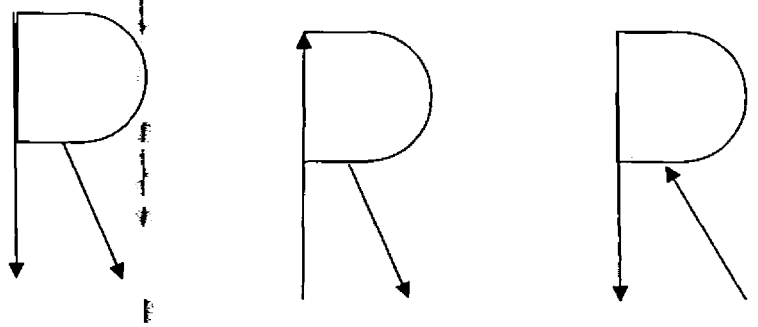
6) Letter M:



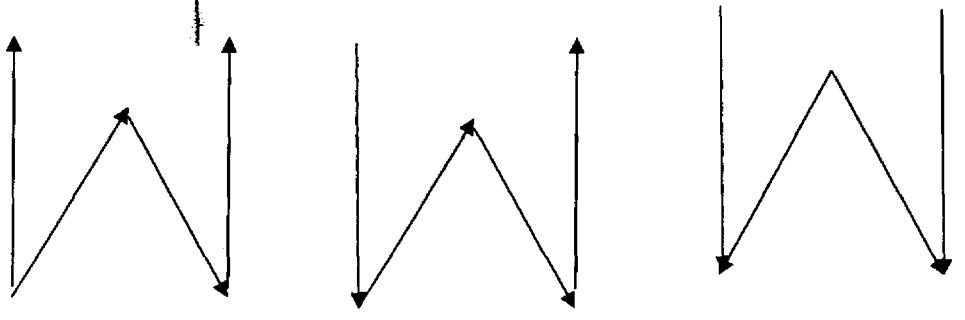
7) Letter P:



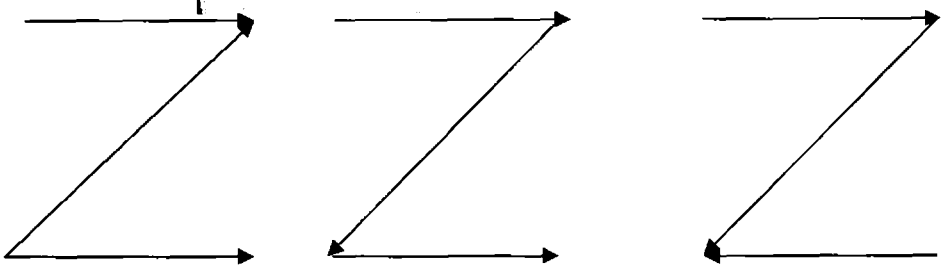
8) Letter R:



3) Letter W:

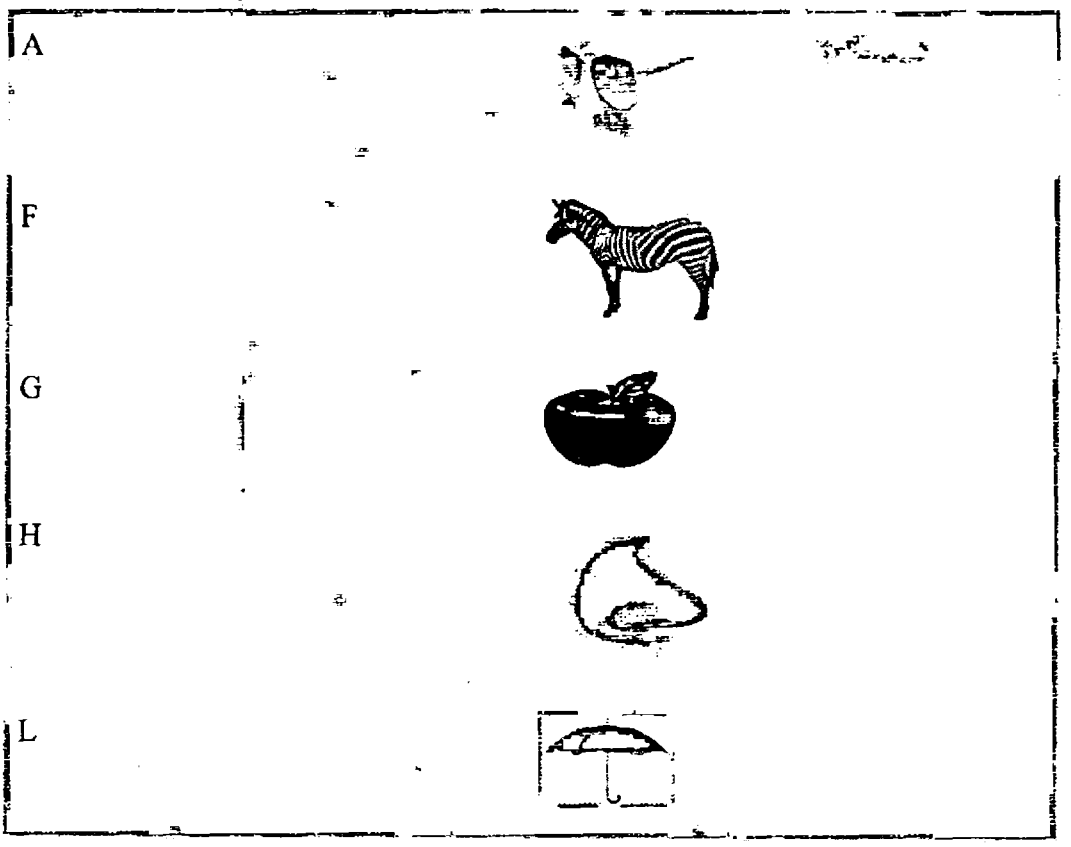


4) Letter Z:



8.1.2 Kindergarten Level Test

Match for the correct pronunciation

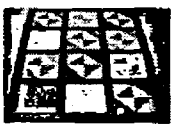


N

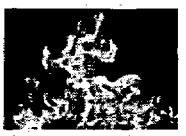
Q

U

W



Z



8.1.3 Primary Level Test

Choose the correct spelling for an object

ii) Aple ii) Appel iv) Apple

iv) Flower v) Flawer vi) Flowar

iv) Glasess v) Glases vi) Glasses

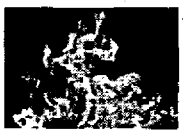
iv) Juic v) Juice vi) Jouce

iv) Icecream v) Icecreame vi) Isecream

iv) Rabit v) Rabbet vi) Rabbit

iv) Shoes v) Shoese vi) Shose

iv) Umberela v) Umberella vi) Umberalla



iv) Worm v) Warm vi) Worrm

iv) Zabra v) Zebbra vi) Zebra

8.1.4 SPSS Written Test Summary

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Pre Test	47	100.0%	0	.0%	47	100.0%
Post Test	47	100.0%	0	.0%	47	100.0%

8.1.5 SPSS Pronunciation Test Summary

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Pre Test	35	100.0%	0	.0%	35	100.0%
Post Test	35	100.0%	0	.0%	35	100.0%

8.1.6 SPSS Spelling Test Summary

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Pre Test	38	100.0%	0	.0%	38	100.0%
Post Test	38	100.0%	0	.0%	38	100.0%

8.2 APPENDIX -B: Associated information

8.2.1 Open-Ended Questionnaire

First, thanks to all those respondents, who fulfill the questionnaire and provide me support in the case study conduction at these institutes. The purpose of the case study is to collect teacher's insights against the integration of mBL with CLS, in perspective of Pakistan educational system. The case study is conducting for the completion of MS (software engineering) thesis titled "Interactive mobile learning environment for school children". For the safe side and preventing from any pitfalls, your record will keep confidential and law abiding steps are taking as ethical considerations. The approvals for the case study conduction are made at the first place from the concerned supervisors, chairman of the department and dean of faculty. Following are the contact information for your satisfaction. Further, reference is available of request.

Research Unit: Department of Computer Science and Software Engineering International Islamic University Islamabad.

Research Supervisor: Mr. Shafiq-ur-Rehman, Assistant Professor, FAST (NU), Islamabad

Co-Supervisor: Mr. Muhammad Imran Saeed, Assistant Professor, IIU, Islamabad

Researcher: Mr. Ghulam Murtaza

Email: ghulam.murtaza@iiu.edu.pk

Cell: 03469293710

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1. Teacher Name _____
2. School _____
3. Gender: ☐ Male ☐ Female
4. Teacher's Signature _____
5. Principal Signature _____

Q No.1 You found the mBL prototype efficient, in terms of Learnability, for children or not? (Description)

Q No.2 What is your impression about the mBL prototype? Do you like it? (Description)

Q No.3 You found this mBL prototype interesting for children or not? (Description)

Q No.4 In your point of view, this mBL technology brings effective results on children learning outside the school usage? (Description)

Q No.5 As mobile technology is easily available everywhere, so you think this technology may utilize children free time or not? (Description)

Q No.6 During using the application, children learned or only enjoyed? (Description)

Q No.7 Is there any negative consequence of the mBL prototype in your point of view? (Description)

Q No.8 Should this mBL technology need to be adopted regularly in schooling system (mBL Suitability), in integration with CLS? (Description)

Q No.9 As a teacher would you like to vote for mBL technology if extended for higher levels classes in future (mBL Environment)? (Description)

Q No.10 How much user friendly you found this application? (Description)

8.2.2 Closed-Ended Questionnaire

Q No.1 Children showed interest in mBL prototype?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.2 The learning of Children improved

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.3 Children showed excitement during using the mBL prototype?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.4 Children learned quickly (within short time) through mBL prototype?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q.No5 This mBL technology is helpful for children even after school

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.6 You like the mBL prototype for children learning?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.7 You found the mBL prototype difficult to use?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.8 You found the mBL prototype user friendly?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.9 You support the mBL technology for future learning?

(1) 0% ----20%, (2) 21% ----40%, (3) 41% ----60, (4) 61% ----80%, (5) 81% ----100%

Q No.10 The mBL technology will make the learning world fast and exciting?