MAPPING HCI PRINCIPLES TO EVALUATE THE LEARNING APPLICATIONS OF THE CCI USERS



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Abstract

The technological innovation in modern times rests upon user interface design to improve the technical intricacy of products to meet the end user requirements. The acceptance level of any technological product depends on the user experience that displays the understanding of users about the end product.

The principal purpose of this study is to recognize the challenges and problems linked to the mobile phone software interface design in the perspective of the Child Computer Interaction (CCI) community. CCI community includes children from age 4-15 years. Regardless of the widespread use of learning applications, less consideration is given to the usability of learning applications from the perspective of the CCI community. During the investigation, the researcher is trying to discover the usability problems faced by the CCI user by utilizing user testing and heuristic approach to assess existing learning applications. The questionnaire technique is carefully chosen to collect the demands from the CCI users about the mobile phone software interface. The findings of the questionnaire are used to develop the design guidelines for the prototype of the mobile phone software interface. Moreover, usability testing is performed to validate the design of the prototype. The result of this study will support mobile phone software interface designers and developers.

This thesis presents how a mobile phone software interface for the CCI users can be designed. The study will help designers to become aware of the needs and requirements of building the designs of E-learning applications for the CCI Community.

Keywords: Usability evaluation, E-learning, CCI (Child computer Interaction).

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Chapter 1

Introduction

Technology is changing the living styles of every field of life in the modern world. The technique of learning has changed with the developments in technology. Electronic learning (E-learning) is becoming mainstream for instructing and learning[1][2]. In the contemporary world, E-learning applications have grown into a rapidly expanding domain in the software design business. From the viewpoint of traditional marketing culture, the practicability of an application needs to be examined properly to make productive, resourceful products. In this particular industry, the key trial is to create an E-learning application that is both educational as well as interactive for the students.

On average, 69 percent of CCI user community surveyed uses a mobile phone (google statics). CCI user community has its own needs and requirements. The attitude that motivates the students to understand the interface of the application diverges from the attitude of the adults. The usability of E-learning applications for the CCI community poses its own requirements. This research will help to evaluate and design the learning application for the CCI user community.

1.1. E-learning

Basically, it is a computer-based instructive framework for learning. It combines learning with fun and creative games. It is a cost-effective method of learning. Distant learning is becoming easier with the development of E-learning applications. People from distant locations can access and learn by using E-learning applications. A significant figure of web-based and mobile learning applications is available. The adaptation and admiration of E-learning applications is increasing world-wide [3]. It is a stress-free and efficient method of learning. It enables us to learn new things anytime, anywhere in the world. Electronic learning is a sort of innovation that supports training and learning, where the mechanism of guidance is through computers, especially including advanced devices like mobile, tablets and laptops[4]. E-learning has been characterized by Nichols as an "instructional method enabled by computerized technology".

The purpose of E-learning is to encourage and help individuals by conveying suitable substances and administrations to satisfy user needs. The growth observed in the usage of E-learning also encourages the software designers to create mobile educational applications. With the increase of demands of these applications, studying and enhancement of usability is also increased. The main question that emerges here is what are the ways to judge an E-learning framework and its usability (user interface, user experience)? Particularly, pertaining to user interaction with the working of that learning application.

However, the users only see the interface of the application as the programming language codes are hidden from them. But the interface of the application is critically important as it determines the achievement or failure of an application as that depends majorly on the interface of that application[5]. The user will not enjoy using the interface if it is dull, uninteresting or challenging to utilize. The user interface of any application is important for the success of that application[6].

1.2. User Interface

User Interface (UI) design in fact describes the graphic layout of the basics of an application that a user directly interacts with in an application or technological invention. This interface can be the control buttons that make television or radio work. It could also be the graphical design of an application.

A mobile user interface (mobile UI) is the visual design of an application that is accessible by the user. This visual design is graphic and touch-sensitive in nature and has become a trend, with the invention and popularity of touch screens. Some now visual and graphic display with engaging applications can be seen in a smartphone or a tablet, allowing the user to use or work with the device's applications, characteristics, content, and purposes. A user interface, also sometimes called a human-computer interface, comprises both hardware and software components. It handles the interaction between the user and the system.

1.3. Usability

'Usability' is basically a method of determining the way individuals can create or invent objects that are more productive and useful for instance computer-interfaces or web pages for their planned objective.

A usable interface should contain following three key aspects:

1. A user should be able to access, comprehend and use the interface with familiarity. Therefore, the user interface should be straightforward to operate even during the first contact with the application.
2. The objective for which the application has been created should be easily achievable.
3. It should be effortless to remember the user interface and its usage on later visits.

There are numerous methods to examine the usability evaluation of learning applications; for example, testing its usability (e.g. user testing); or inspecting it (e.g. heuristic evaluation/ 'expert evaluation') and initiating inquiry or investigation regarding its usability (e.g. questionnaires)

1.4. CCI Community:

CCI is the new term introduced in the HCI. This term means Child Computer Interaction. This term is used for the community of children those are familiar with computer and using computer technologies[1]. The community of CCI includes children age 4-15 years [13]. The needs and requirements of the CCI community are different from other users. Their emotional and educational requirements are different. Usability requirements for any interface are different for the CCI community[1]. This can expand the limit between the interaction of learning applications and users. The interface is of no utilization if it is trouble for the user. [14], [15]. The good interface is directly proportional to the good learning because attention will be only on the learning not on the understanding of the interface of the application [16]. Figure 1.2 explains the relationship between interface and learning. The interface is directly proportional to the learning.

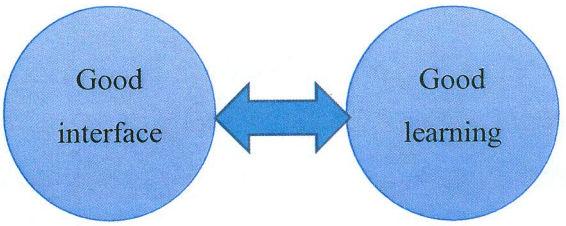


Figure 1.1: Interface interaction with learning

1.5. Motivation:

Technological advancement has given a solution for different issues in human life. The utilization of learning applications has quite expanded in recent years [17]. Multiple applications are already accessible on the play store and app store. The researcher observes that the downloading rate of the E-learning application is high. Reviews show educational institutes and parents are downloading learning applications for the children. The observations of the researcher show that utilizing the learning application for CCI users is a very time taking and exorbitant methodology. So, the inspiration of the author is to assess the easily accessible applications and give recommendations for new applications to make them easy to use for CCI users without any training.

1.6. Research Gap

E-learning mobile applications are created to promote education. E-learning is rising as an important field in the current era such that there have been a lot of developments in creation as well as the functionality of such applications which is becoming complex with time [18]. The assessment of the usage and productiveness of the E-learning application involves complex dynamics. There is a lot of diversity and advancement in E-learning applications. In the E-learning business, the test is to devise an E-learning application that is informative, cooperative and easily accessible for the students. Assessing the practicability of E-learning products from the point of view of users poses its own requirements. The prerequisites and desires of CCI users are different from the other users.[1] CCI user is not an expert user. The first trial of an E-learning application without any assistance from an elder is a difficult task for CCI users. CCI users get confused and irritated while functioning E-learning applications if there is no

guidance[14]. With the increase in the functioning of the application, it has become difficult to fulfil the satisfaction level of CCI users. The key purpose of this research report is to provide suggestions to the designers of E-learning applications so that it ultimately is more beneficial for CCI users.

1.7. Problem Statement

It is necessary to assess the E-learning applications by experts and end-users (CCI Users) to highlight the design and usability issues in current E-Learning products. The research on the usability of E-Learning programs for CCI users is based on Usability guidelines given by Jackob Neilson Heuristics.

1.8. Key Research Questions

RQ1: What are the deficiencies and design issues in available mobile learning applications for CCI users?

RQ2: How to evaluate the existing user interface of learning applications for CCI user applications?

RQ3: How the Prototype UI support users' particularly CCI users?

1.9. Aims and Objectives:

This study principally aims to assess the learning applications for the CCI community. The objectives of the research are:

1. To evaluate e-Learning application for CCI users using the following methods
    i. Heuristic Evaluation
    ii. User Testing
2. To provide prototype based on results
3. To validate the prototype

1.10. Main Contributions:

The way where youngsters perceive the user interface is not just the way in which grown-ups do so. In this research work, the author will identify the problems of the CCI

community for using the learning application and will also give suggestions for the better design of the learning application for the CCI community.

1.11. Thesis Organization:

Chapter 1 defines the introduction of the research work. The E-learning, usability, and CCI user terms were explained in the first chapter.

Chapter 2 details the review of the literature used in this study. This chapter includes an academic paper on HCI, CCI, and usability of learning applications.

Chapter 3 appraises the method used for assessment of the E-learning programs.

Chapter 4 explains the implementation of the phase 1, 2 and 3. It contains the preparation of the usability assessment, task definition, variety of users who will carry out the tasks, apparatus utilized in the assessment, performing the usability assessment, test statistics, inspections and conclusively the overall evaluation.

Chapter 5 covers the important parts of this research report. It comprises of the outcomes of the user testing and Heuristic Evaluation. The prototype development and validation are also included in chapter 5.

Chapter 6 encompasses discussion as well as the solution to the research questions, coming to a productive conclusion and the future work regarding the study is discussed in this chapter.

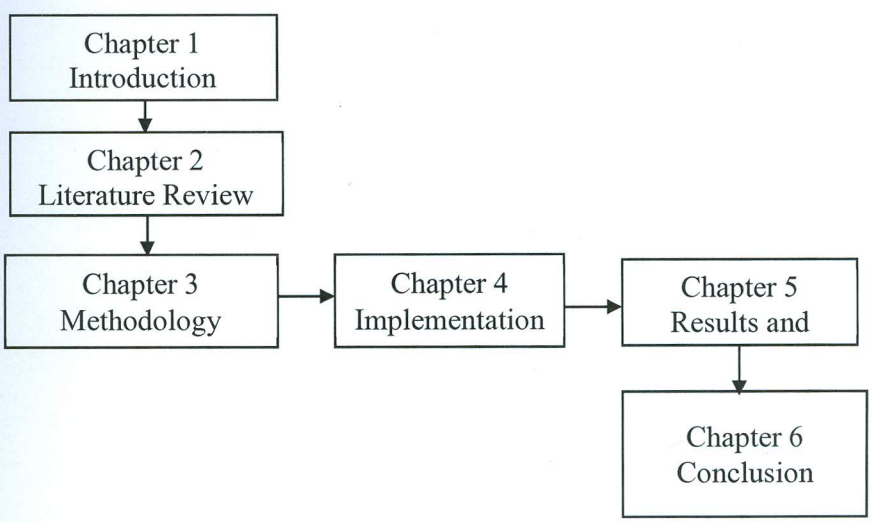


Figure 1.2: Thesis Organization

1.12. Research Phases

The Research is divided into three different phases

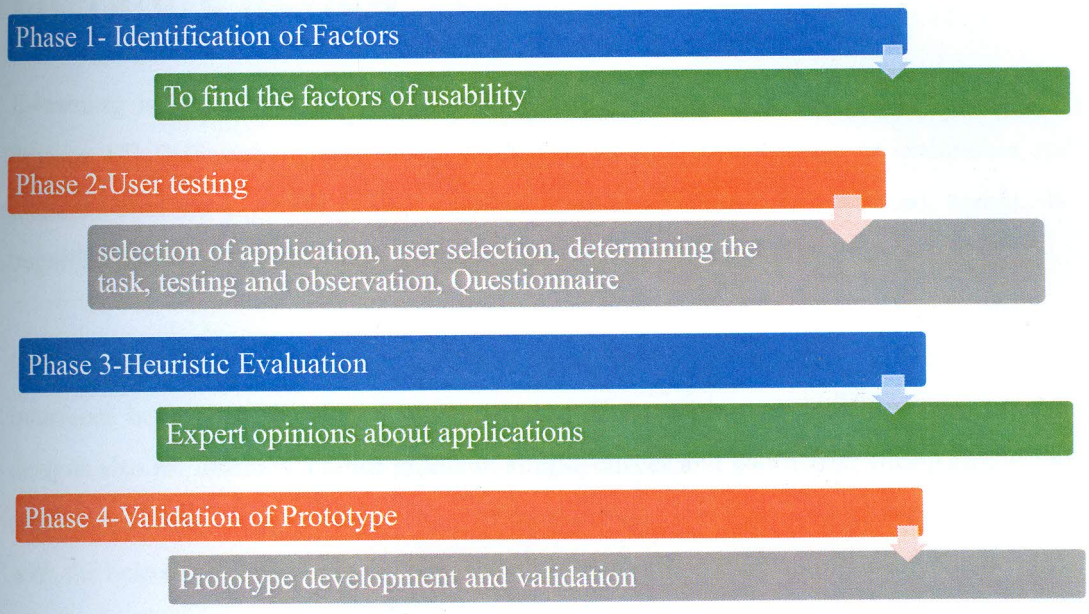


Figure 1.3: Research Phases

Chapter 2

Literature Review

E-learning is distance education or it is learning through the computer or computer devices. [7] Different methods are endorsed to make the interaction of computers and humans better for E-learning. The standard rules of HCI are making visual, verbal, the cognitive interface of E-learning software enhanced day by day. [19]

HCI has played a massive part in developing the mobile interface. Different mobile interfaces have been developed up until now. The mobile user interface has different designs also for instance: colour gradient, simple curves and geometric, strong colour and contrast for readability, functional animation interface. These designs are being advanced with the help of HCI rules day by day, the mobile interface is changing is advancing also.

Child-computer interaction (CCI) is a unique domain of human-computer interaction(HCI)[20]. This field has grown progressively, with its foundation set by the efforts of Seymour Papert and Mitchel Resnick at MIT which was later expanded and developed by Allison Druin, Yvonne Rogers, and Mike Scaife[19]. CCI is the latest field, that concern with the interaction of children with computers, or the interaction of children with computer devices like laptops, mobile, etc. CCI takes most of the inspiration from the HCI field. CCI is the emerging field of HCI. CCI is as yet discovering its direction. The needs and requirements of CCI users are different from the other users so the interactive design for the learning applications Child-Computer Interaction (CCI) is basically the domain that leads the Interaction Design with Children (IDC) [14], [13], [21]. Interactive design has a critical importance since it includes recognizing the demands and anticipations of students as well as exploring and evaluating the essential theories that regulate the prospective applications and presenting an attractive visual design.

Human-Computer Interaction is a vast field. This field has further research areas. CCI is the research area of the HCI. This area is growing day by day. New researches are being done for CCI. IDC is the research area of the CCI. IDC means Interaction Designs with Children. The linkage between the Human-Computer Interaction (HCI), the Interaction Design with Children (IDC) and the Child Computer Interaction (CCI) is explained below in Figure 2.1:

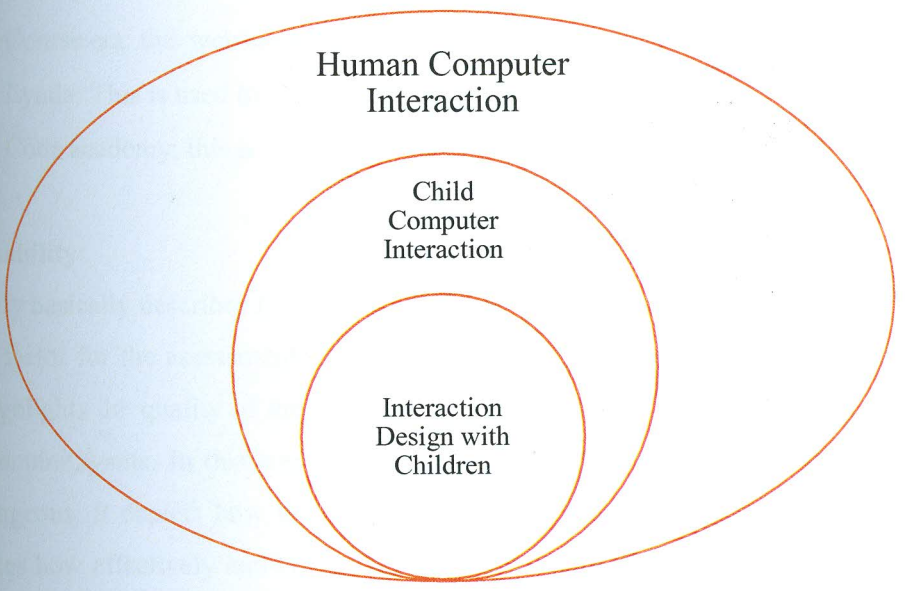


Figure 2.1: Connection of HCI, IDC and CCI

Irrespective of the huge development of E-learning in education and its apparent advantages, the productivity of such applications won't be completely used if the user inclined to not acknowledge and utilize the applications. In this way, the effective accomplishment of E-learning products is contingent on whether the users are happy to embrace and acknowledge the innovation. The use of computers is also increased among children. Many applications have been developed for the welfare of children. In this way, it has become imperative for practitioners and policy makers to comprehend the components influencing the user acknowledgment of electronic learning frameworks so as to improve the CCI users' learning background[27], [28].

E-learning is becoming an essential part of education. Different types of applications have been introduced in the market for E-learning. Subject-based learning application, knowledge base learning application, learning with a fun application, language learning applications have been introduced[1]. Different E-learning applications are:

- Duolingo: it is used for learning different languages.
- Khan Academy: this is the website for learning different concepts.
- Udemy: this website allows a user to learn different computer courses.
- Course era: this website is the learning website for different courses.
- Lynda: This is used to learn different software.
- Code academy: this is used to learn data science and software programming.

2.1. Usability:

Usability basically describes how the human users encounter the system[2]. It is basically a vital factor for the assessment of E-learning advancements and frameworks. Usability also highlights the quality of the product as it places primary emphasis on the users and their genuine wants. In this way examination of usability and its learning procedure is advantageous. It depicts how the computer is being used by the user with ease. It also evaluates how effectively and efficiently user interface used by the user to fulfil the user level. Usability is all about how an end-user effectively and efficiently used the system, how an end-user safely, quickly and efficiently used the system, and how an end-user learns and memorizes the system. The usability main goal is to measure how much a user interface provides the actual functionality.

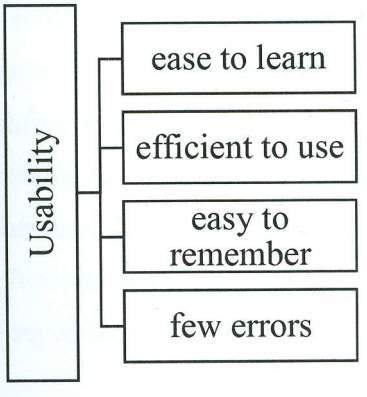


Figure 2.2: Usability measuers

2.1.1. Usability of E-learning:

The demand for E-learning has increased day by day. For looking in a relation of the E-learning and usability the issue of ease of use one needs first to characterize the utilization of an E-learning Increment in the assorted diversity of CCI users, mechanical progressions and radical changes in learning are the basic needs of this particular learning in the institutes. Its usability is more challenging as it is necessary for a developer to fulfil the required educational and psychological needs. Its success is mostly based on usability and effectiveness [35], [4]. If the user interfaces are not easy to understand then user time will be spending more on understanding it and it will create difficulty for users. The interest of using this type of learning could decrease in a scenario where the user gets annoyed if the user interface functionality is slow or poor.

The usability is a crucial element of E-learning in the teaching method. The absence of a suitable usable and user trotted interface structure of various electronic instructive frameworks diminishes the interface's adequacy and productivity. This highlights the significance of the key objective of our research which is to assess the usability of the application interface of a basic developed E-learning software.

To judge the usability of a framework and to establish its usability problems, it is critical to choose proper usability assessment techniques/strategies by thinking about productivity, time, cost-viability, simplicity of utilization, and ability of evaluators. Another main aim of any E-learning application's conceptualization is to be away from any diversion so that all the substance in the CCI users' brains is kept fresh as they have new ideas. In the specific instance of E-learning, the difficulty is to create an intelligent framework that does not confuse the CCI users. It is often observed that an E-learning product is an irrelevant automated substitution of traditional substance, demonstrated via inflexible communication plans and distorted interfaces[36]. At the point when CCI users criticize the E-learning application, it is generally not the preparation. They basically criticize the difficult, confusing or illogical user interface that scares the users off.

2.2. CCI learning Application Designs:

There are quite a lot of distinct concepts relating to the software layouts for youngsters. Those which have been adapted for students are discussed below:

• **User-cantered design** [9]: This method allows the users to indirectly play an active role in setting of the layout of the software. Therefore, this utilizes opinion polls, discussions, and users' surveys to understand the need and desires of a large group of users. Users however can only provide an outlook and assessment of the layout.

• **Contextual design**[6]: The layout of the application is centred on the necessary data, the actions of the users in their everyday life: and the objective of the application.

• **Participatory design**[5]: The prototype product of the software is built as an initial or preliminary version of the actual product. The prototype design and development often include end-user involvement. It is built on swift prototyping not including the stress on its workings. This trial product presumes that for the most part users can properly identify the purpose of an application and the information it should contain and handle. Participation of an end-user in the layout and growth of a prototype or product is deemed as participatory design.

• **Cooperative inquiry**[17]: This approach involves the usage of features from each of the procedures discussed above for the progress of the software design, i.e., examination, questionnaires and involvement of youngsters in the software layout.

• **Informant design**[18]: In this method, the users take part as informers in different phases of software development, involving the design.

• **Learner-centred design**[19]: The software design is modified in the direction of the interests, abilities and the fashion of students. The most important purpose in the model is to motivate learning, make it easily accessible and more interesting with integrating the modern training resources.

• **Constructional design**[20]: The concept here is that the users of the product are themselves able to create a design according to their needs and allocation.

• **Interaction design**[21],[22]: The interaction layout is basically concerned with understanding how the users influence the functionality of the application and systems.

2.3. Mobile Application Testing

This is a procedure through which an application software, created for mobile devices that are light and can be held easily, is examined for its usage, practicability, productivity and demand. Such applications are either already installed in the devices or they have to be installed from application stores that are basically software distribution platforms. Mobile gadgets have observed remarkable progress in the recent years. There are various methods available to calculate the usability of mobile applications.

2.3.1. Functional Testing

Functional testing makes sure that the program is running according to its purpose and need. User interface and Call flows basically direct the test for the assessment of functionality of the application[3].

2.3.2. Laboratory Testing

Network Carriers are generally the ones who conduct this assessment by mimicking the entire wireless network. This exam is done to investigate any malfunctions when voice control is used by a mobile application or data connection is utilized to execute some functions [3] that could be related to server as well as the user. Both sides are tested to maintain productive functionality [3].

2.3.3. Memory Leakage Testing

Sometimes a computer program or mobile software is not able to handle memory it is designated to handle. This could lead to memory loss or poor performance. This can also slow the system. [4] Since mobile gadgets have substantial limitations regarding memory and space, therefore memory leakage testing become highly relevant for the proper function of the device as well as the application.

2.3.4. Interrupt Testing

An application when it is operative may confront numerous disruptions like calls that are outgoing or being received or network coverage outage and improvement. The various kinds of disruptions are:

1) Incoming and Outgoing SMS and MMS

2) Incoming and Outgoing calls

3) Incoming Notifications

4) Battery Removal

5) Cable Insertion and Removal for data transfer

6) Network outage and recovery

7) Media Player on/off

8) Device Power cycle

A product should be competent enough to deal with these disruptions by entering a pending state and returning after that [3]

2.3.5. Usability Testing

Usability testing is done to make sure that the application is accomplishing the purpose for which it was created and receiving a positive reaction from users. This is crucial as the practical usability of a product determines its profit and triumph in the market. [3]

2.3.6. Installation Testing

A number of mobile applications are already installed by default on the devices while some others have to be installed from the application store. Installation testing makes sure that the installation of an application is done efficiently with the user not needing to confront any complication regarding that. This testing process comprises of installation, updating and uninstalling of an application [3]

2.3.7. Certification Testing

To obtain a certificate of compliance, every mobile device must be assessed compared to the standards and regulations established by various mobile platforms [3]

2.3.8. Performance Testing

This testing process is initiated with a purpose to examine the functioning and conduct of the application under specific circumstances for instance the minimum battery, poor network coverage, low accessible memory, synchronized contact with application's server by numerous users and other circumstances. The operation of an application can be

influenced by both i.e. server as well as client side. Performance testing is done with a purpose to examine both,[3]

2.3.9. Heuristic Approach

Heuristic evaluation (HE) is a systematic assessment of a user interface layout for usability. The objective of heuristic evaluation is to discover the usability challenges in a user interface design. It is the extremely frequent utilized assessment procedure; it is cheap compared to other assessment procedures. It is insightful and effortless to persuade prospective assessors to utilize it whilst superior planning is not needed. HE has been widely utilized in the e-learning, however, not much has been done practically to methodically tackle the above-mentioned research challenges in an e-learning perspective. Corresponding research attempts in e-learning studies are rare. The efficiency of this approach for applications is uncertain in numerous studies; as only some attempts have been accomplished to examine such matters (efficiency, practicability , etc) and the majority of the researchers and experts solely operate such approaches and heuristics from out-dated usability research to examine and assess e-learning settings.

Nielsen's Heuristics

Usability assessment of e-learning applications involves unique concentration because of the distinctiveness of the learning procedure itself, the complex traits of the learners and the difference of the learning endeavours. Consequently, every e-learning application consists of complex inner dynamics. Throughout the initial years of e-learning, the idea of usability was either overlooked or utilized simplistically, which indicates that for the most procedure of the assessment, it was done traditionally. E-learning expands the conventional conceptualization of user, task, and context resulting from usability as well as evolution in learning environments as it shifts from formal to informal environment. Assessment of usability should also contain the aspects such as if the design of the learning environment is founded on learning theories and if other essential elements such as enthusiasm and variety of students, and progress are considered or not. The heuristic evaluation has been operated widely in e-learning studies. Numerous of the researches

make use of Nielsen's heuristics or other variations of the same approach not including particular concern for e-learning framework. However, several groups have established heuristics, but one of the most accurate set is created by Nielsen's in 1994. Nielsen polished the list initially established in 1990 by himself and Rolf Molich. Nielsen's Heuristics consist of:

- **Visibility of system status**: Users should be aware of their presence within the software i.e. their position in the system. Also, users should be able to access distinctly noticeable choices of what they can do next within the application. This can be done by make information as well as feedback process easy and quick.

- **Match between system and the real world**: The images utilized should be consistent with the real-world ideas and models. The user interface should communicate the user's language by applying expressions, words, icons, and ideas recognizable to the user and familiar to the real sphere in which the imaged are applicable, structurally.
- **User control and freedom**: Users every so often select user interface utilities by error and will require a distinctly apparent "emergency exit" to go back from the undesirable state without going through a long process or discussion. The options of undo and redo must be built and backed.
- **Consistency and standards**: The users should be able to comprehend application and its feature clearly without any confusions. Therefore, the content should be straightforward without any double meanings. Platform rules should be abided by.
- **Error prevention**: The design should be careful and smart so that errors can be avoided. It should be able to avoid or eliminate an error from taking place. Also, it should be able to detect such problems if they do take place and offer users with an approval option before they perform an action against an error.
- **Recognition rather than recall**: Decrease the user's memory trouble by making items, activities, and decisions self-evident. The user do not need to review information starting with one segment of the format then onto the next. Headings for utilization of the application ought to be discernable or without trouble retrievable at whatever time right.

- **Flexibility and efficiency of use**: Accelerators—unnoticed by the beginner user—may regularly speed up the interface for the expert user such that the system can accommodate both new and skilled users. Let users modify repeated actions.
- **Aesthetic and minimalist design**: Dialogues should not include data which is unrelated or seldom needed. All extra unit of data in a dialogue plays with the important units of information and lessens their comparative prominence.
- **Help users recognize, diagnose, and recover from errors**: Error messages should be communicated in simple language (no codes), so that they specifically reveal the problem, and productively propose an answer.
- **Help and documentation**: Even though it is clearer if the system can be utilized without credentials, it may be essential to deliver assistance and documents. Any such data should be simple to explore, centered on the user's task, list tangible measures to be taken out, and not be too large.

2.4. User Interface Design for Learning Application

These rules can be employed to build UI for learning technology that can basically create a more appealing learning experience. It also offers innovative approaches of teaching complicated ideas and encourages critical approach of thinking.

1. Text: Enable settings of users to differentiate between base size of text, colour of text, and disparity with the background. Moreover, simple basic language ought to be utilized.

2. Icon: Every icon utilised ought to be shown with a tag, a tooltip, and audio note. This trademark lets children, irrespective of their capacity limitations, to understand what to think while clicking on the icon.

3. New Concept of Representation: Make Use of images, texts and audio/video to clarify an unfamiliar idea.

4. Help: Since nearly all kids have weak skills of reading, therefore it is advised to utilize video-clips support that demonstrates children how to work. This type of help reduces the probability of not recognizing a theory utilized in text-based help.

5. Show Site Map: If the program is huge and contains several levels, then a diagram of the program should be displayed. Construct the structure of the diagram in a manner that is easy and simple to comprehend. Moreover, images and text should be utilized to illustrate such diagram.

6. Interface Design: Children generally tend to lose their curiosity in the programs of educations very fast.

7. Use Real Image Representations: It is simpler for a child to draw a real image of representation than a representation of cartoon.

8. Provide Instant Feedback: Children must get immediate feedback after each activity or action. The feedback needs to notify children whether their activities were right and encourage them to remain working with the interface.

9. Use Sounds: Use sounds reasonably to improve the communicating experience of children. Sound should be clear and the talking speed should be appropriate for those kids.

10. Sign Language Actors: For deaf children, use on-screen characters for the recordings of the gesture based communication. Enable them to control the size of the video screen.

11. Physical effort: Using fine motor skills design for children, so the interface can be utilized proficiently and easily and with least exhaustion.

12. Mobile Universal Usability: It is essential to sustain worldwide usability for mobile e-learning software, as mobile applications are turning out to be more and more prevalent and intricate, comprising sophisticated EUI and touchscreen-based interaction designs.

2.5. Learning applications

2.5.1. Dragon Box

Dragon Box series is an informative game, full of fun and engaging activities. Its aim is to instruct Math fundamentals by combining creativity, fun and learning. This is done to make the engagement with application more interesting. Some individuals take Math very seriously; however, Math can be enjoyable for children if educated at a young age applying uncomplicated ideas. All 5 games in the application need up-front payment but do not have in-app purchases fees.

2.5.2. Quick Maths

This application is also designed to make maths easy to understand as it compels kids to remember the numbers, teaching the common math skills of students in grades 2 to 6. Quick Maths is the finest option for self-improvement and boosts kids' skills to deal with the problems and questions of numbers. This application is accessible on the App Store

2.5.3. Khan Academy

The Khan Academy is a non-profit learning group that offers free of charge video lessons and communicating drills. The lectures were formed mainly for distance learning but are also appropriate for usage in the classroom. The lessons are casual in style and prepared for creating understanding, one idea or lecture at a time. Many lectures are presented as electronic blackboard discussions by someone with an obvious passion for the subject.

2.5.4. LingQ Applications

LingQ is a language learning application designed by Steve Kaufmann that offers a variety of audio and written content. LingQ refers to itself as "an online language learning community", and once you're a member you can connect with this group of people to discover a language exchange partner. LingQ courses are offered in 14 languages.

2.5.5. Science360

This National Science Foundation created his application with the purpose of exclusively enabling tab users to view and understand innovative science, engineering news updates images, and videos for children. All substance offered is genuine, high-quality, and revised every week. The substance is also generated by the NSF or collected from scientists and universities all around the globe.

2.6. Related Work

The use of the learning application is increasing day by day in modern education. The Google statics show that on average, 69 percent of CCI users surveyed use a mobile phone. Over 4 million students in schools across the world are a part of our E-learning community. The learning of the CCI user is improving with the use of learning applications. The frequent use of the same application makes the CCI user expert in using that application. He operates it very efficiently and effectively. The focus of the research is to focus on the factors of the usability of the learning application that make it efficient to the user without any guidance or practice. The CCI user can use the learning application effectively for the first time without any guidance.

The research work of different researchers is given below: Authors have worked and found the factors and gaps in the study.

Table 2.1: Related Research Work

	Paper	Author	Factors	Limitation
1	Usability Heuristics Evaluation for E-learning Applications	Asmaa Alsumait	Nielsen Usability Heuristics (NUH), E-learning Usability Heuristics (EUH)	The Study is limited to the learning applications generally. Particularly the CCI users or teenCI users can be studied.
2	Adapting the Heuristic evaluation Method for Use with children	Stuart MacFarlane	Usability, Heuristic Evaluation	The Study is limited to the learning applications generally. Particularly the CCI users or teenCI users can be studied.

3	Design Considerations for Educational Mobile Apps for Young Children	Derek Mak, Dan Nathan-Roberts	**Cognitive Factors:** Knowledge & Literacy, Abstract Thinking, Memory **Physical Factors:** Motor Capabilities	The study is limited to the cognitive and physical factors only. The usability components can be discussed
4	The Usability of E-learning Platforms in Higher Education: A Systematic Mapping Study	Torbjörn Holmström Jenny Pitkänen	Effectiveness, Satisfaction, Efficiency	The Study is limited to the learning applications generally. Particularly the CCI users or teenCI users can be studied.
5	E-Learning Methodologies and Tools	Oye, N.D.	Accuracy and Usability	The Study is limited to the learning applications generally. Particularly the CCI users or teenCI users can be studied.
6	Appropriating and Assessing Heuristics for Mobile Application	Enrico Bertini DIS	Usability, Heuristic Evaluation	The Study is limited to the learning applications generally. Particularly the CCI users or teenCI user can be studied.

Chapter 3

Methodology

In this chapter, the author will explain the methods of evaluation for learning applications. This section includes the detail of the methodology used for the evaluation of the learning application. This chapter includes the introduction of Interaction design, usability test, and Heuristic evaluation.

3.1. Research Methodology

The main scope of this research is to evaluate the usability of learning applications for CCI users. Usability evaluation guides in the development process to recognize and understand the problem and plan changes to rectify the problems. A better understanding of the Learning application mechanism and functions for the CCI user was developed after a comprehensive literature review. In the next step, usability testing was conducted by involving the users of the system. After the usability testing, the Heuristic Evaluation was done. The overall methodology for the research is also shown in the Figure3.1:

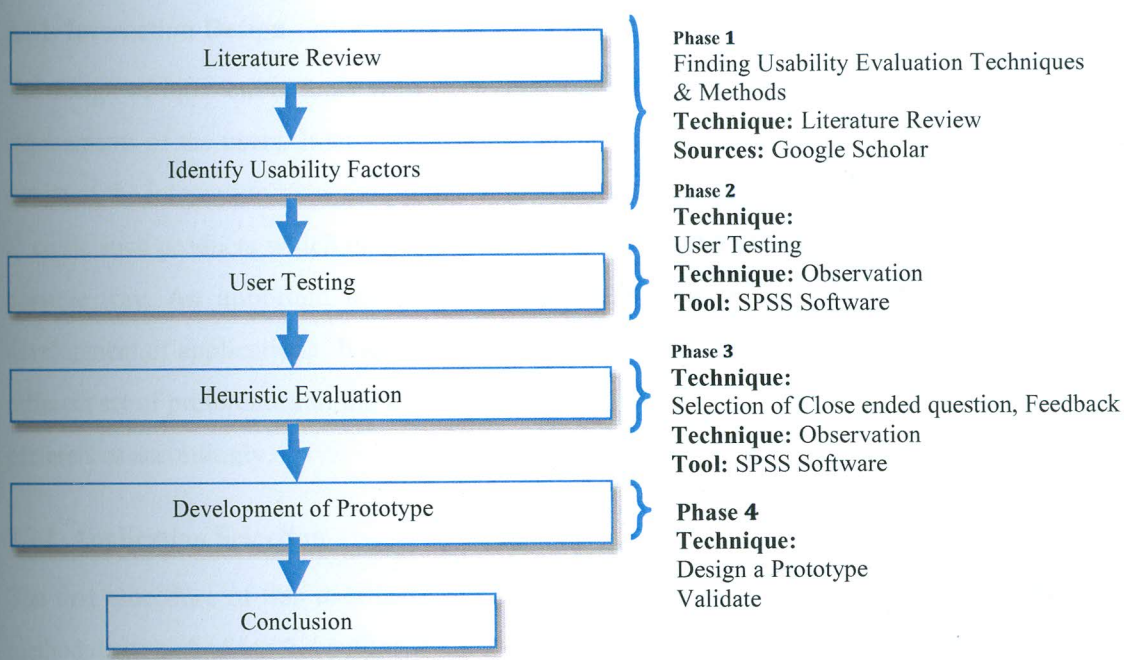


Figure 3.1: Research Methodology

3.2. Phase 1 - Identification of Quality Factors

To identify the key quality factors, an extensive review of the literature is performed. In a result, wide ranges of key quality factors are extracted from the literature. The literature is studied available on the following sources.

1. Google Scholar https://scholar.google.com.pk/
2. Science Direct https://www.sciencedirect.com/
3. IEEE Xplore https://ieeexplore.ieee.org

3.3. Phase 2- User Testing

User testing also called end-user testing. It is one of the best techniques to evaluate the product. Locating the issues and errors in design or functionality is not easy. User testing gives us direct results of how the user will interact with the specific observation. We can observe the users. Questionnaires can also help out in screening the specific and most important issues. User testing can be done by both expert users and novice users. It can be derived after finding the exact success rate of the task done by some users and finding out the difference between both novice and expert users on the same task.

3.3.1. Interaction Design

The design of interaction deals with behaviour patterns of systems and products as per requirements of the users. Interaction design can be understood in simple terms: it is the design of the interaction between products and users. The goal of design of interaction is to create such products which can enable the users to achieve their objectives in the best possible way. An important role is being played by the children in the design and development of applications. It should be kept in mind that different set of children have different set of preferences in the different set of age stages, and they keep changing their preferences accordingly.

3.3.2. Application Selection

The first procedure of this user testing is to choose the application for assessment. The methodology picked by the author is the degree of satisfaction of current clients of that

application. Top 5 applications will be examined and two of the application with the most noteworthy rating and downloads will be chosen.

3.3.3. User Selection

Experiments will be conducted with a different group of CCI users. The members will be of different ages, gender. The experiment will be conducted with participants of CCI users. The group of CCI users for the experiments will be chosen from a different school, grades. Both male and female CCI users will be part of the experiments.

3.3.4. Determine a Task

The researcher determines the task for both selected applications. Users perform those tasks. The researcher observes the CCI users while performing a task and record the observations.

3.3.5. Questionnaire

The questionnaire is a well-known technique to collect demographic data and users' opinions. The types of questions are close-ended questions in which respondents are restricted to choose the answer among already given options. These questions are also called objective questions. One should be very careful while designing a questionnaire. On the basis of literature review and experiments, the researcher will make some questions, these questions will help to collect the quantitative data from CCI users about usability issues in the learning applications. The Questionnaire is according to the Neilson usability rule[38], [39].

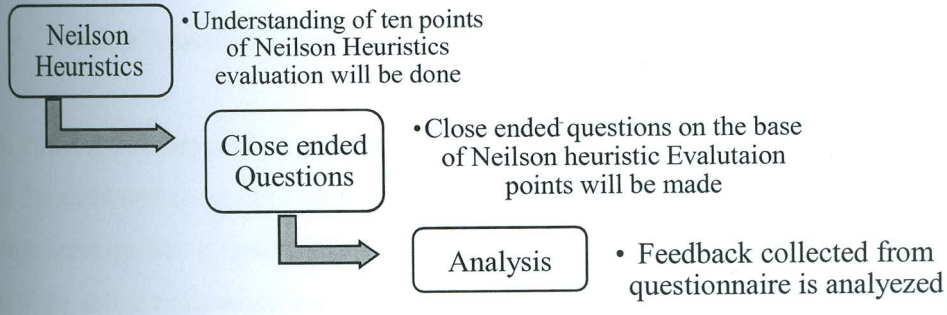


Figure 3.2: Questionnaire Steps

3.3.6. Rating of Questionnaire

The questionnaire has three rating points: agree, neutral and disagree for each question. The user will choose any one of the ratings for each question. The rating of the Questionnaire will help the researcher to evaluate the application. The description of each rating is given in Table 3.1[43], [44]:

Table 3.1: Rating of Questionnaire

	Rating	Description
1	Agree	I don't agree that this is a usability problem at all.
2	Neutral	No opinion
3	Disagree	Major usability problem. Important to fix so should give high priority.

3.4. Phase 3 -Heuristic Evaluation

Nielsen (Nielsen, 1994) suggested a model procedure that is: the expert evaluators evaluate the targeted learning applications. The results of the evaluations are collected. After the problems are combined, the evaluators should agree on the severity of each individual problem (Nielsen, 1994). Applying heuristics produces a list of usability problems (Nielsen, 1994). These problems are classified in different groups in which a numerical scale from 0 to 4 is used to measure the severity of each problem.

- 0 means "not a usability problem at all"
- 1 means "cosmetic problem that should be fixed if enough time is available"
- 2 means "minor problem with low priority", 3 means "major problem with high priority"
- 4 means "catastrophic problem that it is imperative to fix".

3.5. Phase 4-Prototype Design

It is the main and most important part of the research based on the overall evaluation. A design solution was prepared to ensure and re-checked the design issues and confirming that if the above evaluations have been proven to design better. This prototype design is a layout of the application giving a more reliable and user-centric design.

3.6. Conclusion

In the end, research work was concluded with all the details and objectives. Analysis of the factors that how user-centric design can be made? It will be concluded that how an interface be more user-friendly for the CCI user

Chapter 4

Implementation

This section will incorporate the detail of the usability test. The arranging of a usability test is expounded in this segment. The demographics is given. The detail of the tasks to be performed by the users is given in this area. The detail of both chose application is given.

4.1. Findings of Phase 1_Identification of Factors

Phase 1 includes the identification of Usability factors Identification. The factors identified during the Literature Review are:

Measures for the components of usability that are defined in ISO 9241-11:

Effectiveness, Efficiency, Satisfaction. These are major components of all usability models [31], [3], [45]. The ISO 9241-11 standard defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"[46],[47], [48]. The above-mentioned components of usability are explained below:

1.Satisfaction [49],[11]: How the user feels about the user interface? Satisfaction is freedom from discomfort and positive attitudes towards the use of the product.

2. Effectiveness[50]: How quick can the experienced user achieve the task? Effectiveness is the term that defines easy use of system and safeguard of the user from the undesired Conditions.

3. Efficiency: How much does the user like utilizing the user interface? [8]

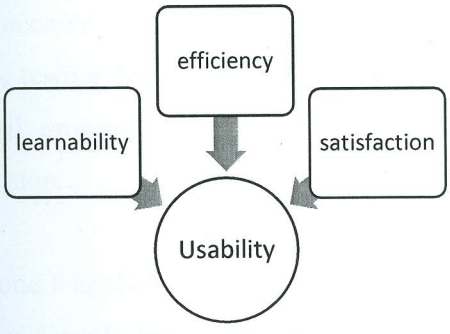


Figure 4.1: Usability Components

4.2. Findings of Phase 2- Usability testing

4.2.1. Planning of Usability Test

A usability test is conducted with the direct involvement of the user. This usability test is conducted to get accurate knowledge about the E-learning application from the perspective of child users. This test will include different phases.

In the first phase was actual testing of the application by the user is done. Users of different ages are selected. They belong to different grades from grade 1 to grade 6. The second phase of the usability test evaluation is done. The users were divided into two groups and given them two different applications to test the usability. Users use applications. The users perform all the tasks given by the researcher. The users are provided with the questionnaire to fill according to their observations.

4.2.2. Task Definition

The meaning of 'Task' is doing the given work in a specified time. It is also a definable piece of work that is done by an individual or a team within the given time[51], [52]. The task can be performed to have some output. Task has various steps that can be performed to fulfil the task. A usability test is also a task and it has some steps also like the selection of participants, conducting Usability test, etc.

4.3. Application Selection

The selection of the applications is a serious troublesome errand as there are a large number of applications accessible on the Play Store. Each and every application in Google Play isn't free. For testing the versatile utility of applications, we need to go to the Play Store. The principal procedure was to choose the most top-rated applications available for free on play store.

For that reason, right around 5 applications were selected in the main procedure and were looked over top ratings of Google Play. After assessing the number of downloads, the

researcher chose two versatile learning applications. Applications were chosen to have a huge number of downloads and having positive surveys with 5 stars. One of the application names is Khan Academy and another application is LingQ; both of these applications were in the reviews. The research is conducted in Pakistan, so the most common applications used by CCI users in Pakistan were selected.

4.3.1. Khan Academy

All of the code in the Khan Academy is composed of utilizing JavaScript and Processing.js. Khan Academy is one such free asset that has its foundations in mathematics yet has extended to cover areas of science, history, and economics. Different exercises, videos relevant to the topic are available on the application. The application contains brief lectures in the shape of videos. Its application also involves additional training drills and tools for teachers. Khan Academy is viewed by many as an incredible platform where children and adults can go to learn about subjects and topics at their own pace CCI users training at their own speed, first fixing the holes in their knowledge and then speeding up their understanding. With Khan Academy, educators can pinpoint differences in their CCI users' grasp, tailor education, and fulfil the demands of all CCI users. In current times, Khan Academy has developed to be the most renowned innovators amid a new group of digital education organizations in K-12 education. They have become so popular that about 10 million distinctive users per month as of February 2014 joined its platform whereas 65% of users are in the United States.

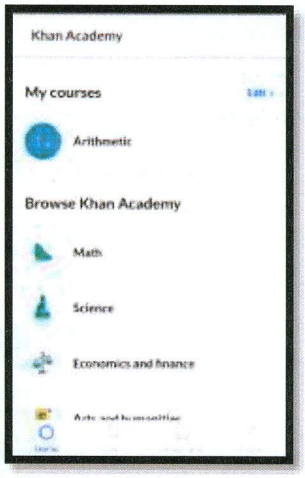


Figure 4.2: Main screen of Khan Academy application

Figure 4.1 shows the main page of the Khan Academy. On the home page of the application, the user can select the subject. Maths, science Economics and finance are the topmost subjects shown on the main page. The user can scroll the list for more options. The user can also edit the settings for the course from the main page.

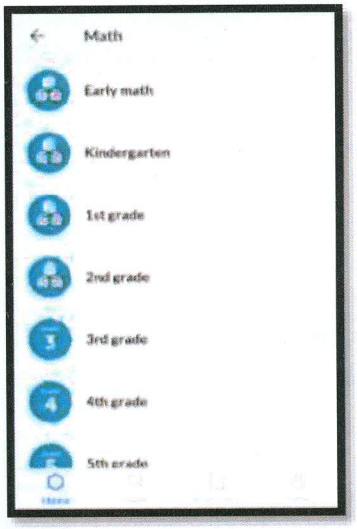


Figure 4.3: Second screen of the Khan Academy application

Figure 4.2 shows the second page opened after selecting the subject. Users can select the grade. Users can scroll down the list of grades for more options. The level of a subject; maths in the application start with Early maths.

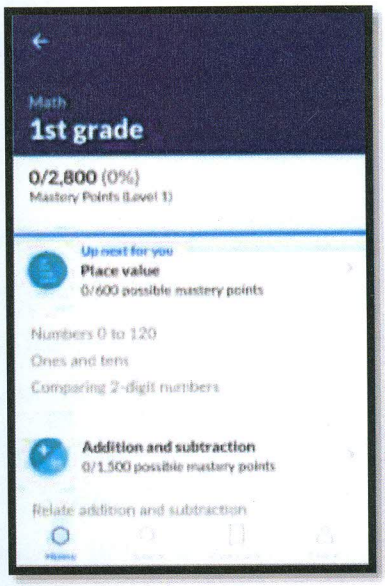


Figure 4.4: Third screen of the Khan Academy application

Figure 4.3 shows the third page. The page is opened when the user selects any level of the grade given. The page contains the name of the topics like addition, subtraction, place value, etc. the user selects any one of the given topics. The user scrolls down for more options.

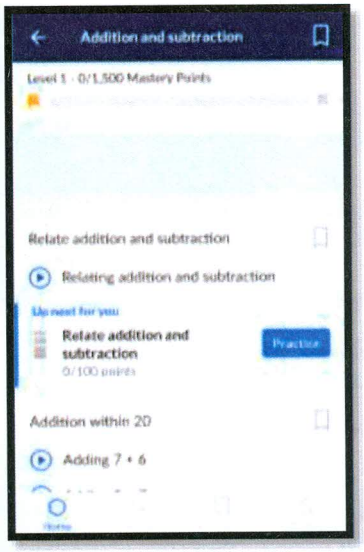


Figure 4.5: Fourth screen of the Khan Academy application

After the selection of the topic from a given list, the next screen is opened. This screen shows the list of videos and practice sessions relevant to the selected topic. The user can select the video and watch the video for a clearer insight of that topic. The user can also select the practice session.

4.3.2. LingQ Application:

LingQ (pronounced "link") is a language learning application designed by Steve Kaufmann that offers a large quantity of audio and written substance. LingQ refers to itself as "an online language learning community", and once you're a member you can engage with this community to find a language exchange partner. It has been one of my primary tools when studying foreign languages. LingQ courses are available in 14 languages, including Spanish, German, French, English, Chinese, Japanese, Portuguese and Italian. As the time of writing, 10 further languages are in beta development.

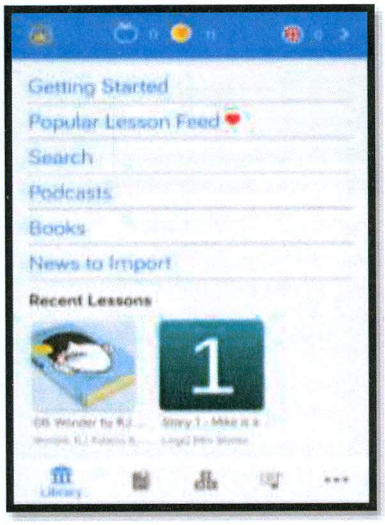


Figure 4.6: Main Screen of the LingQ application

In Figure 4.5 the first screen of the application is shown. The main screen has list with options of getting started, popular lesson feed, search, podcasts, books and news to import. Below the list, the icons of recent lessons are also visible. One can approach directly to the recent lesson.

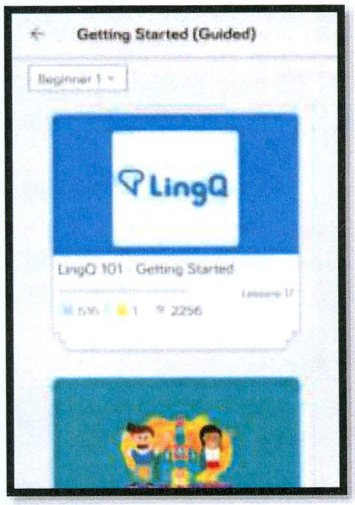


Figure 4.7: Second Screen of the LingQ application

Figure 4.6 shows the next page opens after selecting getting started. The screen contains big icons. The icons show the name of the chapters. The user can also select the level on the same screen. The levels are beginner, beginner 1, intermediate and so on.

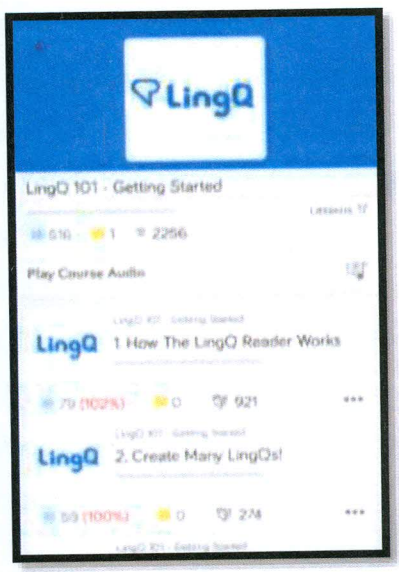


Figure 4.8: Third Screen of the LingQ application

Figure 4.7 shows the screen after the selection of the chapter. The screen contains the list of the lessons relevant to that chapter selected. The list of lessons is given. The user scroll down the list for the selection of the lesson.

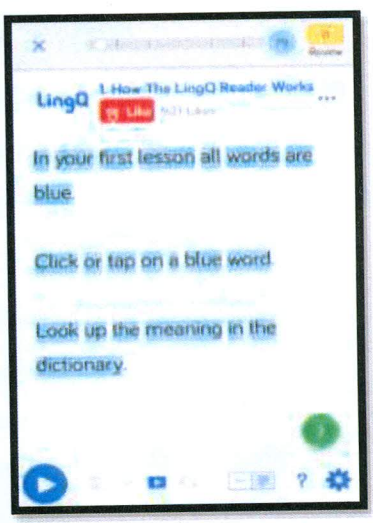


Figure 4.9: Fourth Screen of the LingQ application

Figure 4.8 shows the practice page after the selection of the lesson. The user can listen to the pronunciation of the given paragraph or else can read it. The user can tap on the particular button to find the meaning of that word. The word can also be added to the vocabulary.

4.3.3. Selection of Participants

In the usability evaluation, the aggregate of thirty CCI users was chosen who were at various levels. All users were CCI users of LGS and were chosen from different grades. For better comprehension of the usability test, it is significant that members should realize that what the task is about. For this, the language utilized during the test has a significant job. The English language is a mode of communication and all CCI users can convey in English. Since CCI users are studying in English medium so the language chosen for the test was —ENGLISH. The language utilized in the task is extremely basic and effectively understandable as the CCI users are young and not experienced and it will be difficult for them to understand difficult words.

Prior to the leading task, specifics of every member were taken which include, their names, gender, grade they are studying, rough time period (in months) of their connection with the framework and their collaboration with framework on daily, weekly and monthly basis.

4.3.4. Demographics Tables

The details of the participants who take part in the experiments are given in Table 4.1. The total number of participants is thirty. The numbers of females are eleven and a total number of males is nineteen.

Table 4.1: Number of Males and Females

Female	11
Male	19
Total	30

The detail of the grade the user study is given in Table 4.2. The user participated in the experiment are from grade 1 to grade 6. The number of users from grade 1 is two. The number of users from grade 2 is five. The number of users from grade 3 is ten. The users from grade 4 are ten. One user from grade 5 and two CCI users from grade 6 participate in the experiment.

Table 4.2: Number of a user in each grade

Grade1	2
Grade2	5
Grade3	10
Grade 4	10
Grade 5	1
Grade6	2
Total	30

Table 4.3 shows the frequency of the user's age. The age of the user in the experiment is from 7 years to 12 years. The age of the CCI user is from 4-13 years so all the users in an experiment belong to the group of CCI users.

Table 4.3: Age of the users of the experiment

7 years	2
8 years	5
9 years	10
10 years	10
11 years	1
12 years	2
Total	30

The details of the gender with correspondence of the grade they studied are given in Table 4.4. The users are from Grade1 to Grade6. The number of males and females with each grade is also mentioned.

Table 4.4: Gender and grades across User Groups

	Grade1	**Grade2**	**Grade3**	**Grade 4**	**Grade 5**	**Grade6**
Female	1	1	6	2	1	0
Male	1	4	4	8	0	2

Table 4.5 shows the details of the age of males and females. As the CCI user group is from 3-14 years, so the detail of the age will show that all the users belong to the group of the CCI users. The user from the age of seven to fourteen took part in the experiment.

Table 4.5: Gender and Age across User Groups

	7-8years	9-10 years	11-12 years	13-14 years
female	1	1	6	2
male	1	4	4	8

Table 4.6 shows the details of the experience of CCI users for using mobile applications. The details show that most of the CCI users who participated in the experiment are experienced users, yet few are novice users as well.

Table 4.6: Gender and Experience Distribution across User Groups

	Less Than One	1-3 Years	4-6 Years
Female	2	6	3
Male	0	6	13

4.4. Conduction of Usability Test

The test is conducted at different times according to the suitable timings of CCI users. The mobile and the tablets are used as equipment. Two applications Khan Academy and LingQ were used for evaluation. The start and ending time of the test by each CCI users was noted. Different tasks were given for the usability test to the different groups. The connection with internet is necessary for this test. The tasks are given below:

4.4.1. Task for Khan Academy

Task no.1(opening Practice page):

- Open the application.
- Sign Into the application with username and password.
- Select the subject: Math

- Select your grade i.e. 1st grade, 2nd grade 3rd grade etc.
- Select any topic like Place value, addition and subtraction etc.
- Start practice exercise.
- Do the question.
- Move to second question
- Select another Practice exercise.
- Do some questions
- Go to the main page

Task no. 2 (Searching Criteria)

- Open search page
- Enter any topic
- View the details related to the topic you searched

Task no. 3 (Personalizing a profile)

- Open the page of get personalized
- Select your grade
- Select the subject
- Edit the courses

4.4.2. Task for LingQ:

Task no.1(Selecting Exercise):

- Open the application
- Select getting started
- Select your level i.e. beginner, intermediate or advanced
- Select topic of your interest
- Open the lesson
- Start the exercise
- Listen to full paragraph.

Task no.2 (Search Page):

- Search by courses

- Search by lessons
- Search by the keywords

Task no. 3 (Checking Vocabulary):

- Open vocabulary
- Listen to the pronunciation of each vocabulary.

4.5. Experiment Observations:

Test was performed by the CCI Users. The tasks were performed for the two applications: Khan Academy and LingQ. During the test users were observed. Detail of the observation for the usability components are given in Table 4.7[53]:

Table 4.7: Table of the Usability task

Effectiveness	Tasks completed, Errors in task
Efficiency	Task time
Satisfaction	Satisfaction with the feature, User Pleasure

Effectiveness, Efficiency, and Satisfaction are the components of the usability that were observed during the test[54]. The details of each usability factor are given in Table 4.8.

- Effectiveness will be measured by checking the number of clicks and the number of errors during the task.
- Efficiency will be checked by measuring the time taken to complete the task. If the time consumed by the user to complete the time is less than the efficiency is more.
- Satisfaction will be measured by the subjective rating of user towards the application. User will rate the application. CCI user will rate the application with satisfied or not satisfied.

Table 4.8: Table of the detail of Usability Task

	Usability metrics	**Questions**
Effectiveness	Number of clicks. Number of errors occurred during task.	1. How many click (touch) to solve task? 2. How many errors occurred during task?
Efficiency	Time to complete task	3. How much time taken to complete given task?
Satisfaction	Subjective rating of users' acceptance toward applications after using application (e.g., levels of agree – disagree)	4. Are the users satisfied with the application?

4.5.1. Findings of Questionnaire

This area includes the main part of the research report. This area includes the planning, making questionnaires, distributing it and analysing.

4.5.2. Planning of Questionnaires:

Questionnaires were designed to get quantitative facts. Questionnaires were organized to get the potential and flaws of the system. The final results will be complied after the statistical conclusion of questionnaire. CCI users of different grades and ages were selected. CCI users were asked to use famous two learning applications. CCI users were given hardcopy of the Questionnaire.

4.5.3. Questionnaire Design phase

Questionnaire design phase start after understanding the user interaction with system. The format of Questionnaire is adaptive design of Lund Arnold method for measuring usability questionnaires and the reliability measure prove is taken from the paper that states[55], [56], [27]: Reliability was measured utilizing Cronbach's alpha. When Cronbach Alpha is equivalent to or more than .60, measurement's internal validity is elevated (Malhotra, 1999). The values are .98 for YB, .95 for TTK, .95 for THM, .93 for EKE, .93 for T, .96 for ISB, .96 for SE and .88 for SG[10]. These values demonstrate that the dimensions are reliable and the elements that are necessary to be calculated are accurate.

4.6. Findings of Phase 3-Heuristic Evaluation

4.6.1. Selection of the Experts

The Heuristic Evaluation is the expert base testing. For this first the experts were selected. Four experts were selected from the IT industry. All of the experts are from Pakistan. Three of the participants who are Head of the QA in application and have prior experience with the selected applications. Other expert evaluator is working as a product manager in Application/game development agency. The specifics of the experts are provided in the Table 4.9

Table 4.9: Experts Demographics

Sr#	Gender	Country	Degree	Profession	Experience of evaluation of Learning Application
1	M	Pakistan	Masters	QA	3 years
2	M	Pakistan	Masters	QA	2 years
3	M	Pakistan	Masters	QA	3 years
4	M	Pakistan	Masters	Product Manager	3 years

Chapter 5

Results and Discussion

This section includes the details of the findings of the experiment conducted. Questionnaire results will also be explained in this chapter. The evaluation of the results is also discussed in the chapter.

5.1. Results of Phase 1- Identify the Usability Factors

To determine how compatible and practical a user interface is, the ISO standard defines three quantifiable characteristics:

- Effectiveness: Precision and totality with which users accomplish particular objectives;
- Efficiency: Assets spent relative to the precision and totality with which users accomplish objectives;
- Satisfaction: Freedom from uneasiness and encouraging opinions about the usage and productivity of the product.

5.2. Results of Phase 2- User Testing

Khan Academy

5.2.1. Observations Results

The details of the observation are given below. The observations details taken during the experiment by the author is given below.

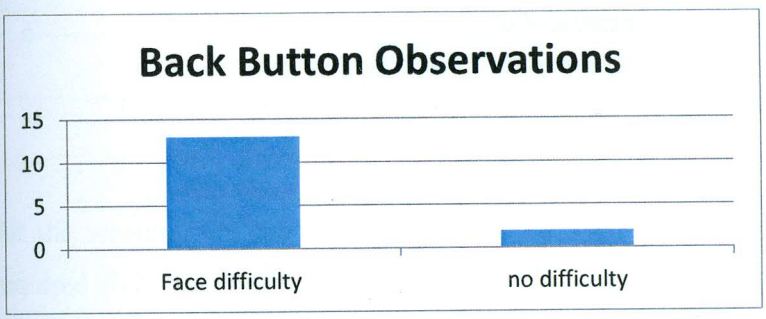


Figure 5.1: Back button observation

The observation of back button is shown in Figure 5.1. CCI users face difficulty in finding the back button. The Khan Academy application has back button at the top of the

application. So CCI users feel difficulty in finding the back button. Thirteen CCI users find it difficult to go back.

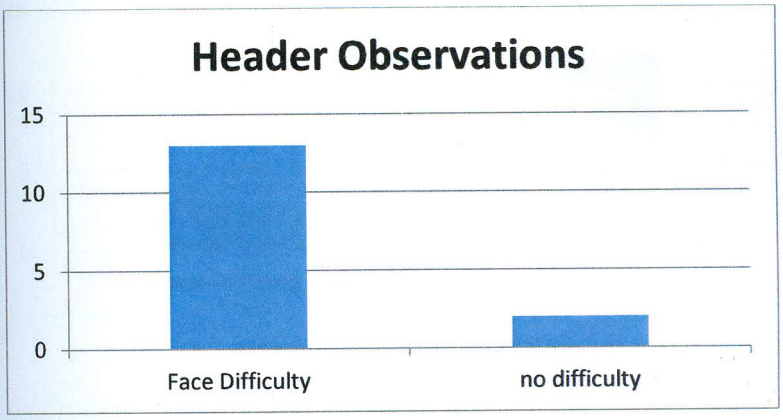


Figure 5.2: Header observation

The Figure 5.2 shows the observations for the header of the main page. CCI users face difficulty in finding the subject name due to the header. In the application the main page has a large header. Header has changing settings options. CCI users get confuse while finding the name of the subjects as the names are below that header.

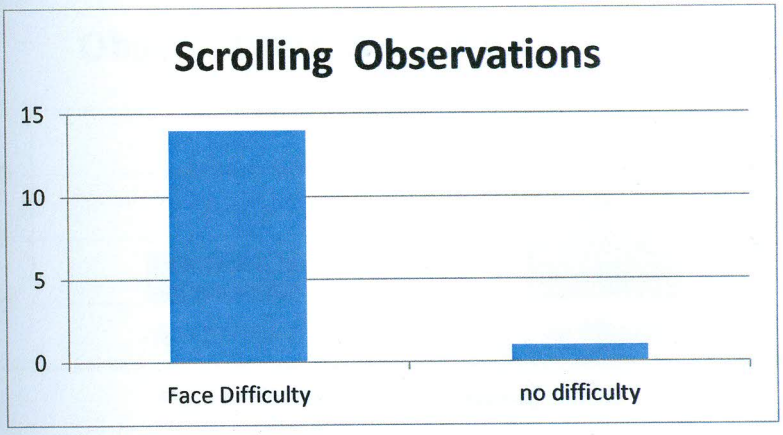


Figure 5.3: Scrolling observation

The results for the scrolling are shown in the Figure 5.3. CCI users face difficulty in finding the required field while scrolling down, as during scrolling the view of some things disappears. The CCI user is young so it is difficult for them to remember the items on the top while scrolling.

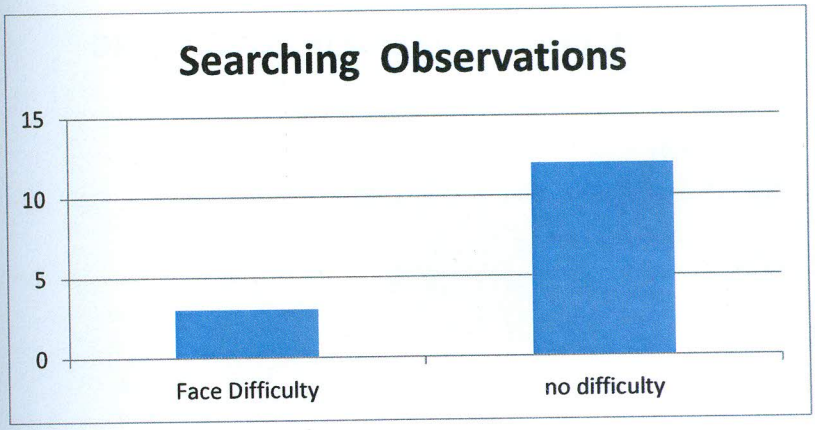


Figure 5.4: Searching Observation

The task was given to the users to search by words or search by the subject. The Figure 5.4 shows the result of searching; most of the CCI users are satisfied while doing searching. The CCI users do searching easily. The task of searching the keywords was given to the users while doing the experiment. Most of the CCI user did the task of searching easily and efficiently.

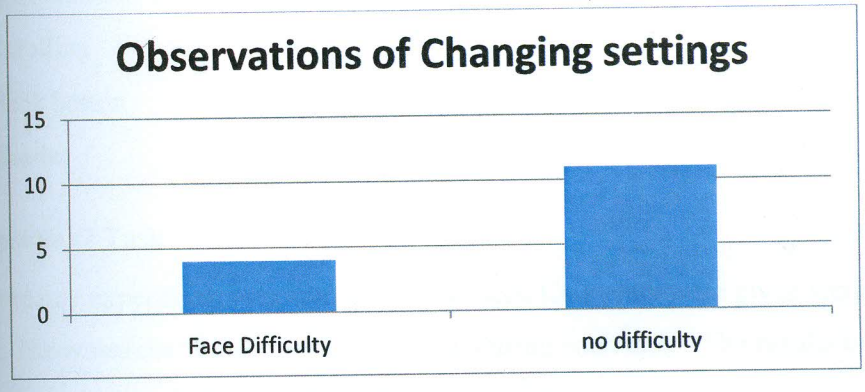


Figure 5.5: Observation of changing settings

The last task was to change the settings of the application. The language of the application is changed by the users. The curriculum of Canada, or default English is chosen by the user. The results of the task for changing of settings are shown in the Figure 5.5. The results show that most of the CCI users change the settings efficiently and effectively. Most of the CCI users did not face difficulty in changing settings of the application. The users personalize the application efficiently.

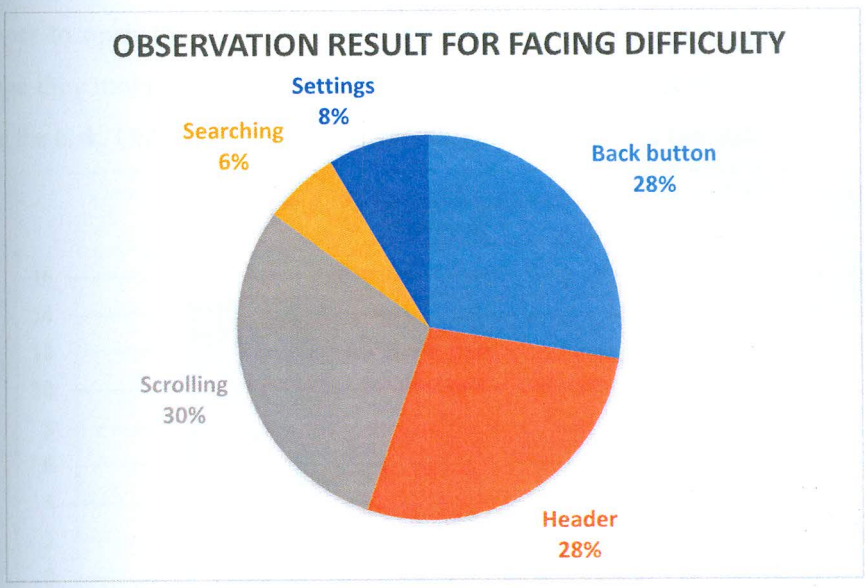


Figure 5.6:Summarize Observations for difficulty faced by user

The author summarized the observations results. The results are show in the Figure 5.6. The summary identifies the factors of the application those creates difficulty for the CCI user. Three factors were identified during the observation of the experiment. The factors those were identified are:

- Scrolling
- Back button
- Header

5.2.2. Results of Task

Khan Academy experiment was held with CCI users. CCI users were given some tasks to perform. The researcher notes the observations during each task. The results of task are completed or not completed is elaborated.

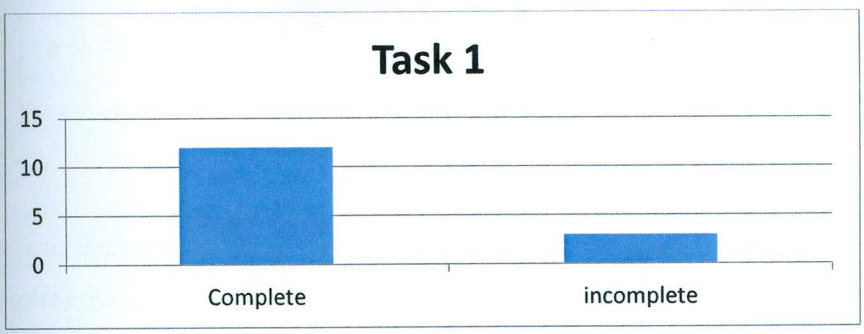


Figure 5.7: Results of Task 1

Task 1 was to open the practice page. CCI users first open the application. From the home page they move to the practice page and users solve the sums. Twelve CCI users complete the task. Only three CCI user were unable to complete the task.

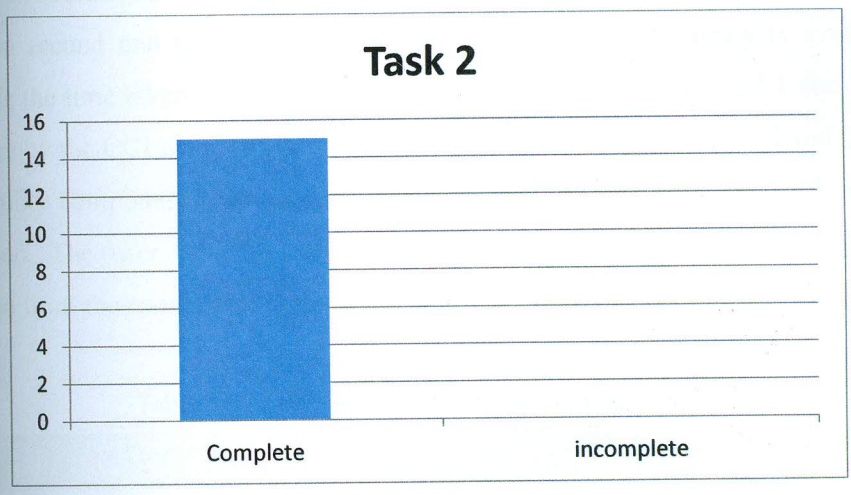


Figure 5.8: Results of Task 2

Task 2 was to search some of the keywords in the application. The results of the Task 2 are given in Figure 5.8. All the users perform the task quickly and efficiently. All the users were able to complete the Task 2.

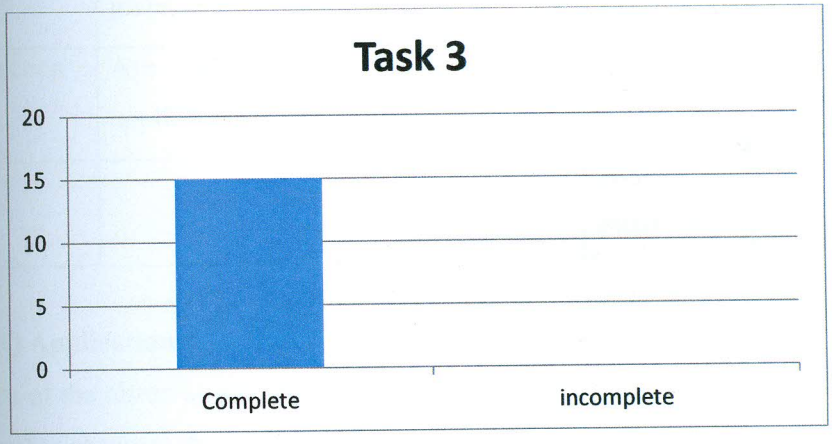


Figure 5.9: Results of Task 3

Task 3 was to Personalize the application. All the users perform this task and all of the users complete the task efficiently. No user was unsuccessful in completing the task. The details of Task 3 are given in Figure 5.9.

5.2.3. Evaluation of the Usability Components

For the evaluation of the effectiveness the number of clicks and the numbers of errors are counted. The result show that in task one the number of clicks and number of errors are more than second and third task. The usability component efficiency is evaluated by measuring the time taken to complete the task. The results in the Table 5.1 show that the time taken by the CCI users to complete first task is more than the second and third task. The usability component 'satisfaction' is measured by asking from the CCI user about satisfaction. The user will tell whether the application is satisfactory or not. It is concluded from the results that most of the CCI users are satisfied with the application.

Table 5.1: Table of Usability components measurement

	Questions	**T1**	**T2**	**T3**	**total**
Effectiveness	How many click (touch) to solve task?	168	77	50	295
	How many errors occurred during task?	60	24	14	96
Efficiency	How much time taken to complete given task?	79	35	56	170
Satisfaction	Are the users satisfied with the application?	Satisfied		9	
		Not satisfied		6	

5.3. LingQ Applications:

The results of the observations, task completion for the LingQ application are explained. The researcher observes the CCI user while performing the tasks. The researcher explains the results of the observation below

5.3.1. Observation Result:

The observation is taken during the experiment by author while CCI user was doing experiment. The author observes the users. The detail of observation is given:

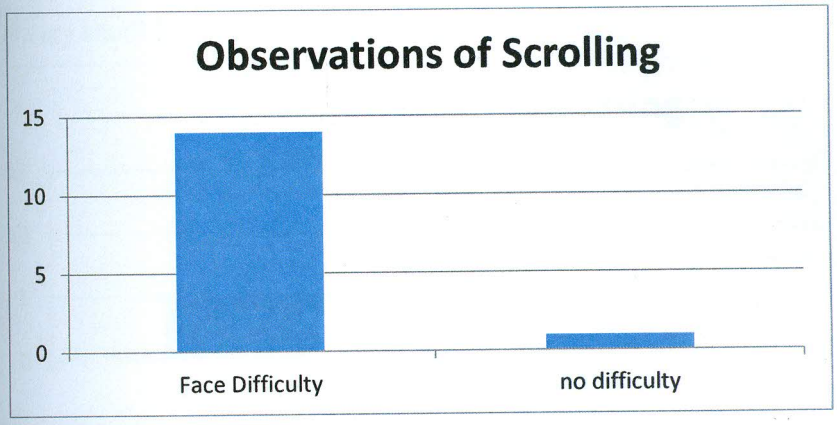


Figure 5.10: Observation of Scrolling

Different task was given to the CCI users. They perform all the tasks. The researcher observes that during performing each task most of the CCI users face difficulty in selecting the lesson. The difficulty was due to scrolling down. While scrolling down the user cannot view all the list at once. The CCI user is young so it seems difficulty for them to choose the required field while scrolling.

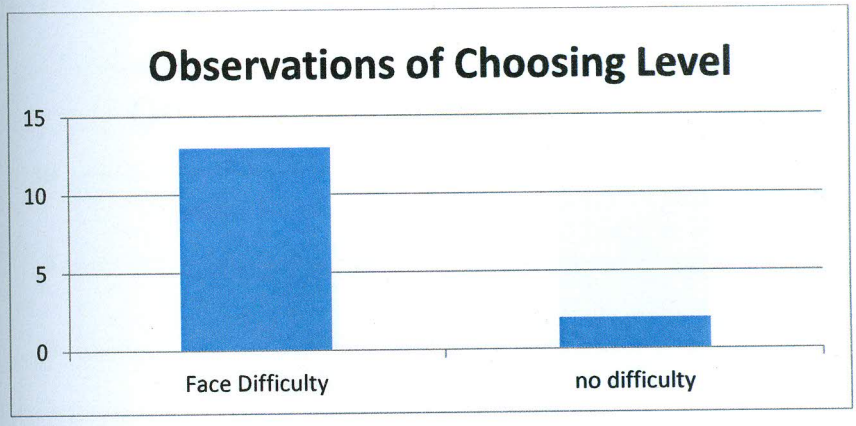


Figure 5.11: Observation of Level Choosing

The task was given to the CCI user to change the level of the difficulty. The user can select any level i.e. beginner, intermediate for the lesson practice. The result of observation shows that most of the CCI user face difficulty in choosing the level. The

user gets confuse while finding the button as the button for choosing the level of difficulty is very small in top corner.

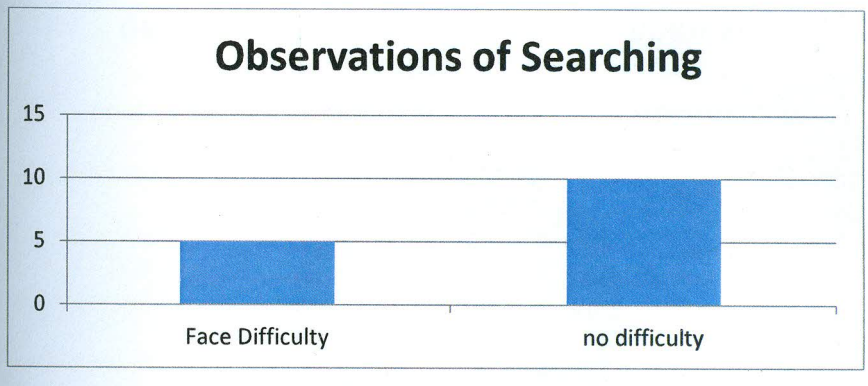


Figure 5.12: Observation for Searching

The CCI user was given task to search by words and search by course. One can change this using the main settings. Lessons Home Page OR. Lesson Screen -> Gear Icon -> Home Settings -> Interface Language. The Figure 5.12 shows the result of the observation. It shows that the CCI user did not find any difficulty while doing the task of searching by words or searching by course. User very easily search the words or the course.

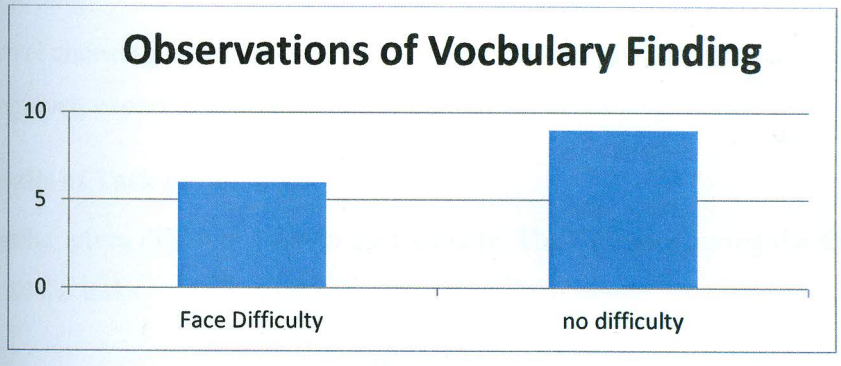


Figure 5.13: Observation for Vocabulary Finding.

The last task given to the CCI user during the experiment was to find the vocabulary of the daily task and listen the pronunciation of the word and look the meaning of the word. For going to the page of the vocabulary a button is given below. The user just clicks the button once and directly reach to the required page. The users do as how they are guided

by the instructions of the task. The results of the observation show that the CCI user did not face any difficulty for doing the task.

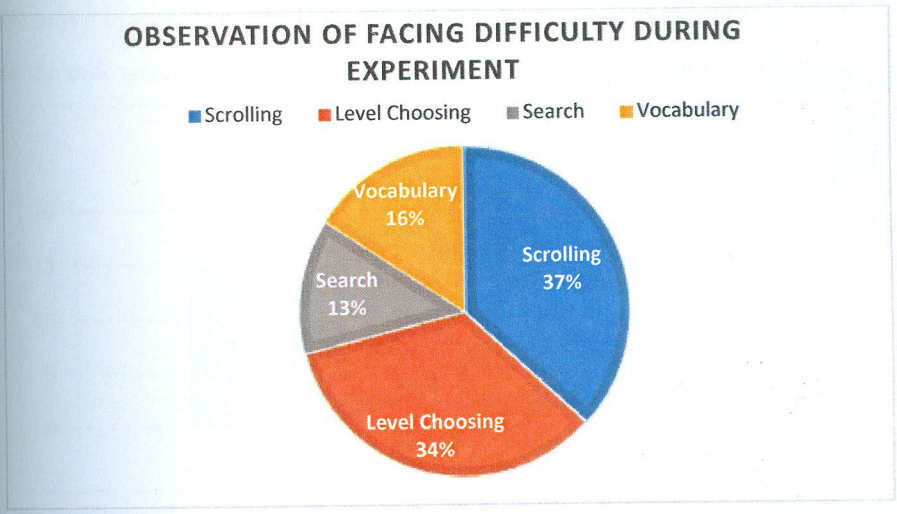


Figure 5.14: Summary of the Observations

The author summarized the observations results. The results are show in the Figure 5.14. The summary identifies the factors of the application those creates difficulty for the CCI user. Four factors were identified during the observation of the experiment. The factors those were identified are:

- Scrolling
- Level choosing from the beginner, expert or intermediate
- Searching
- Vocabulary pronunciation listening

5.3.2. Results of Task performed:

The researcher gives different Task to the CCI user. The CCI user during the experiments performs all the tasks.

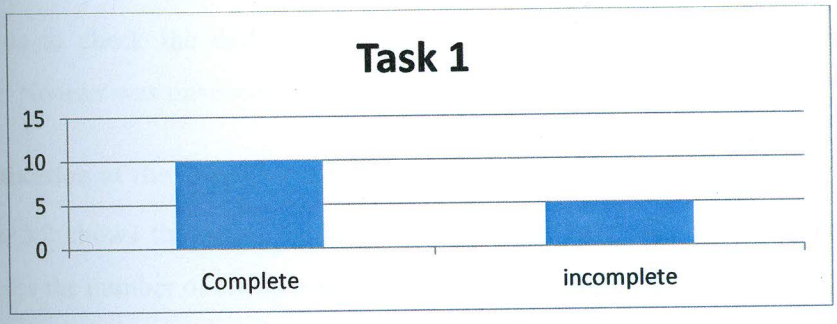


Figure 5.15: Results of Task 1

Task 1 was to open the exercise. CCI users first open the application. From the home page they move to the exercise page and users listen and read paragraph. Ten CCI users complete the task while only five CCI users were not able to complete the task.

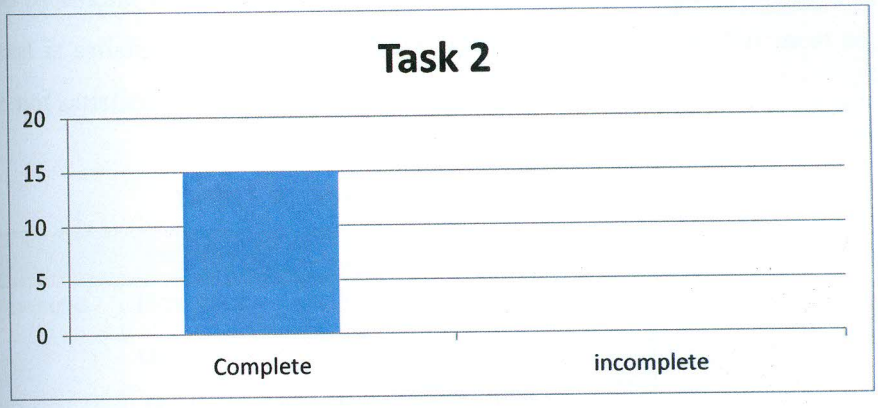


Figure 5.16: Result of Task 2

Task 2 was to search some of the keywords in the application. All the users perform the task quickly and efficiently. All the users were able to complete the Task 2.

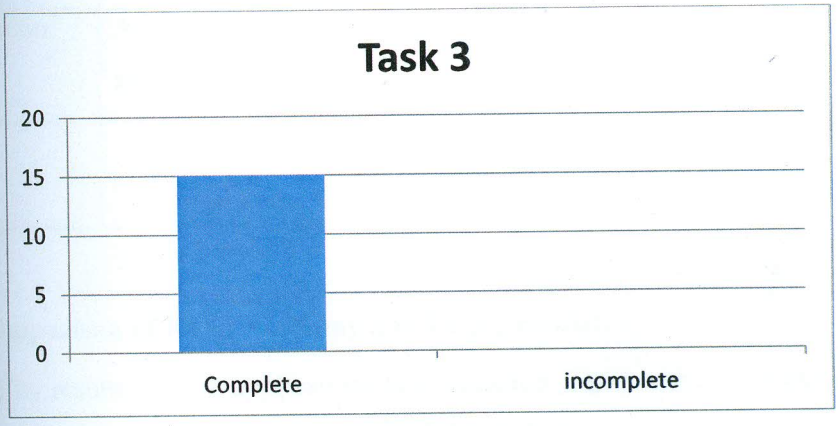


Figure 5.17: Results of Task 3

Task 3 was to check the daily task vocabulary. All of the users complete the task efficiently. No user was unsuccessful in completing the task.

5.3.3. Evaluation of the Usability components

The Table 5.2 shows the detail of the usability components. For the evaluation of the effectiveness the number of clicks and the numbers of errors are counted. The result show that in task one the number of clicks and number of errors are more than second and third

task. The usability component efficiency is evaluated by measuring the time taken to complete the task. The results show that the time taken by the CCI users to complete first task is more than the second and third task. The usability component 'satisfaction' is measured by asking from the CCI user about satisfaction. The user will tell whether the application is satisfactory or not. It is concluded from the results that most of the CCI users are not satisfied with the application.

Table 5.2: Table of Results Usability Components

	Questions	**T1**	**T2**	**T3**	**total**
Effectiveness	How many click (touch) to solve task?	151	126	50	327
	How many errors occurred during task?	67	29	16	112
Efficiency	How much time taken to complete given task?	108	61	35	205
Satisfaction	Are the users satisfied with the application?	Satisfied		5	
		Not satisfied		10	

5.3.4. Comparison of Khan Academy and LingQ results:

The usability results of both applications are compared. The number of clicks will define the degree of effectiveness. The results in Table 5.3 show that as number of clicks of LingQ is more than the Khan Academy so the effectiveness of the Khan Academy is more than the LingQ. Effectiveness is measured by the errors made by the user. If the errors are more effectiveness is less. Results shows that effectiveness of the Khan Academy is more than LingQ as number of errors made in Khan Academy is less than the LingQ. The time taken to complete the task during the experiment will measure the efficiency of that application. If the time taken to complete the Task is less than the efficiency is more. The results show that time taken to complete the tasks of Khan

Academy is less than the LingQ, so the Efficiency of the Khan Academy is more than the LingQ.

Table 5.3: Comparison of two applications

	LingQ				Khan Academy			
	T1	T2	T3	total	T1	T2	T3	total
Effectiveness	151	126	50	327	168	77	50	295
	67	29	16	112	60	24	14	96
Efficiency	108	61	35	205	79	35	56	170
Satisfaction	Satisfied		5		Satisfied			9
	Not satisfied		10		Not satisfied			6

5.4. Analysis of Questionnaire

Two applications are tested in this paper. Analysis of both applications is done in above section. The analysis shows that Khan Academy is more easy to use for the CCI users than the LingQ. So, the researcher will focus on the detail of the Khan Academy questionnaire.

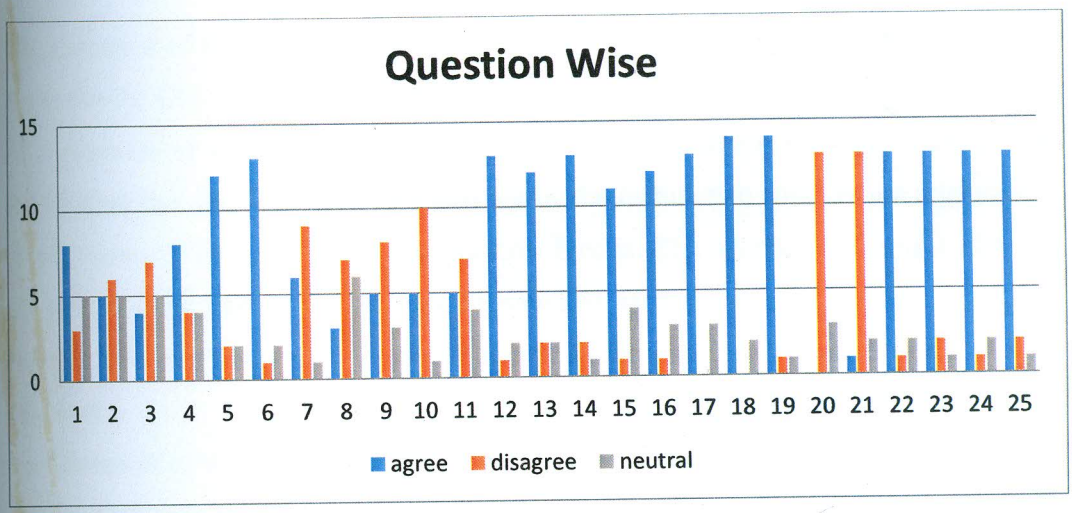


Figure 5.18: Graph of result of individual question

The terms from this questionnaire were evaluated based on the following terms: Agree, neutral and disagree. If the percentage of the agree scale is more than it will be good

feature of that application. Otherwise the more percentage of the Disagree will show that the user is not satisfied for that particular feature. The Questionnaire consists of 25 questions. The result of each question is explained separately. Details of question categorized are given below:

5.4.1. Visibility of System Status

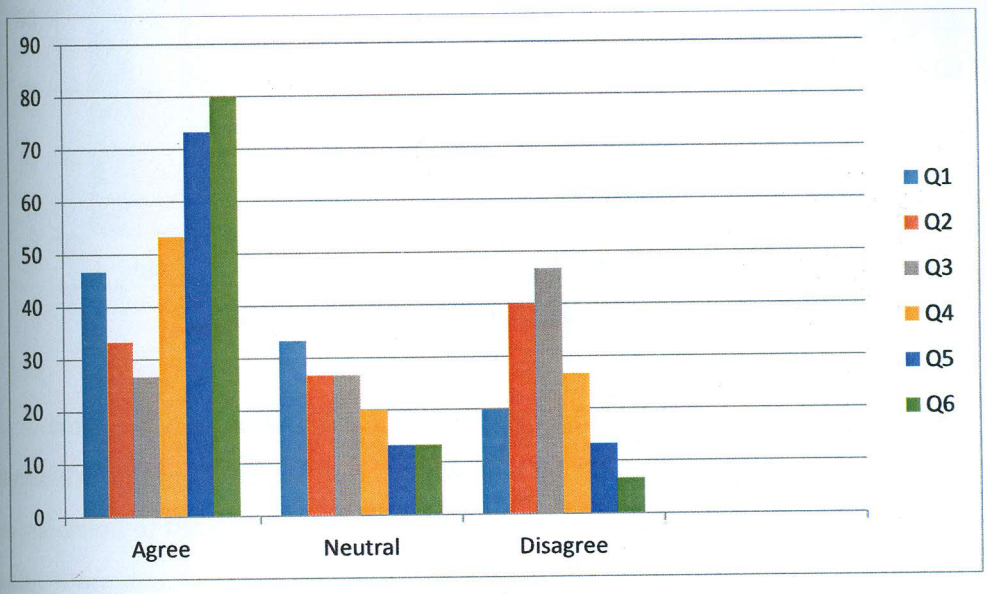


Figure 5.19: Results of Visibility of System

The statement of the question one is: The right feedback is given on time. The results show that the CCI user is satisfied by the feature that the feedback is given on the time. The statement of the question two is: Contents are organized in proper manner. The results show that the CCI user is not satisfied by the feature that contents are organized in proper manner. The statement of the question three is: The interface (design) is pleasant. The results show that the CCI user is not satisfied by the feature. The statement of the question four is: Font is easy to read. The results show that the CCI user is satisfied by the feature.

The statement of the question five is: Language is easy to understand. The results show that the CCI user is satisfied by the feature. The statement of the question six is: The results of task performed are visible. The results show that the CCI user is satisfied by the feature.

5.4.2. Match Between the System and the Real world

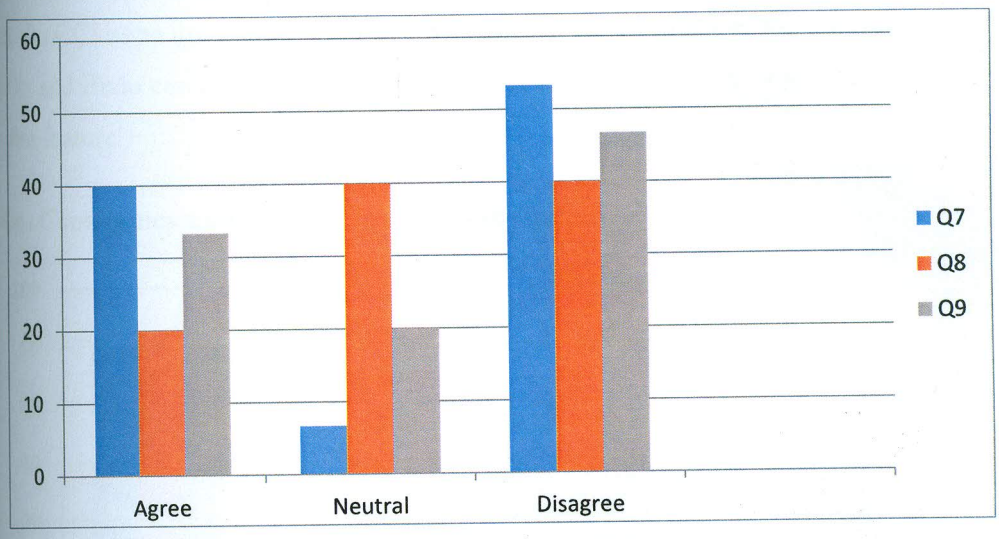


Figure 5.20: Result of Match between system and real world

The statement of the question seven is: Everyday life words are used in application is the statement of the question. The results show that the CCI user is satisfied by the feature. The statement of the question eight is: The buttons and icons are easy to understand. The results show that the CCI users are not satisfied by the feature. The statement of the question nine is: The information is arranged in good order. The results show that the CCI users are not satisfied by the feature.

5.4.3. User Control and Freedom

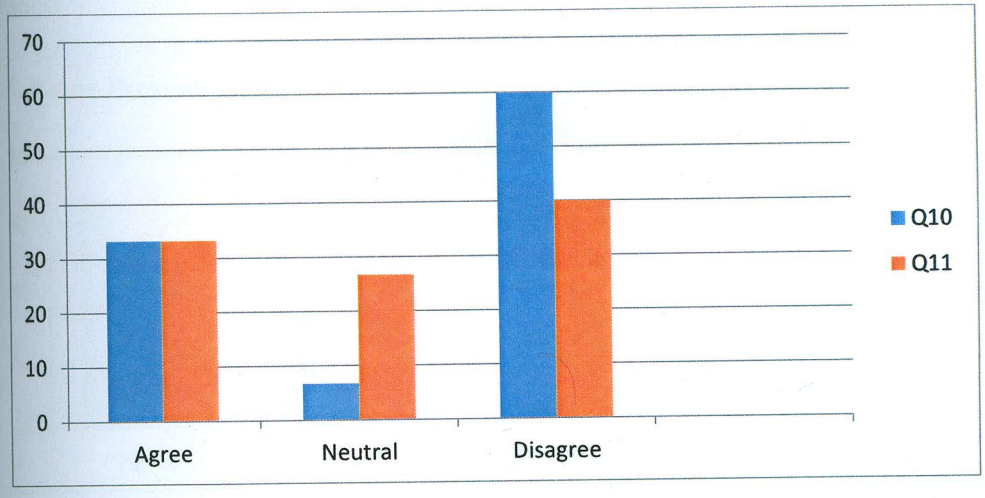


Figure 5.21: Results of User Control and freedom

The statement of the question ten is: It is easy to control the application. The results show that the CCI users are not satisfied by the feature. The statement of the question eleven is: Undo and Redo can be done easily. The results show that the CCI users are not satisfied by the feature.

5.4.4. Consistency and the Relevance of site content

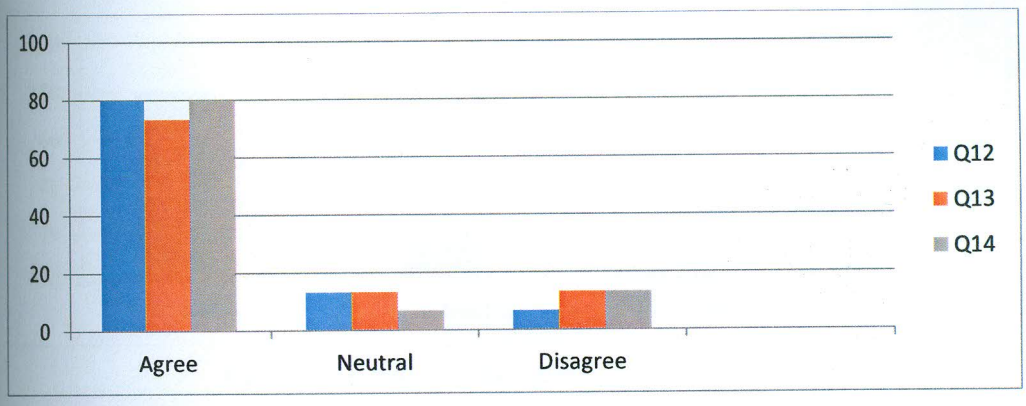


Figure 5.22: Results of Consistency

The statement of the question twelve is: The same words, concepts or action refer to same action. The results show that the CCI users are satisfied by the feature. The statement of the question thirteen is: Contents are clear. The results show that the CCI users are satisfied by the feature. The statement of the question fourteen is: The design of application is same throughout. The results show that the CCI users are satisfied by the feature.

5.4.5. Error Prevention

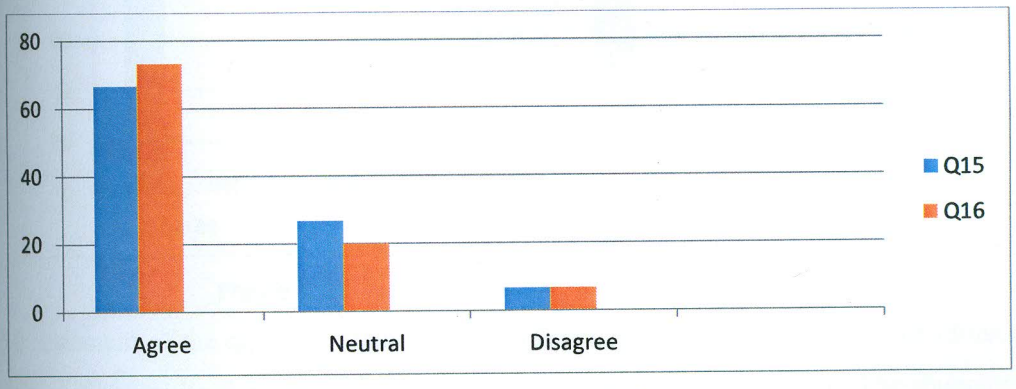


Figure 5.23: Results of Error Prevention

The statement of the question fifteen is: No serious errors occurred. The results show that the CCI users are satisfied by the feature. The statement of the question sixteen is: In case of errors it provides instructions for recovery. The results show that the CCI users are satisfied by the feature.

5.4.6. Recognition Rather than Recall

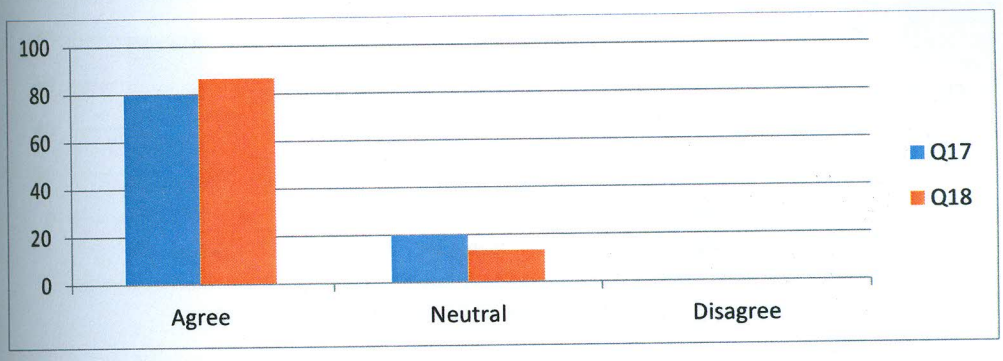


Figure 5.24: Results of Recognition rather than Recall

The one of the Neilson Heuristics is Recognition rather than Recall. It contains two questions. The statement of the question seventeen is: Objects, options for selection, and actions I take are visible. The results show that the CCI users are satisfied by the feature. The statement of the question eighteen is: Instructions on how to use the application are visible. The results show that the CCI users are satisfied by the feature.

5.4.7. Flexibility and efficiency of use

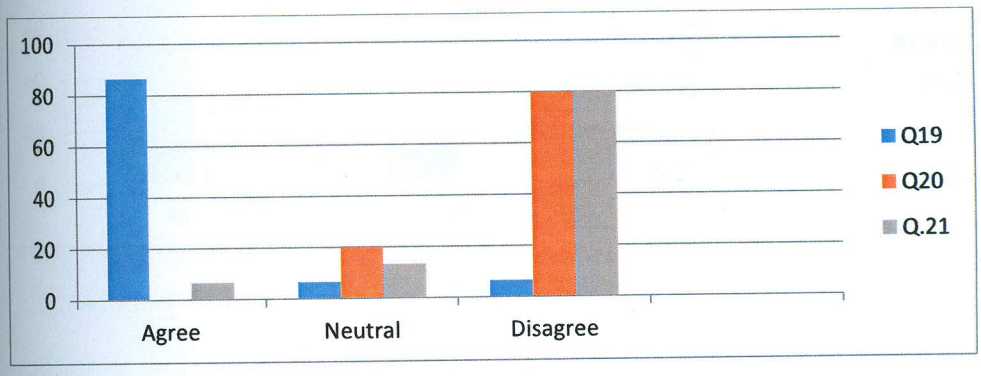


Figure 5.25: results of Flexibility and Efficiency of use

The statement of the question nineteen is: Application is flexible, and user can adjust the settings. The results show that the CCI users are satisfied by the feature. The statement

of the question twenty is: New user can use it without any difficulty. The results show that the CCI users are not satisfied. The statement of the question twenty-one is: Using application requires less steps. The results show that the CCI users are not satisfied.

5.4.8. Aesthetic and minimal design

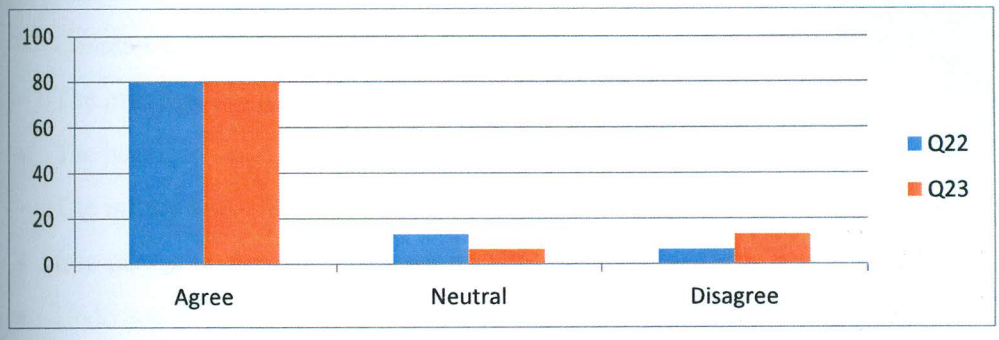


Figure 5.26: Results of Aesthetic and minimal design

The statement of the question is twenty-two is: The information is relevant. The results show that the CCI users are satisfied. The statement of the question is twenty-three is: There are too many screens. CCI users expresses that there are large number of screens on the application.

5.4.9. Help and Support

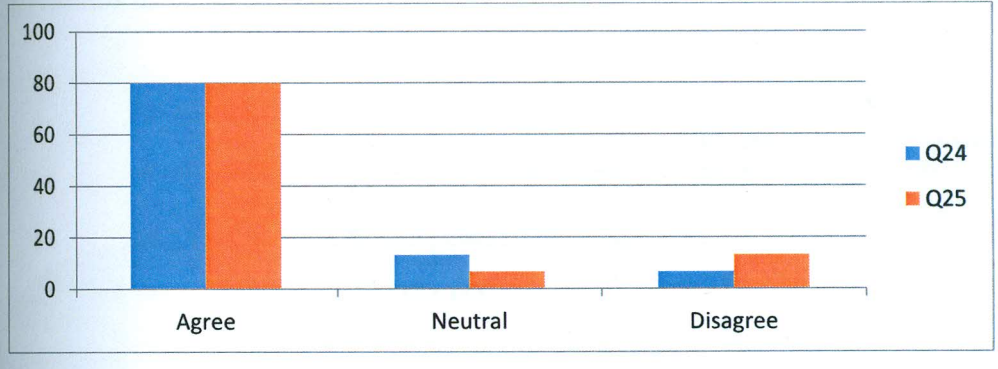


Figure 5.27: Results of Help and Support

The statement of the question twenty-four is: The application has a help facility. The results show that the CCI users are satisfied. The statement of the question twenty-five is: Information is easy to search. The results show that the CCI users are satisfied.

5.5. Unsatisfactory Features of the application

After finalizing the result of each question individually the author will find out the features of the application from which the CCI user is not satisfied. The list of unsatisfactory features of the application will help the author to focus on these features improvement while developing a new mobile prototype. The features are given:

- Contents are organized in proper manner
- The interface (design) is pleasant
- The buttons and icons are easy to understand.
- The information is arranged in good order
- It is easy to control the application
- Undo and Redo actions can be done easily.
- Using application requires less steps.
- There are too many screens

5.6. Mapping Observation with unsatisfactory features of application

The observations and the analysis of the close ended questions of the question is given below. The author map the drawbacks of application collected during observation with the reults of the questionnaire. It will help the author to have the breif look on the featuers of application those needs improvements.

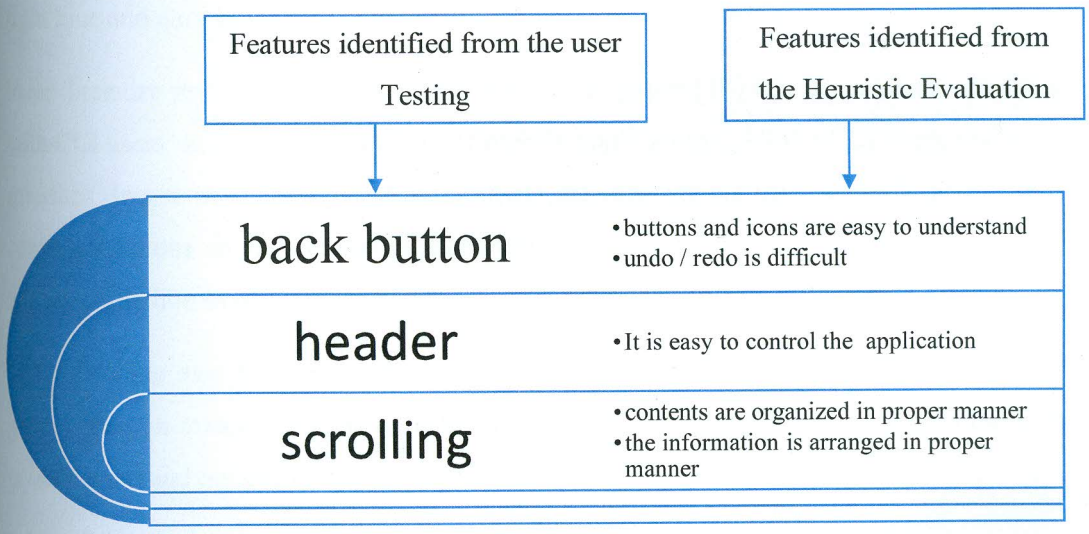


Figure 5.28: Relation Between Observations and Questionnaire results

The author map the problems gathered during the observation and the weaknesses of the applications gathered by the questionnaire analysis. During observation author observe that CCI users are facing problem in finding the back button. CCI users also pointed during filling questionnaire that buttons are difficult to find. The author also finds during the observation that header on the main page of the application is confusing the CCI user. CCI user go to setting page instead of selecting the subject. CCI user also explained that they find application difficult to use during questionnaire attempting. The header on every page confuse CCI user a lot. The attention of the CCI user is diverted towards the header while using the application.The researcher also finds that CCI user gets confuse while scrolling down. The CCI user cannot see the list of all subjects in one glance, so when CCI user is finding subject , grade or exercise while scrolling down some of the subjects, grades etc. disappears that make the CCI user in trouble. The researcher also finds through the questionnaire analysis that CCI user is not satisfied by the desgin of the application. The desgin is not attractive for the CCI users. CCI users feel that desgin is not colourful, it has so many screens and lot of steps are required for reaching to the practice exercise.

The researcher also finds in the literature review that the CCI user are attracted towards the colourful application. In paper [14] through the experiment we come to know that light blue and dark blue colurs are most favourite colours of the CCI user.

From literatire review author also finds out that in paper [14] the experiment was done with CCI users to make the interface of mobile applications. All the CCI users make the interface desgin with cartoons, draw animals etc. this shows that the CCI ussers need some animations in the desgin of the mobile application. The interface without any clipart, animation or drawing is not attractive for the CCI users.

The researcher also finds from the observation of the second application that CCI user gets confuse in selecting the level of lesson i.e. begnier, intermidiate, expert. As the icon is very small and not easily visible on the screen.

5.7. Results of Heuristic Evaluation

The scholars established a usability specification for the Khan Academy software and the findings attained from the expert assessments are summarized below:

Table 5.4 displays the comprehensive quantitative findings after performing the heuristics assessment on Khan Academy application by every heuristic.

In this test the heuristics assessment uncovered 42 problems overall, of which 13 were cosmetic glitches, this being 31% of all usability challenges and 14 lesser difficulties were also found (33% of all usability problems). Finally, 15 main problems were detected, producing 36% of all usability issues.

The 'visibility of system status' heuristic identified more problems, with 3 cosmetic, 4 minor and 4 major ones. This means that the application was found to be a little attractive. The next heuristic was 'match between system and real world, with 2 cosmetic, 3 minor and 2 major ones. This indicates that the Khan Academy has fewer matches between system and real world. The next heuristic was 'user Control and freedom, with 2 cosmetic, 2 minor and 0 major ones. The other heuristic was 'Consistency and Standards, with 1 cosmetic only. The next heuristic was 'Error Prevention, with 4 cosmetic, 1 minor and 1 major ones. The next heuristic was 'Recognition rather than recall, with 1 cosmetic, 2 minor and 0 major ones. The next heuristic was 'Flexibility and efficiency of use, with 3 major ones. The next heuristic was 'Aesthetic and minimalist design, with 3 cosmetic, 2 minor and 0 major ones the next heuristic was 'Helps users recognize, diagnose, and recover from errors, with 1 cosmetic only. The last heuristic was 'Help and documentation, diagnose, and recover from errors, with 1 cosmetic only.

Nevertheless, some professional assessors emphasized the subsequent complications related to these heuristics:

1) A Few logos are not graphically and theoretically distinctive.

2) How to reverse procedures is not visibly specified.

In end, the professional assessors established that Khan Academy could be very challenging for beginner users because it was designed for qualified users, but it could turn out to be much simpler and clearer for beginners with time.

Table 5.4: Heuristic Evaluation Results

	Cosmetic	Minor	Major	Catastrophic	
1. Visibility of system status	3	4	4	0	11
2. Match between system and the real world	2	3	2	0	7
3. User control and freedom	2	2	0	0	4
4. Consistency and Standards	1	0	0	0	1
5. Error Prevention	4	1	1	0	6
6. Recognition rather than recall	1	2	0	0	3
7. Flexibility and efficiency of use	0	0	3	0	3
8. Aesthetic and minimalist design	3	2	0	0	5
9. Helps users recognize, diagnose, and recover from errors	1	0	0	0	1
10. Help and documentation	1	0	0	0	1
	13	14	15	0	42
	30.95%	**33.33%**	**35.71%**	**0%**	

5.8. Phase 4- Prototype and its Analysis

In this portion the researcher will analyse the built prototype. The prototype is built on the basis of the data collected in the above section. The researcher main focus is on the

features on those CCI user was not satisfied. The researcher will improve the unsatisfied features of the application that was analysed by the CCI user in the experiment.

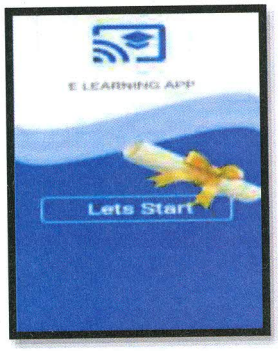


Figure 5.29: First Screen of Prototype

The screen shows the starting page of the application. It only contains one button on the screen to press. When the user will press the 'Let's Start' button the application will start.



Figure 5.30: Main Page of Prototype

The Figure 5.30 shows the main screen of the prototype. It contains icons of courses, videos, lessons and practice session. No scrolling is required. All the icons are shown on one glance.

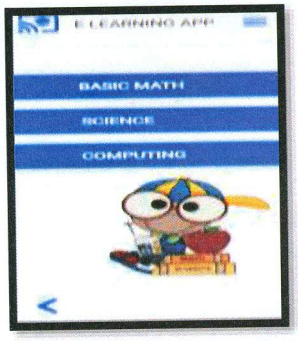


Figure 5.31: Subject Selection

The Figure 5.31 shows the screen that is opened when user selects the courses. The user can select any one subject. The list of the subject is given. Basic maths, Science and computing are the main subjects. The user can select anyone of the given subjects.

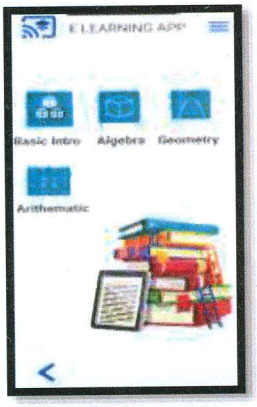


Figure 5.32: Topic selection screen

The Figure 5.32 shows the screen when user select any subject. The screen shows that user can select any topic relevant to that subject. After clicking the maths subject, the user can select the topic. No scrolling is required. All the topics are visible on the same screen.

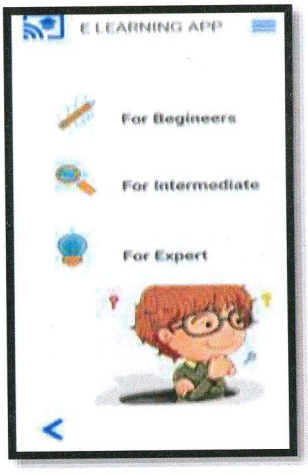


Figure 5.33: Level of difficulty choosing

The Figure 5.33 shows the screen for the level choosing of difficulty. The user can select the level. The level of the difficulty shown in the screen is beginners, intermediate and expert level. The user can choose the difficulty level according to its needs.

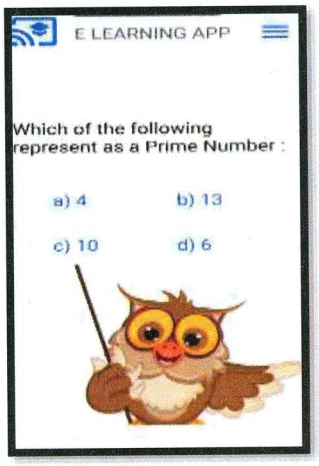


Figure 5.34: Screens of the Practice session

The Figure 5.34 shows the practice page of the exercise. The user can solve the exercises relevant to the subject and topic selected. If the user gives correct answer then the appreciation words will be appeared on the screen, on the other side if the question is answered with an incorrect answer then Retry option will appear.

5.9. Task given for User Testing of Prototype

The first task was to select subject, then chapter and watch the video related to that. The second task was to select the level of the videos for the beginner, expert or intermediate. The third task is to open the practice session and solve the practice exercise. The fourth task that was given to the CCI user is to find the button of the search. The detail of each task is explained below:

Task 1(select subject)

- Open the application
- Select the subject
- Select the chapter
- Watch video

Task 2 (select the level)

- Open the lesson
- Select level
- Watch video

Task 3(Practice session)

- Open practice session
- Do exercise

Task 4 (search)

- Click menu button
- Open search bar

5.10. Task completion result

The tasks were given to the users. The Figure 5.35 shows the detail of the task completion. The results show that the CCI user completes all the first three tasks of the experiment. The results show that 14 CCI users are able to complete the Task 4 yet only one user was unable to complete the task 4.

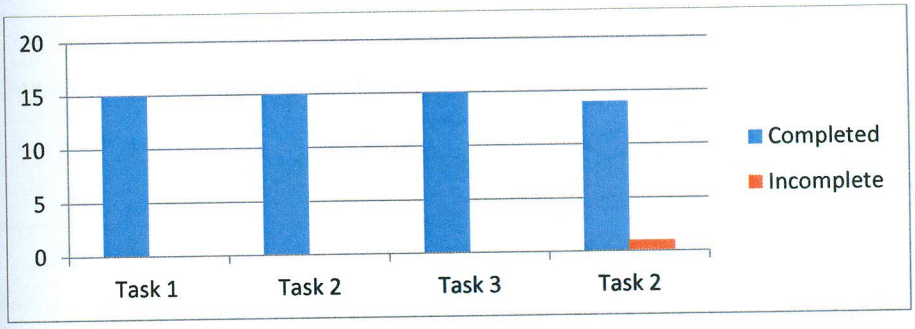


Figure 5.35: Task Completion

5.11. Observation Results of Prototype

The Table 5.14 shows the detail of the usability components. For the evaluation of the effectiveness the number of clicks and the numbers of errors are counted. The result show that in task one the number of clicks and number of errors are more than second and third task. The usability component efficiency is evaluated by measuring the time taken to complete the task. The results show that the time taken by the CCI users to complete first task is more than the second and third task. The usability component 'satisfaction' is measured by asking from the CCI user about satisfaction. The user will tell whether the application is satisfactory or not. It is concluded from the results that most of the CCI users are not satisfied with the application.

Table 5.5: Usability Components of Prototype

	Questions	T1	T2	T3	T4	total
Effectiveness	How many click (touch) to solve task?	61	77	47	39	224
	How many errors occurred during task?	1	2	2	11	16
Efficiency	How much time taken to complete given task?	47	46	48	22	163
Satisfaction	Are the users satisfied with the application?	Satisfied		14		
		Not satisfied		1		

5.12. Questionnaire Results for Prototype

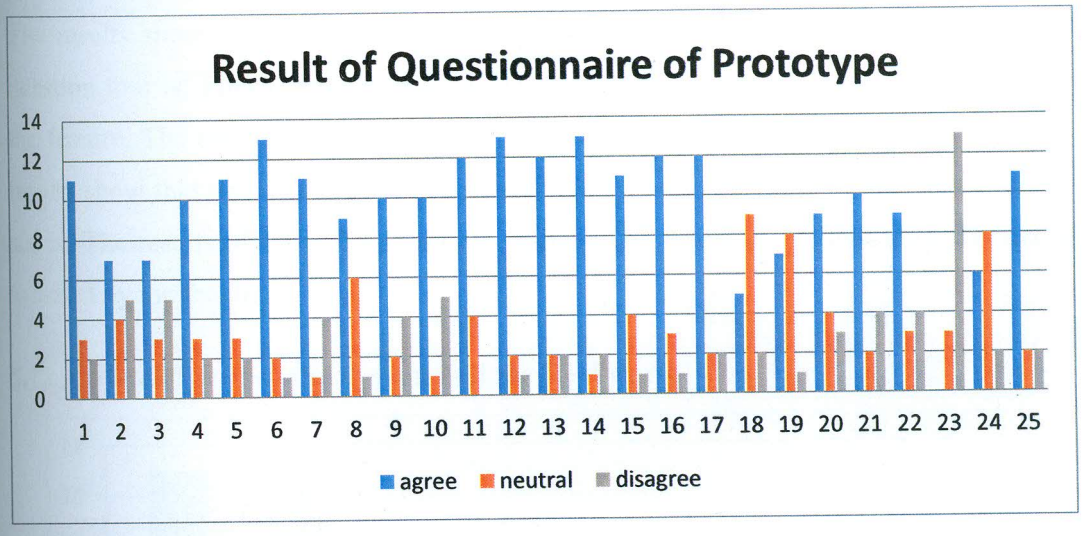


Figure 5.36: Questionnaire Individual Response

The terms from this questionnaire were evaluated based on the following terms: Agree, neutral and disagree. If the percentage of the agree scale is more than it will be good feature of that application. Otherwise the more percentage of the Disagree will show that the user is not satisfied for that particular feature. The Questionnaire consists of 25 questions. The result of each question is explained separately. Details of question categorized are given below:

5.12.1. Visibility of System Status

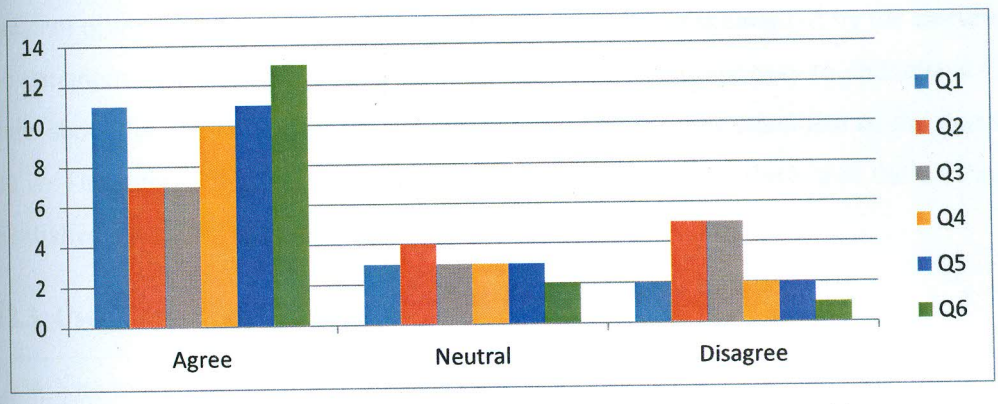


Figure 5.37: Results of visibility of system

The statement of the question one is: The right feedback is given on time. The results show that the CCI user is satisfied by the feature that the feedback is given on the time. The statement of the question two is: Contents are organized in proper manner. The results show that the CCI user is satisfied by the feature that contents are organized in proper manner. The statement of the question three is: The interface (design) is pleasant. The results show that the CCI user is satisfied by the feature. The statement of the question four is: Font is easy to read. The results show that the CCI user is satisfied by the feature. The statement of the question five is: Language is easy to understand. The results show that the CCI user is satisfied by the feature. The statement of the question six is: The results of task performed are visible. The results show that the CCI user is satisfied by the feature.

5.12.2. Match Between the System and the Real world

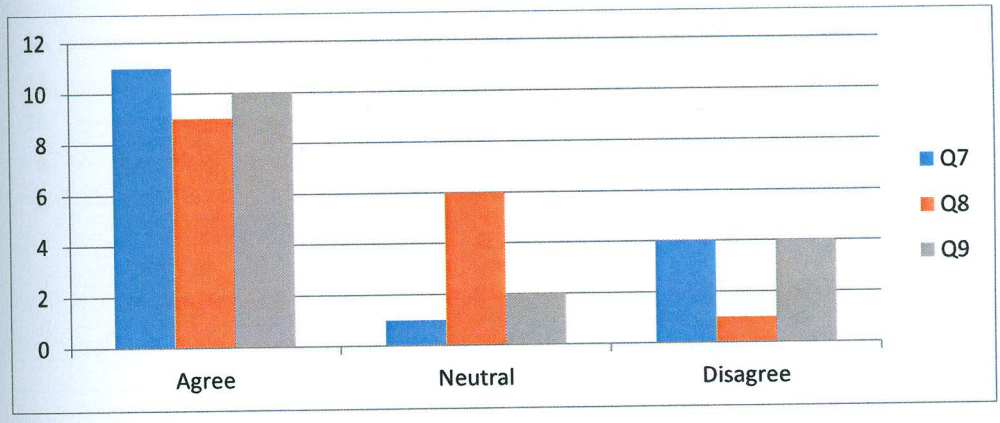


Figure 5.38: Results of Match between system and Real world

The statement of the question twelve is: The same words, concepts or action refer to same action. The results show that the CCI users are satisfied by the feature. The statement of the question thirteen is: Contents are clear. The results show that the CCI users are satisfied by the feature. The statement of the question fourteen is: The design of application is same throughout. The results show that the CCI users are satisfied by the feature.

5.12.5. Error Prevention

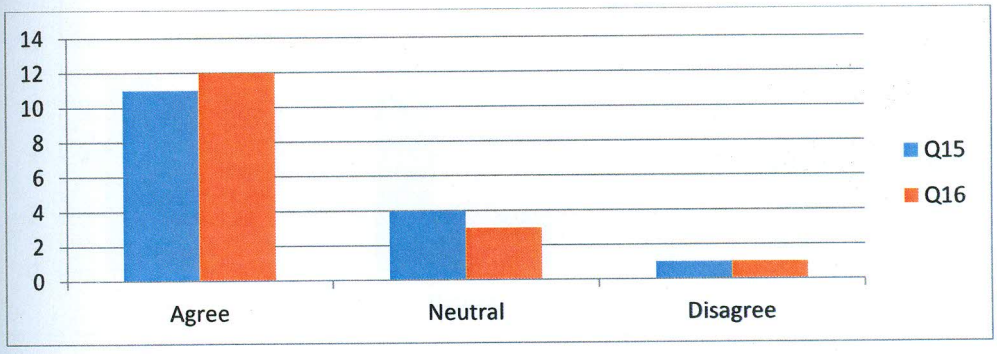


Figure 5.41: Results of Error Prevention

The statement of the question fifteen is: No serious errors occurred. The results show that the CCI users are satisfied by the feature. The statement of the question sixteen is: In case of errors it provides instructions for recovery. The results show that the CCI users are satisfied by the feature.

5.12.6. Recognition Rather than Recall

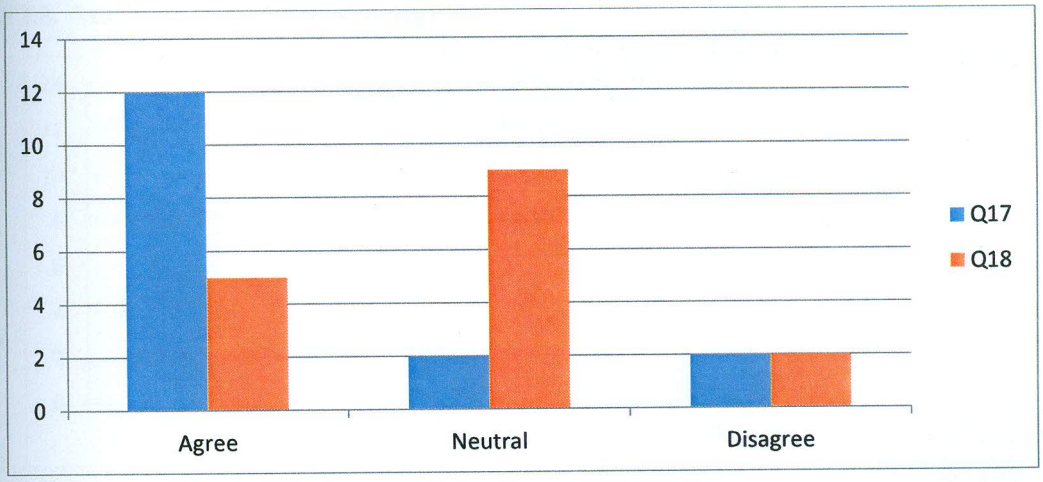


Figure 5.42: Results of the Recognition rather than recall

The statement of the question seventeen is: Objects, options for selection, and actions I take are visible. The results show that the CCI users are satisfied by the feature. The statement of the question eighteen is: Instructions on how to use the application are visible. The results show that the CCI users remain neutral.

5.12.7. Flexibility and efficiency of use

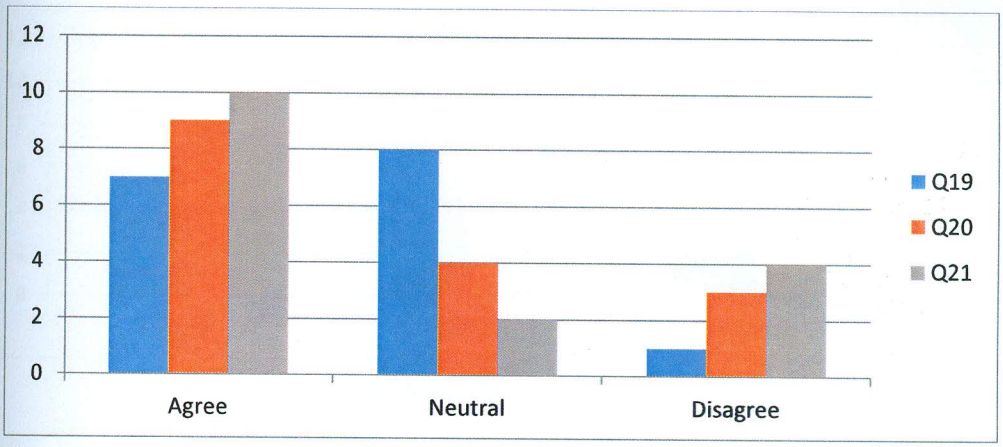


Figure 5.43: Results of Flexibility and efficiency to use

The statement of the question nineteen is: Application is flexible, and user can adjust the settings. The results show that the CCI users show neutral result. The statement of the question twenty is: New user can use it without any difficulty. The results show that the CCI users are not satisfied. The statement of the question twenty-one is: Using application requires less steps. The results show that the CCI users are not satisfied.

5.12.8. Aesthetic and minimal design

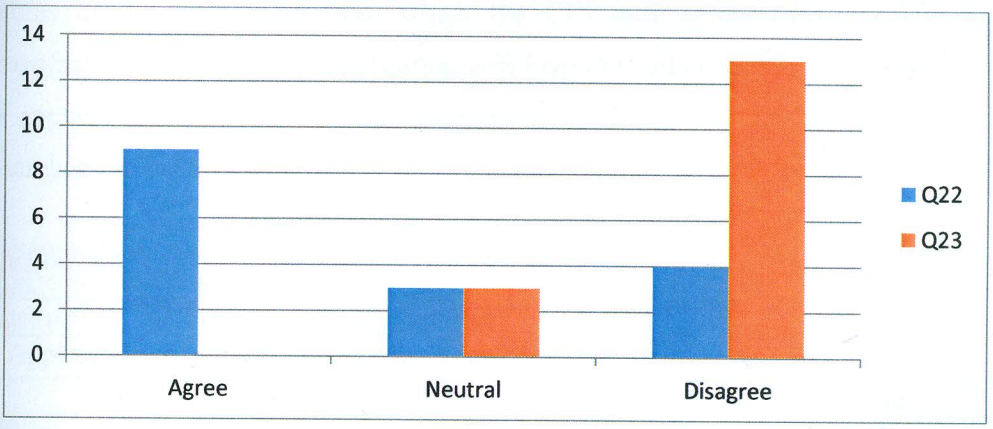


Figure 5.44: Results of Aesthetic and minimal design

The statement of the question is twenty-two is: The information is relevant. The results show that the CCI users are satisfied. The statement of the question is twenty-three is: There are too many screens. CCI user states that there are too many screens on the application.

5.12.9. Help and Support

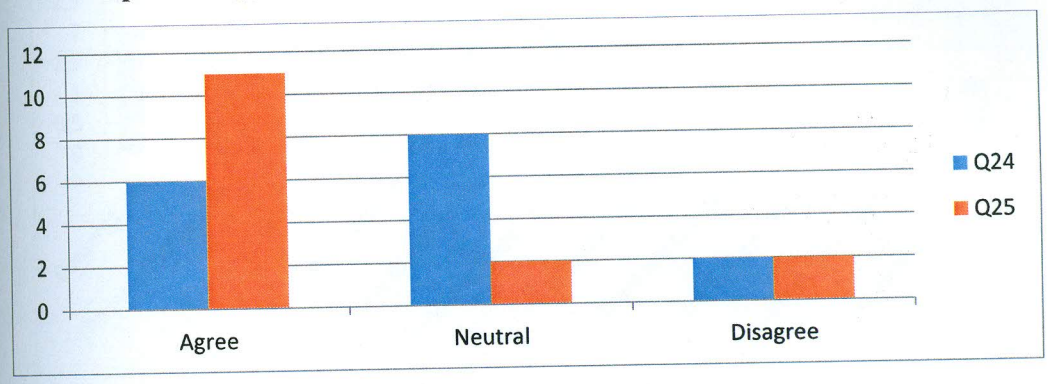


Figure 5.45: Results of Help and Support

The statement of the question twenty-four is: The application has a help facility. The results show that the CCI users are show neutral behavior. The statement of the question twenty-five is: Information is easy to search. The results show that the CCI users are satisfied.

5.13. Details of unsatisfactory features

After finalizing the result of each question individually the author will find out the features of the application from which the CCI user is not satisfied. The list of unsatisfactory features of the application will help the author to compare its results with the application results. After the comparison of prototype and the application the researcher will easily conclude that the prototype is improved or not.

Table 5.6: Overall disagree features of Prototype

Features	Satisfaction
Instructions on how to use the application are visible	Neutral
Application is flexible and user can adjust settings	Neutral
There are too many screens	Not satisfied
The application has a help facility	Neutral

5.14. Comparison of the results

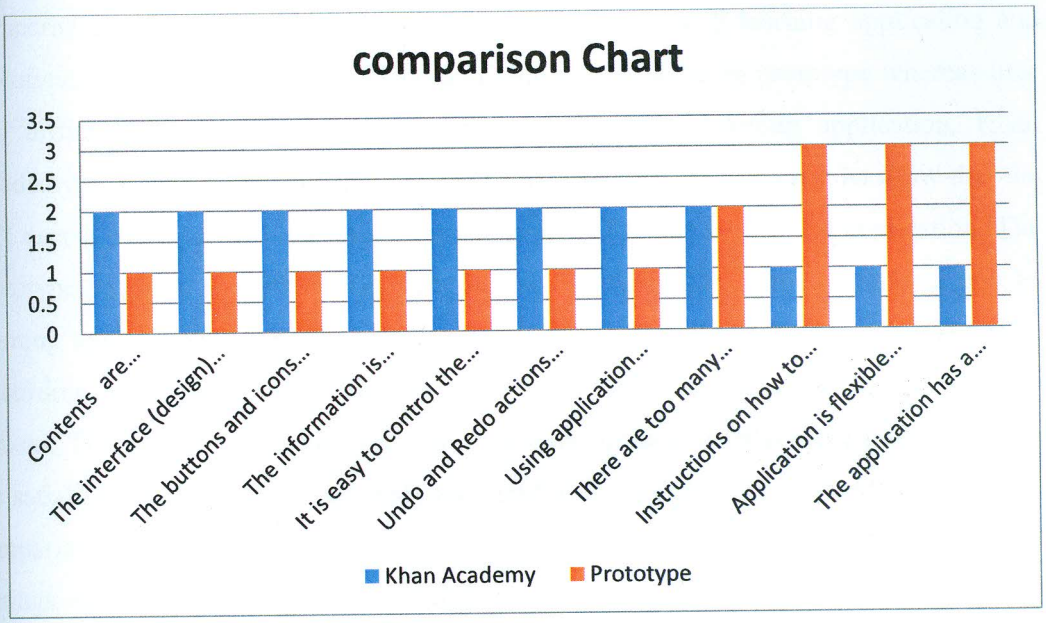


Figure 5.46: Comparison of E-learning Application and Prototype

The Figure 5.46 shows the comparison of the two applications. The blue color bar lines are for the results of the Khan Academy while the orange color shows the results of the prototype. The above figure also shows that the scale 1 is for the agree, the scale 2 shows disagree and the scale 3 shows the neutral.

The author compared the features of the application and prototype. According to the CCI user the contents of the Khan Academy are not arranged properly but the prototype contents are organized in the proper way. The CCI user states that the interface of the prototype is more pleasant than the Khan Academy. The user feels more attraction towards the interface of the prototype as it contains colorful clip arts. The third point for the comparison is that buttons and icons are easy to understand. The CCI user states that the Khan Academy buttons are difficult to use whereas the prototype buttons are easy to understand and easy to use. The information is arranged in good manner is the fourth point of the comparison of the learning application and prototype. According to the CCI user the information is not arranged properly in Khan Academy whereas the information

is arranged properly in the prototype. The result of the statement: it is easy to control the application. Shows that prototype is easy to use than the Khan Academy. The author compared the features Undo and redo is compared for the E-learning application and prototype. The results show that Undo and redo is easy to do in prototype whereas user feel difficulty in undo and redo while operating the E-learning application, Khan Academy. The feature: Using application requires fewer steps. The results show that the CCI user is satisfied with the prototype as compared to the E-learning application. The prototype requires less steps. The user is not satisfied with neither prototype nor E-learning application when it comes to the statement that there are too many screens. According to the results both the prototype and E-learning application have too many screens. The feature: Instructions to how to use the application was compared. The users are satisfied with the, Khan Academy and neutral for the prototype for this feature. The comparison was done for the feature: the application is flexible, and user can adjust settings easily. The CCI user is neutral for this feature with the E-learning application. The user did not think that the prototype is flexible. The application has help facility, this feature is compared. The results show that E-learning application has help facility whereas for the prototype the CCI user remains neutral.

5.15. Comparison of Observation

After the comparison of the Questionnaire statements. The observations collected for the usability components effectiveness, efficiency and satisfaction will also be compared. The Table5.26 shows the readings of the observations of the usability components.

The comparison of the number of clicks show that number of clicks while using the E-learning applications are more than the number of click while using the prototype. The results of the errors done during the task were compared. The results show that more errors were made during completing the task of the E-learning application as compared to the prototype. The results of time taken to attempt the task are compared. The results show that time taken to complete the task of Khan Academy is more than the prototype.

Table 5.7: Comparison of the Task Time, Errors and Clicks

Khan Academy				
	T1	T2	T3	total
Errors till The End Task	60	24	14	96
Clicks till The End Task	168	77	50	295
Time Taken to Complete All Tasks Approximately	108	61	35	205
Prototype				
	T1	T2	T3	T4	Total
Errors till The End Task	1	2	2	11	16
Clicks till The End Task	61	77	47	39	224
Time Taken to Complete All Tasks Approximately	47	46	48	22	163

Chapter 6
Conclusion

This chapter includes analysis, responding to the research question and authentication of assessment within the thesis.

6.1. Discussion

The objective of this research report was to assess the usability and practicability of e-learning application by utilizing proper methods and means. To do that, the largely managed e-learning program of Khan Academy and LingQ application are chosen as case study. To assess the user interface in enhanced method, a well-organized structural approach has been adopted

Various approaches and practices are applied globally to gauge the usability. Every usability assessment method affects different methodologies of teaching and understanding. To receive more precise outcomes, User Testing technique and Questionnaire have been used as the principal devices to uncover the findings.

6.1.1. Research Questions

Research Question 1: The mobile learning applications those were tested by the CCI user are the top-rated applications on the play store. It was identified through usability evaluation (user testing) and heuristic approach (expert evaluation) that users face problems with the current available applications with respect to usability. The application is difficult to use by the CCI user for the first time. The user gets confuse with many of the features of the application. The header on the main page confuses the user. The scrolling interface makes trouble for the user. The little icons were difficult to find by the users. The inappropriate place of the buttons makes difficulty for the user to find it. User testing was conducted by the author to analyse and identify the usability issues. The issues are highlighted in Chapter 5.

Research Question 2: Usability Evaluation concentrates on how users can understand concepts more effective and properly and utilize a product to attain their objectives. It

also describes the satisfaction of users with that method. To assemble this data, experts use a range of approaches that collect opinion from users about plans connected to an application. In this research the researcher uses the method of the Heuristic evaluation. The Neilson Heuristic evaluation technique was used to evaluate the application usability. Research question 3: The experiment was conducted to find the features of the learning applications those create confusion for the CCI users. User testing was done to find the problematic features. The interaction design was used to develop the prototype. User testing and questionnaire technique was used to validate the prototype. The results show that prototype support the demands of CCI users.

6.2. Recommendation

The authors have following recommendations that might be helpful in designing the software user interface of mobile phone for CCI user. These recommendations are based on the literature review, findings of questionnaire results, and observations of CCI user during questionnaires conductions, prototype designing and testing.

6.2.1. CCI USABILITY HEURISTICS (CCIUH) with the explanations

The CCI users have their own needs and demand. The usability of the interface is different from other users. The heuristics for the CCI user usability are given. A comprehensive explanation of each heuristics has been combined to improve usability evaluator and to clearly use the heuristics while assessing the e-learning program.

CCIUH 1-Design an attractive layout

The interface made for the CCI user is made attractive by the efficient use of the animations or clipart. The colourful interface attracts the CCI user. The screen design for the CCI user appears to be an attractive layout if it is simple, i.e., uncluttered, readable, and memorable. The font choice, colours and sizes are consistent with good child screen design.

CCIUH 2- Buttons and icons visible easily

The interface made for CCI user is efficient if the user can easily use it. The usability of the interface is enhanced for the CCI user if every button on the screen is easy to understand. The buttons must be much visible that CCI user find it easily. The button of small size and located in inappropriate place make the usability of the interface poor.

CCIUH 3 – less steps and less screens

The application interface made for the CCI user is attractive for the user if its design has less steps to reach to required field. The interface with less screens is liked by the CCI users. The CCI user is a dabbler user so more the number of screens more is the trouble for the user.

CCIUH 4- No scroll design

The interface made for the CCI user must be simple. The CCI users are not expert users. The users get confuse with complex design of the interface. The interface can be made simple and easy to use by avoiding the scrolling design. The scrolling of the application for choosing any option make the user in difficulty.

CCIUH 5- Avoid Header

The simple design is easy to use by the CCI user. The interface is more usable if the design is more simple. The main things of the application must be on the top. The CCI user gets confused to see the less important things on the header as the first attention of the user goes to the header. The interface can be made attractive for the CCI user by avoiding header or using small header.

6.3. Conclusion

The major purpose of this study is to discover the necessary demands and desires of CCI users concerning the mobile phone software interface, the usability problems and satisfaction level. To boost the main purpose, broad literature review is performed to understand the problems of CCI users with mobile phone software interface and services, current software interface layout is offering.

Author realized that there are several problems CCI user face related to the layout of the mobile phone software interface. To clarify and examine usability difficulties in the applications available. The first step that carried out was of literature review in order to gain insight knowledge about the usability evaluation methods and to find related research work. In the second step, the author selected two applications "Khan Academy" and 'LingQ'. User testing was carried out on the same applications by users. User testing was carried out and observations were noticed. It was through the findings from literature review and heuristics evaluation that ultimately helps the author in designing the tasks and questionnaire for user testing participants. The results were gathered helped in making the prototype. With the help of Prototype evaluation, the researcher was able to conclude the CCI usability Heuristic for the learning applications.

6.4. Future Work

The writer considers that the suggestions given in this research might be beneficial in planning and improving the software user interface of mobile phone for aging people with diminishing eyesight. A Few recommendations for future research are described below, built on the conclusions from previous sections of thesis. The learning application can have the social interaction feature. Moreover, the feature of online help by the designer could also be added.

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APPENDICES

APPENDIX A

CCI users Survey for Research

The scholar of computer science department of Bahira University is conducting a research in order to improve the learning application. Gathering information from CCI users is a vital part of this research. Please fill out both parts of this questionnaire. If you have completed this questionnaire in another class, please DO NOT fill it out again. Thank you.

Part I

Please circle a response for each question. When you are done, return the questionnaire to a CCI users' representative.

- What is your gender?

☐ Female

☐ Male

- What is your highest level of education?

☐ Grade 1

☐ Grade 2

☐ Grade 3

☐ Grade 4

☐ Grade 5

☐ Grade 6

- What is your age?

☐ 7-8 years

☐ 9-10 years

☐ 10-11 years

☐ 12-13 years

☐ 13-14 years

☐ 14-15years

➢ How long have you using mobile applications?

☐ Less than 1 year

☐ 1 - 3 years

☐ 4 - 6 years

☐ 7 - 10 years

☐ More than 10 years

Part II.

Which application you are using:

☐ Khan academy

☐ LingQ

Open the application and follow the instructions as guided you. Then fill the form.

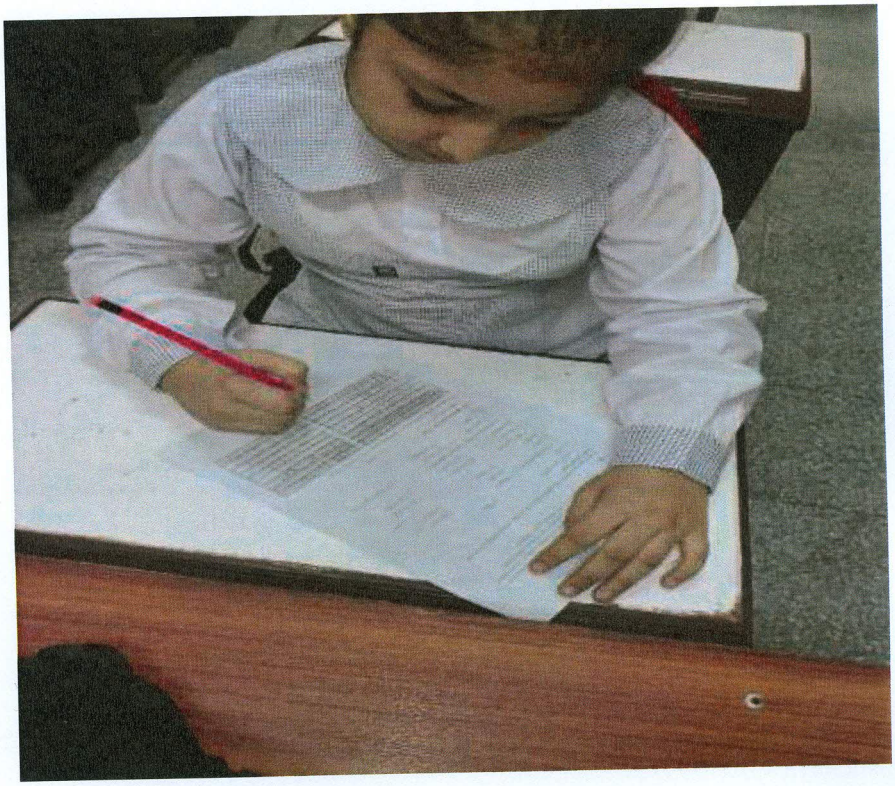
Ser.	Questions	Levels for disagree or agree		
I. Visibility of application status and contents				
		Agree	**Neutral**	**Disagree**
1	The right feedback is given on time			
2	Contents are organized in proper manner			
3	The interface (design) is pleasant			
4	Font is easy to read			
5	Language is easy to understand			
6	The results of task performed are visible.			
II. Match Between the System and real world				
		Agree	**Neutral**	**Disagree**
7	Everyday life words are used in application			
8	The buttons and icons are easy to understand			

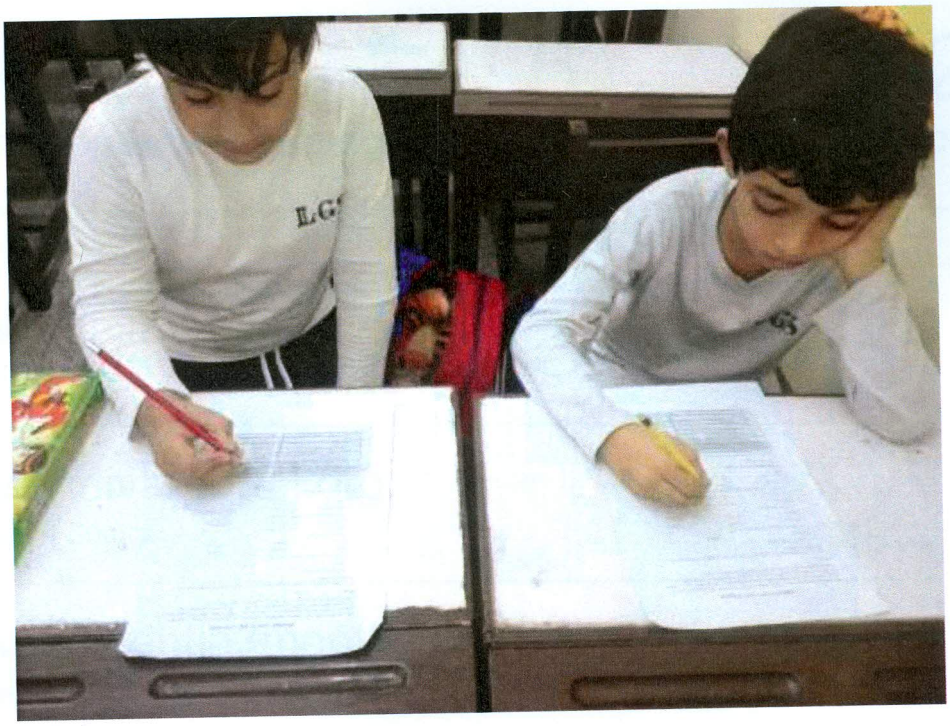
9	The information is arranged in good order			
III. User Control and Freedom				
Agree			**Neutral**	**Disagree**
10	It is easy to control the application			
11	Undo ad Redo can be done easily			
IV. **Consistency and Relevance of site content**				
		Agree	**Neutral**	**Disagree**
12	The same words, concept or action refer to same thing.			
13	Contents are clear.			
14	The design of application is same throughout			
V. Error Prevention				
		Agree	**Neutral**	**Disagree**
15	No serious errors occurred			
16	In case of error it provides instructions for recovery			
VI. Recognition rather than recall				
		Agree	**Neutral**	**Disagree**
17	Objects, options for selection, and actions I can take are visible.			
18	Instructions on how to use the application are visible			
VII. Flexibility and efficiency of use				
		Agree	**Neutral**	**Disagree**
19	Application is flexible and user can adjust settings			
20	New (Novice) user can use it without			

	any difficulty			
21	Using application requires less steps			
VIII. Aesthetic and minimal design				
		Agree	**Neutral**	**Disagree**
22	The information is relevant.			
23	There are too many screens			
IX. Help and support				
		Agree	**Neutral**	**Disagree**
24	The application has a help facility			
25	Information is easy to search			

APPENDIX B







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