ENHANCING USABILITY THROUGH VISUALIZATION TECHNIQUES FOR YOUNG LEARNERS: A CASE STUDY OF THE PROPOSED ONE LAPTOP PER CHILD (OLPC) PROJECT IN KENYA

NICHOLIS MUTISYA MUTUA

MASTER OF SCIENCE

(Computer Systems)

JOMO KENYATTA UNIVERSITY OF

AGRICULTURE AND TECHNOLOGY.

2016

Enhancing usability through visualization techniques for young learners: A case study of the proposed One Laptop Per Child (OLPC) project in Kenya

Nicholis Mutisya Mutua

A thesis submitted in partial fulfillment for the degree of Masters of Science in Computer Systems in the Jomo Kenyatta University of Agriculture and Technology

2016

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.-

Signature ……..…… Date…….

Mr. Nicholis Mutua

This thesis has been submitted for examination with our approval as the University supervisors.

Signature …… Date ……

Dr. Wilson Cheruiyot

JKUAT- Kenya

Signature …….. Date ……

Dr. Stephen Kimani

JKUAT- Kenya

DEDICATION

I dedicate this work to my loving wife Grace, parents, my big brother Sam and my son Samuel Junior for the support and strength throughout the entire process. You are always my heroes.

ACKNOWLEDGEMENT

First and foremost am grateful to the almighty God for seeing me through the research and even for having taken me through my undergraduate program. I am vividly grateful for the encouragement and unwavering support I received from my project supervisors Dr. Wilson Cheruiyot and Dr. Stephen Kimani; you are such wonderful people in my life. God bless you abundantly.

Overwhelming encouragement and financial support from my family, dad, mum and brothers, I really appreciated. You are a family am always proud of. My other regards goes to Dr. Kimwele and Mr. Mkala, who always kept me on toes and encouraged me on this research. My friends and colleagues, who in one way or the other assisted me in compiling my work, feel appreciated. Gods' blessings are upon you always.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

OLPC: One Laptop Per Child.

HCI: Human Computer Interaction.

UNESCO: United Nations Educational, Scientific and Cultural Organization.

ICT: Information Communication Technology.

PTTCs: Primary Teacher Training Colleges.

SPSS: Statistical Package for Social Sciences.

IDI: In Depth Interviews.

MOEST: Ministry of Education, Science and Technology

ABSTRACT

The idea of combining the effective visualization techniques to enhance usability among young learners is becoming a problem in human computer interface (HCI). Although several visualization techniques have been established for user interfaces development, the integration of these visualization techniques has not been done. The research enhanced usability through identification of the appropriate visualization techniques for young learners and integrated them to develop an appropriate user interface for the One Laptop Per Child (OLPC) project in Kenya. Both tree visualization techniques and the category visualization techniques were integrated in creating an efficient user interface for young learners. The user interface created was implemented and evaluated through interaction with young learners and the results were positive since optimal information dissemination was observed.

CHAPTER ONE

INTRODUCTION

1.1 Background

Usability is said to be a quality attribute that assesses how easy user interfaces are to use. It also refers to methods for improving ease-of-use during the design process. The idea of visualization has enhanced the communication in human beings since the dawn of man. This is formation of mental visual images and the act or process of interpreting in visual terms or putting into visible form. It is divided in to four categories. They include: Data visualization, information visualization, metaphor visualization and the concept visualization. With the four approaches to visualization this research focused on the information visualization which deals with the semantic networks of treemaps on information in an HCI setting. Four basic strategies were used to classify visualization techniques according to hierarchical representations of categories(Garcia *et al.,* 2014).

The concept of usability was originally articulated somewhat naively in the slogan "easy to learn, easy to use". The blunt simplicity of this conceptualization gave HCI an edgy and prominent identity in computing. It served to hold the field together, and to help it influence computer science and technology development more broadly and effectively. However, inside HCI the concept of usability has been re-articulated and reconstructed almost continually, and has become increasingly rich and intriguingly problematic. Usability now often subsumes qualities like fun, well-being, collective efficacy, aesthetic tension, enhanced creativity, flow, support for human development, and others. A more dynamic view of usability is one of a programmatic objective that should and will continue to develop as our ability to reach further toward it improves. Any well designed user interface enhances optimal user interaction by addressing six basic quality components associated with usability (Carroll, 2012). They include:

i. Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?

ii. Efficiency: Once users have learned the design, how quickly can they perform tasks by use of the design or any other related technology?

iii. Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?

iv. Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?

v. Satisfaction: How pleasant is it to use the design and to what degree does it address the set goals and objectives?

vi. Utility: Does it do what users need? This refers to the design's functionality and how well the user is getting full satisfaction of the needs.

Visualization is any technique for creating images, diagrams or animation to communicate a message. The use of visual imagery has been an effective way to communicate both abstract and concrete ideas since the dawn of man. According to (Lengler&Eppler, 2007) it is a systematic, rule based, external, permanent and graphical representation that depicts informational in a way that is conducive to acquire insight, developing and elaborate understanding or communicating experiences. They found that visualization can help the user to articulate the implicit knowledge as in visual metaphor and stimulate knew thinking like with the mind map.

Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. It is the planning and design of how people and computers work together so that a person's needs are satisfied in the most effective way.

The One Laptop Per Child (OLPC) project is a non-profit organization that seeks to provide laptops to children in poor and remote areas. This project serves to create educational opportunities for the world’s poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning. Different developing countries have

adopted different user interfaces for young learners which have led to partial addressing of the OLPC project objectives. Kenya is on its first stages of implementing the OLPC project and the success in the project will depend on the adoption an effective and relevant usability visualization techniques.

1.2 Problem Statement

Many visualization techniques have been researched in different fields. The usability of these techniques in dissemination of knowledge to different levels of learners has not been exhaustively done (Martin-Moncunill*et al*., 2013). There is no research which tries to analyze the effective usability visualization techniques for young learners in order to come up with an efficient user interfaceto be implemented in the OLPC project in Kenya. One of the advantages identified in the visualization techniques that have been evaluated is that these techniques offer a general preview of contents of the whole collection of digital resources (Garcia*et al*., 2014) hence no usability enhancement to different level such as young learners.

1.3 Justification

ICT is an increasingly influential factor in education. Computers and mobile phones are used in developed countries both to complement established education practices and develop new ways of learning such as online education (Sandhya and Sunita, 2011). Due to the fact that ICT is a diverse set of tools and resources which can enhance effective and efficient communication between the teacher and pupil, the adoption of the best visualization techniques enhances effective learning process making usability study on the visualization techniques for young learners important to different stakeholders.

The findings of this study were useful to various organizations especially the Government of Kenya which is in the process of making more informed choices in policy formulation with regard to usability strategies on the OLPC project implementation.

This study will enhance smooth management in the education sector through the adoption of effective usability visualization techniques. The use of ICT in all

departments of administration has become paramount in the process of achieving the vision of using ICT tools in education management. This research provides the necessary strategies towards implementation of OLPC project in primary schools to improve the quality of services offered.

The primary school teacher use these research findings to equip themselves with the skills required in their planning and delivering of services to the pupils. They will therefore enrich and sharpen their delivery skill to enhance effective implementation process. The research assists the pupils to prepare psychologically in using the ICT tools right from their young ages. The students will learn to appreciate the use of modern technology through the ICT tools.

1.4 Research Questions

1. What are the effective usability visualization techniques for information dissemination to the young learners?
2. How can the effective usability visualization techniques for young learners be integrated to enhance effective user interface?
3. How can we develop and implement an efficient user interface for young learners to change the pedagogical practices in primary schools.
4. How can we evaluate the user interface created to ensure appropriate usability for young learners?

1.5 Objectives

1.5.1 Broad objective

To develop and implement an efficient user interface for young learners through integration of usability visualization techniques.

1.5.2 Specific objectives

The specific objectives are:-

1. To identify the effective usability visualization techniques for information dissemination to young learners.
2. To establish how to integrate the effective usability visualization techniques for young learners in enhancing an efficient user interface.
3. To develop and implement an appropriateuser interface for young learners to change the pedagogical practices in primary schools.
4. To evaluate the user interface created to confirmappropriate usability for young learners.

1.6 Scope

This research study focused on young learners and their tutors in Kenya. The actual data was collected in Makueni County located in Eastern province on the appropriate usability visualization techniques for young learners. The research ensured diversified selection of different learners to enhance validity and reliability of the research study. The study also considered research reports from other developed and developing countries.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this section a review on the critical points of the current use of ICT tools in the process of enhancing usability through visualization techniques in use for the young learners user interface will be done. Our main focus is to identify the best usability visualization techniques for dissemination of information to the young learners. The theoretical contributions from the previous research findings and the general scrutiny of these will be put into focus. This will bring in to attention the policy framework put in place to enable a proper understanding of the relationship between usability and information visualization techniques and how the two can work together in improving the service delivery of primary school teachers and enhance optimal economic growth of the country. The plan put forward by Kenyan government will be analyzed in order to come up with the best implementation of enhanced usability visualization techniques to ensure smooth transition from the current systems to the planned ICT equipped systems.

2.2 Usability

According to Carroll, (2014) usability is enhanced through creativity and design rationale. A design is said to be good if it consists of a combination of well-designed input and output procedures which fulfills the user's requirements in the most successful manner. A good design is one which allows its users to focus on the data in order to perform their activities without using any specific procedures.

The emergence of collaboration, mobility, and new types of user devices and interactions is a major theme driving HCI beyond the desktop, Shaer&Hornecker,(2010). Until the late 1970s, the only humans who interacted with computers were information technology professionals and dedicated hobbyists. This changed disruptively with the emergence of personal computing in the later 1970s. Personal computing, including both

personal software (productivity applications, such as text editors and spreadsheets, and interactive computer games) and personal computer platforms (operating systems, programming languages, and hardware), made everyone in the world a potential computer user, and vividly highlighted the deficiencies of computers with respect to usability for those who wanted to use computers as tools Grudin, (2012).

2.3 Visualization techniques

Visualization is a systematic, rule based, external, permanent, and graphic representation that depicts information in a way that is conducive to acquire insights, develop an elaborate understanding or communicating experience. According to Koshman, (2004), the cross-system comparison of a visualization-based system with a traditional text-based system is useful for rethinking training methods and interface concepts that maximize the potential of visually-oriented methods to retrieving information for both novice and expert users.

According to Garcia, *et al*., (2014)design of interfaces according to visualization techniques can be classified in to four main divisions. Each of the group can be divided into small sub-categories as shown in figure 2.3-5.

2.3.1 Tree visualization technique

Tree visualization technique is a classic type of visualisation implemented to locate resources hierarchically using different levels through the use of navigation structures (Garcia, *et al*., 2014). In many applications information can be structured using two trees. One tree is taxonomy of some objects, and the other is a tree where each node is associated to one of the objects in the taxonomy. Thus, several nodes can be associated to the same object. In this case it is not immediately obvious how often and where an object of the taxonomy occurs in the object tree (Burch &Diehl 2006). For instance a learner will have to navigate through from alphabets and choose vowels in order for either the small or the capital vowel to be displayed on the screen as shown in the figure 2.3-1 below.

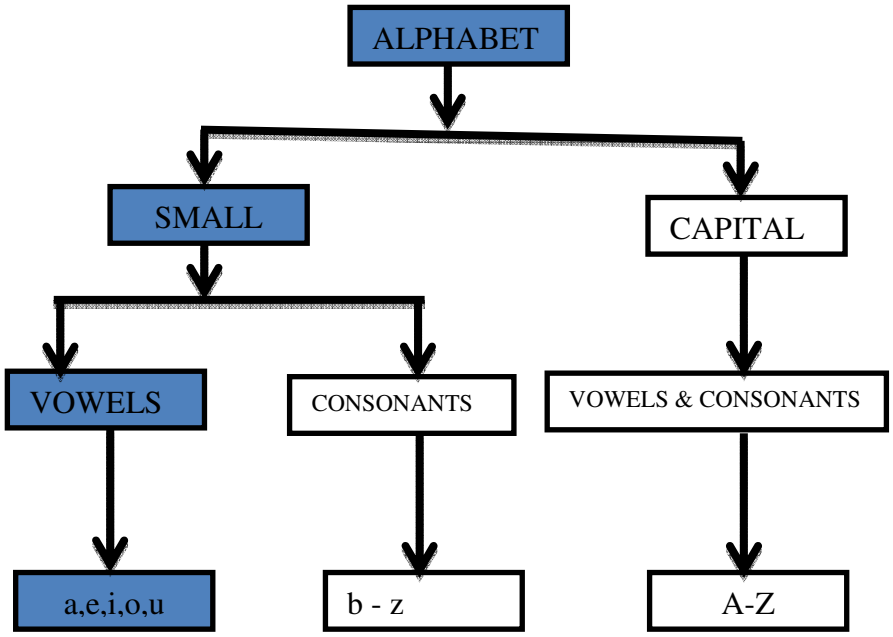


Figure 0-1 Tree visualization technique(Garcia, *et al*., 2014)

2.3.2 Radial visualization technique

Radial visualization is the practice of displaying data in a circular or elliptical pattern and is an increasingly common technique in information visualization research (Draper *et al*., 2009). This representation uses links that identify a navigation structure according to a previously defined classification. Radial visualizations place visual elements along a circle, ellipse, or spiral on the screen. Many radial techniques can be regarded as projections of visualization from a Cartesian coordinate system into a polar coordinate system as shown in figure 2.3-2. According to (Garcia *et al*., 2014) this technique can be grouped in to three divisions. They include:-

i. Radial interface technique allows the central location of nodes to be consulted for any information search to be successful. This technique displays the selected node in the central part of the navigation structure. The radial positioning (Eades&Sugiyama, 1990) presents nodes in concentric circles according to their depth.

ii. Radial search interface technique presents additional components at graphical levels. This is achieved through placing of nodes with different sizes according to the number of digital resources associated with the term.

iii. Relation interface technique is a radial visualization technique which only permits representing the terms related to the level of hierarchy consulted through its navigation structure. Thus hiding the terms related to levels above or below the current category. Radial visualizations can be useful for depicting information hierarchies, but they suffer from one major problem.As the hierarchy grows in size, many items become small, peripheral slices that are difficult to distinguish (Stasko& Zhang 2005).

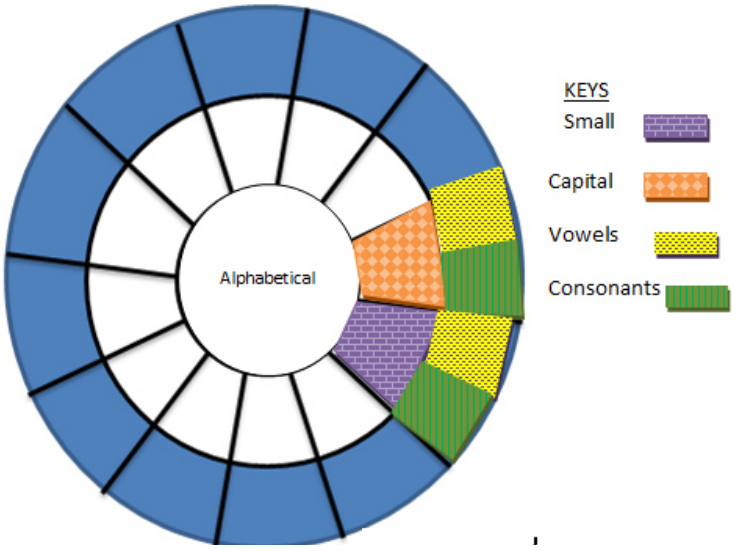


Figure 0-2 Radial visualization techniques(Garcia, *et al*., 2014)

2.3.3 Hyperbolic visualization technique

Hyperbolic interface is similar to radial technique structures but differs in the use of focus and context techniques based on hyperbolic geometry for visualizing and manipulating large hierarchies (Garcia *et al*., 2014). It can be sub divided into two visualization subtypes:-

i. Sunburstis technique which uses radial rather than a rectangular layout. Items in a hierarchy are laid out in radial form with the top of the hierarchy at the center and deeper levels farther away from the center.

ii. Hypertreeinterface technique is a hyperbolic-structured technique which allows the selection of nodes by using zooming and panning techniques by using the focus and context techniques as shown in figure 2.3-3. Participants pointed out the small "slice" size of files and directories that were near the periphery of the visualization and said that it was difficult to distinguish the different attributes (name, type, size, quantity, etc.) of such slices (Stasko& Zhang 2005).

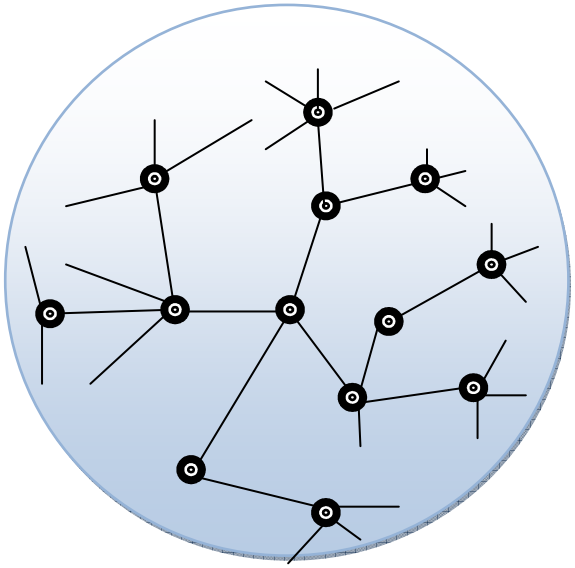


Figure 0-3 Hyperbolic visualization technique(Garcia, *et al*., 2014)

2.3.4 Category visualization technique

This visualization technique is also referred to as the folder navigation technique is appropriate for handling hierarchies and classifications (Garcia *et al*., 2014). It can be divided into two subtypes:-

i. Treemaps interface technique display the hierarchical structure of all available spaces on screen by using rectangular slices and displays information hierarchically based on a recursive subdivision workspace rectangular layout.

ii. Icicle interface facilitates the representation of terms using hierarchical clustering. Within the navigation process, objects that join or leave a group are identified according to the selected area of a new level of hierarchy.

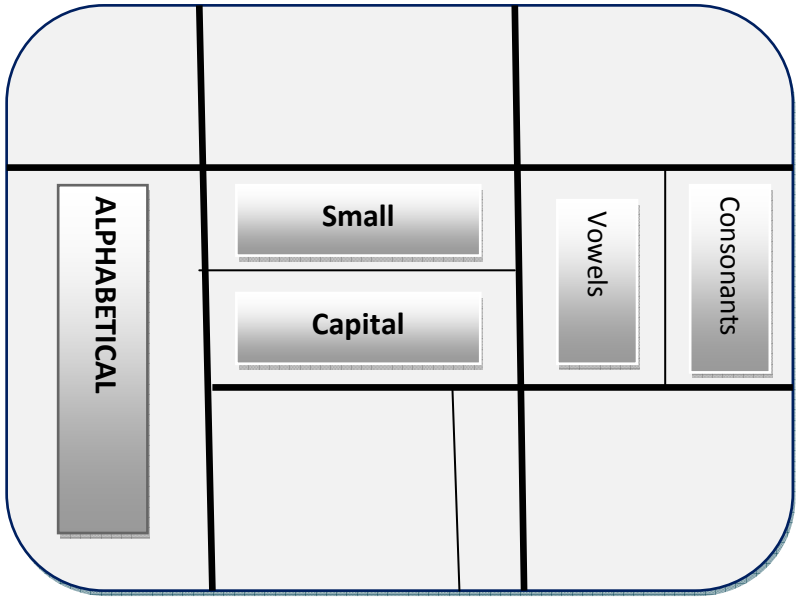


Figure 0-4 Category visualization technique(Garcia, *et al*., 2014)

Because visualization outputs are used directly by human users, user study was an essential part of this research area. The complexity involved in user study is caused by the differences of types of users with different levels of knowledge, skills, age, interests, etc. The users at client-side systems need simple and intuitive solutions because security is not their main goals when searching for information (Dang and Dang, 2013). The detailed study of these visualization techniques brought forth the integration of the most effective techniques to create an efficient interface for the young learners.

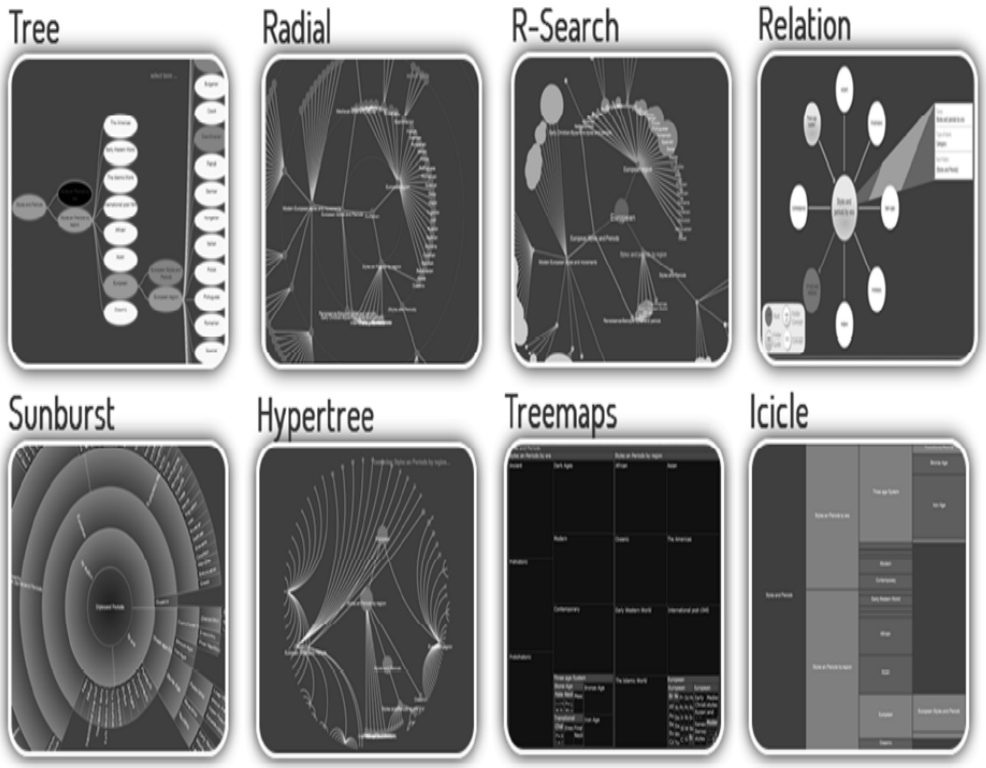


Figure 0-5 Design of interfaces (Garcia,*et al*., 2014).

2.4 The Service Delivery Concept

Education is at the confluence of powerful and rapidly shifting educational, technological and political forces that will shape the structure of the educational systems across the globe. As noted by the UNESCO world education report, the ICTs challenge traditional conceptions of both teaching and learning by configuring how teachers and learners gain access to knowledge. These traditional means of accessing knowledge are more time consuming and are not sufficient to provide quality education as required by the Kenyan government.

According to Dugglebyet *al*., (2004) one of the governments fundamental objective is to ensure that the education sector seeks to harness the power and availability of ICT in its training and development. In the process of using technology effectively, educators need to be trained in using technology and ensure that they develop a good understanding of

the use of ICT materials in service delivering. Technology is used to enhance learning in all institutions in the world and therefore it is important for educators to be comfortable using it to ensure that students get the full advantages of educational technology. Teaching with technology is different from teaching within a typical classroom. Teachers must be trained in how to plan, create, and deliver instruction within a technological setting. It requires a different pedagogical approach. Teachers must find a way to assess students on what they take away from a class and meaningful, known knowledge, especially within an eLearning setting.

The implementation of ICT in primary schools requires the same approach since all ICT skills are directly related to technology. Hence, it is only indispensable to strongly integrate ICT in the learning journey of students who are themodifiers of the present and future society. However, some research argues that in the actual schools, ICT is unsuccessfully integrated in the curriculums (Howell &Lundall, 2000; Ramos, 2010).Computers and relatedtechnologies are increasingly influencing many aspects of our social and work lives as well as many of our leisure activities (Teo,*et al*., 2008) and they have the potential to transform the nature of education.Given that teachers act as the change agent for technology in education (Zhao,*et al*, 2004), it is essential that in-service and pre-service teachers have basic ICT skills and competences. According to UNESCO report, teachers, professors and school administrators should be given basic training that will enable them to integrate ICTs into the teaching programs. With this in mind the provision of ICT skills to teachers in primary schools becomes a paramount issue towards the implementation of ICT in education. The National Information and Communication Technology Strategy for Education and Training recognize that integration of technology to support teaching and learning is necessary to improve learning outcomes and prepare students for the demanding jobs (Oredo, 2008). It is therefore widely accepted that ICT implementation in the current education system will enhance quality teacher education and the use of these ICT equipment to ensure quality service delivery. In fact the question amongst the proponents of ICT use in education is no longer “if” but rather “which” and “how” these technologies can be effectively implemented (Oredo, 2008).

Allan,*et al,*. (2003) studied ICT implementation and school leadership: case studies of ICT integration in teaching and learning. The study shows that the strategy adopted by a school in instituting such change and the resulting variation of pedagogical practices using ICT is strongly dependent on the school leaders' vision and understanding of the role and impact of ICT in the curriculum, their goals and objectives for ICT integration, as well as the history, culture and background of the school and its general vision and mission. Since this leadership rests upon the hand of the teachers in management, then the idea of ensuring strong ICT skills in teachers has becomeone of the main objectives in the education sector.

The Study of Primary Children's Representations of information and communication technologies and approaches to ICT use in primary schools, involving explicit, systematic teaching of ICT skills, may lead to optimal use of scarce government resources. Exploratory use of ICT within open-ended project work, reflecting the kind of use that computer-literate adults make of ICT, might be more likely to provide the context for children's rapid development of a complex range of ICT skills. According to research finding, by Torgersonand Zhu, (2003) the process of learning takes optimal effect when all senses are involved in the process of acquiring knowledge.

ICT changes the characteristics of problems and learning tasks, and hence play an important task as mediator of cognitive development, enhancing the acquisition of generic cognitive competencies as essential for life in our knowledge society.

2.5 Research Gaps

There is no research which has addressed the effective usability visualization techniques in different levels especially for young learners.

There is no effectively developed software which integrates the appropriate usability visualization techniques to be used by young learners for information dissemination.

2.6 Theoretical framework

The independent variables were the four visualization techniques which were analyzed in order to identify and integrate the appropriate visualization techniques for young

learners. The user interface is the depended variable developed from the independent variable after integration as shown in the figure 2.6-1 below. The four usability visualization techniques were analyzed to determine the appropriate one for young leaners. These lead to integration, development and implementation of an appropriate user interface for young learners.

Figure 0-6 Theoretical framework

CHAPTER THREE
METHODOLOGY

3.1 The Research Design

A research designs are the procedures and method which were employed during the actual research. In this research a survey research was conducted in primary schools. Survey research is one of the most important areas of measurement in applied social research. The broad area of survey research encompasses any measurement procedures that involve asking questions to the respondents. A "survey" can be anything forms a short paper-and-pencil feedback form to an intensive one-on-one in-depth interview (Trochim, 2006). In this research, two methods of surveys were conducted. They include questionnaires and interview surveys which were administered to the Kenyan primary school teachers on the appropriate usability visualization techniques for young learners aged three to ten years.

3.2 The Target Population

A population is a complete set of individuals, cases or objects with some common observable characteristics (Mugenda&Mugenda, 2003). It is the total collection of elements about which the study wishes to make some inferences (Carter& Schindler, 2008). This research focused on selected eighteen ICT experts and one hundred and eighty primary school teachers in Kenya. This was done in order to collect primary data with the use of questionnaires and interviews from which an effective user interface was to be constructed to be used by the young learners.The user interface designed after integration of the visualization techniques was tested for enhanced usability by twenty one young learners.

3.3 Sampling Frame

Dencombe, (2007) define a population frame as an object list of the population from which researcher can make his or her selection of samples. It is the source material or

device from which a sample is drawn. It is a list of all those within a population who can be sampled, and may include individuals, households or institutions. This research focused on ICT experts and primary school teachers in the six sub- counties of Makueni County.

3.4 Samples and Sampling Techniques

This research used random sampling in order to select the respondents. In order to give every respondent in the population a chance of being included in the study, purposive random was appropriate in which samples of elements are chosen based on the study for instance subjects are selected because of some unique characteristics they possess.

The researcher used three ICT experts in each sub-county and three teachers from each sampled primary school in the county. Ten primary schools in each of the six sub-counties of Makueniwere randomly selected. According to Mugenda&Mugenda, (2003) a sample size should be economical and representative of the targeted population. In this case the total size wasone hundred and ninety eight respondents.

3.5 Data Collection Procedures

In the data collection, the two major approaches which include quantitative and qualitative were used. Secondary datawas collected from the reports from other developed and developing countries which have adopted the OLPC project, the available curriculum used by the P1 teachers in the Primary Teacher Training Colleges (PTTCs) and any other data that exists from the available sources. Since the curriculum implemented comes from the government through the Ministry of Education, Science and Technology (MOEST) a lot of data was found on the policies governing these institutions. Primarydata was collected from the primary school teachers who are in service in the Kenyan primary schools. This was done using a structured questionnaire which were administered to the respondents.

Qualitative methods of data collection were used in In Depth Interviews (IDI). This was done in order to provide any informal information that would assist in creating the appropriate user interface for young learners. These IDI was conducted from ICT

teachers fromPrimary Teacher Training Colleges (PTTCs). Other ICT experts who were willing to share their knowledge and experience were also considered in this research. They include computer studies teachers in other higher learning institutions and experts from private firms.

3.6 Pilot Test

During this research a pilot study in one sub-county and ten primary schools which fall in the sampled schools in Makueni County was carried out. The inputs from this discussion were added to the questionnaires before distributing them to the respondents.

In order to confirm the validity of the research tool, the questionnaires were carefully examined to confirm proper coverage of the research objectives and to ensure content validity. Two types of validity were addressed and stated regarding to which steps to be taken to assess validity. The face validity looked at the likelihood that a question would be misunderstood or misinterpreted. The pilot study to pre-test the survey instruments enhanced the validity of the research. Content validity saw that the instruments used provided an adequate coverage of the implementation of ICT in service delivery of primary school teachers in Kenya. The use of expert opinions and pretests of open ended questions enhanced both content and face validity.The reliability of the questionnaire was also determined through the pilot study. According to this study a total of thirteen respondents which is 6.6% of sample size was used for pilot testing involving eight likert questions from the questionnaire. Cronbach's Alpha formula was used to estimate the internal consistency of the study tool. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. Cronbach's alpha can be written as a function of the number of test items and the average inter-correlation among the items as shown below.

$$\alpha = \frac{N.C}{V+(N-1).C} \qquad \text{……………………………….. 3.7.1}$$

Where:

N is the number of items,

C is the average inter-item covariance among the items

V equals the average variance: V is 1 for standardized Cronbach's alpha.

Table 3.7-1Questionnaire reliability test summary

Section	Question number	Cronbach's Alpha	Cutoff	Comment
A	3	0.936	0.7	Reliable
A	5	0.806	0.7	Reliable
B	8	0.821	0.7	Reliable
B	9	0.808	0.7	Reliable
C	10	0.787	0.7	Reliable
D	12	0.973	0.7	Reliable
E	15	0.794	0.7	Reliable
F	17	0.968	0.7	Reliable

Table 3.7-1 shows that the Cronbach's Alpha for all items tested was above 0.7, hence the questionnaire reliability was suitable.

3.7 Data Processing and Analysis

All the questionnaires were examined forreliability. The collected data was edited, coded and tabulated using the Statistical Package for Social Sciences (SPSS). Both qualitative and quantitative techniques of analyzing data were used. In qualitative methods content analysis and evaluation of the text materials were involved. Quantitative method involved the use of diagrams such as tables and charts. Inferential statistics was applied

to show whether the analyzed findings and conclusions should be applied to the targeted population. All these measures were used to enhance effective decision making towards the development and implementation of an efficient user interface for young learners in OLPC project to change the pedagogical practices in primary school in Kenya.The data processingidentified tree visualization technique and category visualization technique as the appropriate usability visualization techniques for young learners.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents, data analysis and discusses findings from the research conducted from different primary schools in Makueni county Kenya. The information gathered through questionnaires, was analyzed using statistical methods such as frequency tables, graphs andcronbach's alpha among others in order to find the effective visualization techniques for young learners'efficient user interface creation.The information gathered from the In Depth Interviews was used to validate and enhance reliability of the data collected from the questionnaires. A system was developed through integration of visualization techniques and evaluated on its effectiveness.

4.2 Survey Questionnaire and interview response rate

The study used simple random sampling to select ten primary schools in each sub-county. The researcher administered the instruments where the respondents were available to complete the instrument. In cases where the informants could not give an immediate response, the drop and pick method was used. The use of percentages and averages provided the required measures of summary that reduced the data from onehundred and ninety eight respondents in to a meaningful form. From one hundred and ninety eight administered questionnaires onlyone hundred and seventy five usable questionnaires were returned and analyzed. This represented 88.384% response rate. A total of one hundred and thirty seven respondents were involved in the In-Depth Interview which constitutes to a percentage of 69.19%.

4.3 Demographic analysis of the respondents

In this section, a detailed analysis of the responses obtained from different firms which enhanced the selection of the effective visualization techniques was done. To make the

data representative, the target group was segmented according to gender, age, level of education and work experience in ICT sector.

4.4 Gender distribution

The distribution of the questionnaires was balanced on the gender with at least one third rule emphasized on each. Figure 4.3-1 shows that male respondents were more than female respondents, perhaps an indication that the field of ICT sector is flocked with more male than female due to nature of the work. This representation based on gender is however not subject of the research.

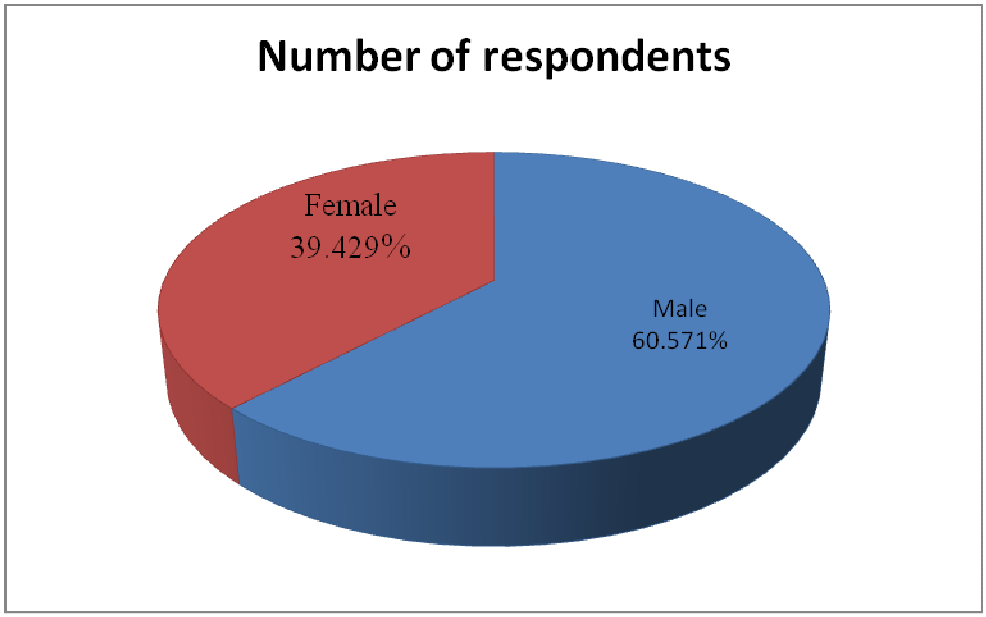


Figure 0-1 Gender distribution graph of the questionnaire respondents

4.5 Age distribution

The data in Table 4.3-1 shows clearly that people of different age groups embrace the adoption of ICTs in primary schools differently. The age distribution tried to capture adults of various age groups. Majority were between 21 and 34 years. This actually justifies that the field of ICT is still young in Kenya and most primary school teachers and ICT experts are not experienced in this field.

Table 0-1 Age distribution of the questionnaire respondents

Years	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 20 years	7	4.000	4.000	4.000
20-34 years	71	40.571	40.571	44.571
35-50 years	58	33.143	33.143	77.714
51-60years	32	18.286	18.286	96.000
Above 60 years	7	4.000	4.000	100.000
Total	**175**	**100.00**	**100.00**	

4.6 Education level distribution

Table 4.3-2represents all levels of education with majority of the respondentsbeing diploma holders and below. This implies that majority of primary school teachers are in possession of P1 certificates and diploma in education.

Table 0-2 education level distribution of the questionnaire respondents

Education level	Frequency	Percent	Valid Percent	Cumulative Percent
Diploma and below	103	58.857	58.857	58.857
Degree	65	37.143	37.143	96.000
Masters and above	7	4.000	4.000	100.000
Totals	**175**	**100.0**	**100.0**	

4.7 Work experience in ICT sector

The data in figure 4.3-2shows that majority of the respondents have work experience of 6-10 years. With that experience this research ensured the comments from the experienced persons were critically put into analysis to enhance creation of an efficient user interface. Lack of many years' experience is an indicator that the field of ICT usage in primary schools lacks experienced personnel who can provide adequate service and also involve themselves in innovative activities in implementing the OLPC project in Kenya.

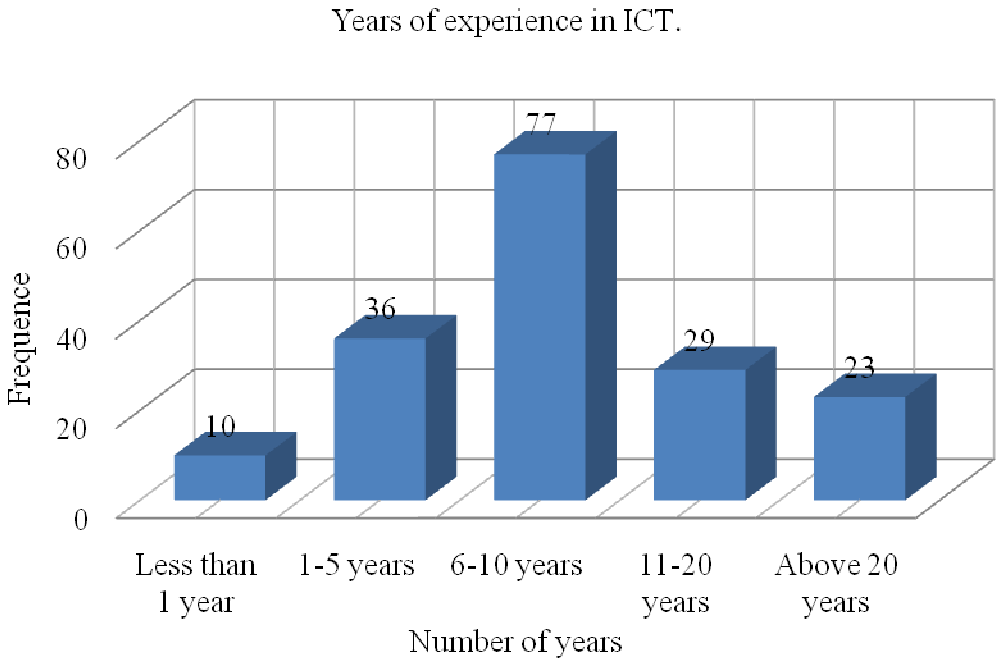


Figure 0-2 Work experience column chart.

4.8 Tree visualization

The respondents' comments on the appropriateness of the use of tree visualization technique in creating user interface for different age groups of learners were tabulated as shown in table 4.4-1 and analyzed in the table 4.4-2.

Table 0-3 Tree visualization results of the questionnaire respondents

AGE IN YEARS FOR THE YOUNG LEARNERS	Tree visualization technique				
	Strongly agree	agree	Not sure	disagree	Strongly disagree
3 – 4 YEARS	12	51	78	26	8
5 – 6 YEARS	18	52	63	28	14
7 - 8 YEARS	63	55	38	12	7
9 - 10 YEARS	89	62	13	5	6

Table 0-4Tree visualization technique appropriateness results

Learners aged 3 and 4 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	12	6.9	6.9	6.9
Agree	51	29.1	29.1	36.0
Not sure	78	44.6	44.6	80.6
Disagree	26	14.9	14.9	95.4
Strongly disagree	8	4.6	4.6	**100.0**
Total	**175**	**100.0**	**100.0**	

Learners aged 5 and 6 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	18	10.3	10.3	10.3
Agree	52	29.7	29.7	40.0
Not sure	63	36.0	36.0	76.0
Disagree	28	16.0	16.0	92.0
Strongly disagree	14	8.0	8.0	**100.0**
Total	**175**	**100.0**	**100.0**	
Learners aged 7 and 8 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	63	36.0	36.0	36.0
Agree	55	31.4	31.4	67.4
Not sure	38	21.7	21.7	89.1
Disagree	12	6.9	6.9	96.0
Strongly disagree	7	4.0	4.0	**100.0**
Total	**175**	**100.0**	**100.0**	
Learners aged 9 and 10 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	89	50.9	50.9	50.9
Agree	62	35.4	35.4	86.3
Not sure	13	7.4	7.4	93.7
Disagree	5	2.9	2.9	96.6
Strongly disagree	6	3.4	3.4	100.0
Total	**175**	**100.0**	**100.0**	

Table 4.4-2 shows that tree visualization technique is appropriate for young leaners. The degree of appropriateness increases with ages from three to ten years. This is an

indication that both single and multiple-treevisualization areeffective for the young learners user interface. The single-tree visualization techniques were recommended for the young learners aged three to five years in the interviews.

The comments on the extend of using tree visualization technique in user interface design to enhance effective usability for young learners were tabulated as shown in table 4.4-3 and analyzed in table 4.4-4.

Table 0-5 Tree visualization usability results

S.NO	COMPONENTS	TREE VISUALIZATION TECHNIQUE				
		Excellent	Good	Fair	Poorly	Very poor
1.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.	82	74	4	11	4
2.	**Efficiency**: Quick use of the design to perform basic tasks.	73	68	13	11	10
3.	**Memorability**: Ease of proficiency re-establishment.	70	77	15	8	5
4.	**Errors**: Susceptibility to and recovery from errors.	64	78	6	16	11
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.	85	81	4	1	4
6.	**Utility**: Design's functionality and full satisfaction of user needs.	61	105	5	2	2

Table 0-6 Tree visualization usability enhancement results

Ease to accomplish basic tasks during the first time they encounter the design.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	82	46.9	46.9	46.9
Good	74	42.3	42.3	89.1
Fair	4	2.3	2.3	91.4
Poor	11	6.3	6.3	97.7
Very Poor	4	2.3	2.3	**100.0**
Total	**175**	**100.0**	**100.0**	
Quick use of the design to perform basic tasks.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	73	41.7	41.7	41.7
Good	68	38.9	38.9	80.6
Fair	13	7.4	7.4	88.0
Poor	11	6.3	6.3	94.3
Very Poor	10	5.7	5.7	**100.0**
Total	**175**	**100.0**	**100.0**	
Ease of proficiency re-establishment.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**

Excellent	70	40.0	40.0	40.0
Good	77	44.0	44.0	84.0
Fair	15	8.6	8.6	92.6
Poor	8	4.6	4.6	97.1
Very Poor	5	2.9	2.9	100.0
Total	**175**	**100.0**	**100.0**	
Susceptibility to and quick recovery from errors.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	64	36.6	36.6	36.6
Good	78	44.6	44.6	81.1
Fair	6	3.4	3.4	84.6
Poor	16	9.1	9.1	93.7
Very Poor	11	6.3	6.3	100.0
Total	**175**	**100.0**	**100.0**	
Pleasant to use the design and address the set goals and objectives.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	85	48.6	48.6	48.6
Good	81	46.3	46.3	94.9
Fair	4	2.3	2.3	97.1
Poor	1	.6	.6	97.7
Very Poor	4	2.3	2.3	100.0
Total	**175**	**100.0**	**100.0**	

Design's functionality and full satisfaction of user needs.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	61	34.9	34.9	34.9
Good	105	60.0	60.0	94.9
Fair	5	2.9	2.9	97.7
Poor	2	1.1	1.1	98.9
Very Poor	2	1.1	1.1	100.0
Total	**175**	**100.0**	**100.0**	

The table 4.4-4 shows that tree visualization enhances optimal user interaction by addressing six basic quality components associated with usability. The minimum percentage of those in agreement was 80.57% for the quick use of the design to perform basic tasks and how effective the design is address the set goals and objectives.A maximum of 94.86% was obtained in the design's functionality and how well the users are getting full satisfaction of their needs.

4.9 Radial visualization

The respondents' comments on the appropriateness of the use of radial visualization technique in creating user interface for different age groups of learners were tabulated as shown in table 4.5-1 and analyzed in table 4.5-2.

Table 0-7radial visualization results of the questionnaire respondents

AGE IN YEARS FOR THE YOUNG LEARNERS	Radial visualization technique				
	Strongly agree	agree	Not sure	disagree	Strongly disagree
3 – 4 YEARS	27	17	5	74	52
5 – 6 YEARS	32	19	9	77	38
7 - 8 YEARS	56	42	23	38	16
9 - 10 YEARS	84	53	21	12	5

Table0-8 Radial visualization technique appropriateness results

Learners aged 3 and 4 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	27	15.4	15.4	15.4
Agree	17	9.7	9.7	25.1
Not sure	5	2.9	2.9	28.0
Disagree	74	42.3	42.3	70.3
Strongly disagree	52	29.7	29.7	100.0
Total	**175**	**100.0**	**100.0**	

Learners aged 5 and 6 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	32	18.3	18.3	18.3
Agree	19	10.9	10.9	29.1
Not sure	9	5.1	5.1	34.3
Disagree	77	44.0	44.0	78.3
Strongly disagree	38	21.7	21.7	100.0
Total	**175**	**100.0**	**100.0**	
Learners aged 7 and 8 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	56	32.0	32.0	32.0
Agree	42	24.0	24.0	56.0
Not sure	23	13.1	13.1	69.1
Disagree	38	21.7	21.7	90.9
Strongly disagree	16	9.1	9.1	100.0
Total	**175**	**100.0**	**100.0**	
Learners aged 9 and 10 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	84	48.0	48.0	48.0
Agree	53	30.3	30.3	78.3
Not sure	21	12.0	12.0	90.3
Disagree	12	6.9	6.9	97.1
Strongly disagree	5	2.9	2.9	100.0

Total	**175**	**100.0**	**100.0**	

Table 4.5-2 shows that radial visualization technique is fairly appropriate for young leaners. The degree of appropriateness is increasing with ages from three to ten years. This is an indication that radial interface, radial search and relation interface techniques are fairly effective for the young learners user interface but they may be effective for learners above ten years of age. Relation interface visualization techniques were recommended for the young learners above five years in the interviews.

The comments on the extend of using radial visualization technique in user interface design to enhance effective usability for young learners were tabulated as shown in table 4.5-3 and analyzed in table 4.5-4.

Table 0-9 Radial visualization usability

S.NO	COMPONENTS	RADIAL VISUALIZATION TECHNIQUE				
		Excellent	Good	Fair	Poorly	Very poor
1.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.	46	37	26	42	24
2.	**Efficiency**: Quick use of the design to perform basic tasks.	35	51	22	36	31
3.	**Memorability**: Ease of proficiency re-establishment.	48	35	27	38	27
4.	**Errors**: Susceptibility to and recovery from errors.	40	38	33	42	22
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.	44	42	25	35	29
6.	**Utility**: Design's functionality and full	43	34	32	39	27

	satisfaction of user needs.					

Table 0-10 Radial visualization usability enhancement results

Ease to accomplish basic tasks during the first time they encounter the design.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	46	26.3	26.3	26.3
Good	37	21.1	21.1	47.4
Fair	26	14.9	14.9	62.3
Poor	42	24.0	24.0	86.3
Very Poor	24	13.7	13.7	100.0
Total	**175**	**100.0**	**100.0**	
Quick use of the design to perform basic tasks.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	35	20.0	20.0	20.0
Good	51	29.1	29.1	49.1
Fair	22	12.6	12.6	61.7
Poor	36	20.6	20.6	82.3
Very Poor	31	17.7	17.7	100.0
Total	**175**	**100.0**	**100.0**	
Ease of proficiency re-establishment.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	48	27.4	27.4	27.4

Good	35	20.0	20.0	47.4
Fair	27	15.4	15.4	62.9
Poor	38	21.7	21.7	84.6
Very Poor	27	15.4	15.4	100.0
Total	**175**	**100.0**	**100.0**	
Susceptibility to and quick recovery from errors.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	40	22.9	22.9	22.9
Good	38	21.7	21.7	44.6
Fair	33	18.9	18.9	63.4
Poor	42	24.0	24.0	87.4
Very Poor	22	12.6	12.6	100.0
Total	**175**	**100.0**	**100.0**	
Pleasant to use the design and address the set goals and objectives.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	44	25.1	25.1	25.1
Good	42	24.0	24.0	49.1
Fair	25	14.3	14.3	63.4
Poor	35	20.0	20.0	83.4
Very Poor	29	16.6	16.6	100.0
Total	**175**	**100.0**	**100.0**	

Design's functionality and full satisfaction of user needs.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	43	24.6	24.6	24.6
Good	34	19.4	19.4	44.0
Fair	32	18.3	18.3	62.3
Poor	39	22.3	22.3	84.6
Very Poor	27	15.4	15.4	100.0
Total	**175**	**100.0**	**100.0**	

The table 4.5-4 shows that radial visualization enhances moderately effective user interaction by fairly addressing the six basic quality components associated with usability. The minimum percentage of those in agreement was 44.00% for the design's functionality and how well the users are getting full satisfaction of their needs. A maximum of 49.14% was obtained in quick use of the design to perform basic tasks and how pleasant and effective the design is in address the set goals and objectives.

4.10 Hyperbolic visualization

The respondents' comments on the appropriateness of the use of hyperbolic visualization technique in creating user interface for different age groups of learners were tabulated as shown in table 4.6-1 and analyzed in table 4.6-2.

Table 0-11Hyperbolic visualization results of the questionnaire respondents

AGE IN YEARS FOR THE YOUNG LEARNERS	Tree visualization technique				
	Strongly agree	agree	Not sure	disagree	Strongly disagree
3 – 4 YEARS	2	1	23	56	93
5 – 6 YEARS	1	5	60	25	84
7 - 8 YEARS	4	4	21	74	72
9 - 10 YEARS	19	35	36	64	21

Table 0-12 Hyperbolic visualization technique appropriateness results

Learners aged 3 and 4 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	2	1.1	1.1	1.1
Agree	1	.6	.6	1.7
Not sure	23	13.1	13.1	14.9
Disagree	56	32.0	32.0	46.9
Strongly disagree	93	53.1	53.1	100.0
Total	**175**	**100.0**	**100.0**	

Learners aged 5 and 6 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	1	0.6	0.6	0.6
Agree	5	2.9	2.9	3.4
Not sure	60	34.3	34.3	37.7
Disagree	25	14.3	14.3	52.0
Strongly disagree	84	48.0	48.0	100.0
Total	**175**	**100.0**	**100.0**	
Learners aged 7 and 8 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	4	2.3	2.3	2.3
Agree	4	2.3	2.3	4.6
Not sure	21	12.0	12.0	16.6
Disagree	74	42.3	42.3	58.9
Strongly disagree	72	41.1	41.1	100.0
Total	**175**	**100.0**	**100.0**	
Learners aged 9 and 10 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	19	10.9	10.9	10.9
Agree	35	20.0	20.0	30.9
Not sure	36	20.6	20.6	51.4
Disagree	64	36.6	36.6	88.0
Strongly disagree	21	12.0	12.0	100.0

Total	**175**	**100.0**	**100.0**	

Table 4.6-2 shows that hyperbolic visualization techniques are not appropriate for young learners' user interface, though the degree of appropriateness is directly proportional to the age in years. This is an indication that Sunburst and Hypertreeinterface techniques are not effective for the young learners user interface due to the use of focus and context techniques based on hyperbolic geometry for visualizing and manipulating large hierarchies. Hyperbolic visualization techniques were recommended for the young learners above ten years in the interviews.

The comments on the extend of using hyperbolic visualization technique in user interface design to enhance effective usability for young learners were tabulated as shown in table 4.6-3 and analyzed in table 4.6-4.

Table 0-13 Hyperbolic visualization usability

S.NO	COMPONENTS	HYPERBOLIC VISUALIZATION TECHNIQUE				
		Excellent	Good	Fair	Poorly	Very poor
1.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.	12	5	23	65	70
2.	**Efficiency**: Quick use of the design to perform basic tasks.	8	15	17	86	49
3.	**Memorability**: Ease of proficiency re-establishment.	15	9	20	52	79
4.	**Errors**: Susceptibility to and recovery from errors.	2	6	26	69	72
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.	13	8	31	67	56

6.	**Utility:** Design's functionality and full satisfaction of user needs.	10	9	24	86	46

Table 0-14 Hyperbolic visualization usability enhancement results

Ease to accomplish basic tasks during the first time they encounter the design.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	12	6.9	6.9	6.9
Good	5	2.9	2.9	9.7
Fair	23	13.1	13.1	22.9
Poor	65	37.1	37.1	60.0
Very Poor	70	40.0	40.0	100.0
Total	**175**	**100.0**	**100.0**	
Quick use of the design to perform basic tasks.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	8	4.6	4.6	4.6
Good	15	8.6	8.6	13.1
Fair	17	9.7	9.7	22.9
Poor	86	49.1	49.1	72.0
Very Poor	49	28.0	28.0	100.0
Total	**175**	**100.0**	**100.0**	
Ease of proficiency re-establishment.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	15	8.6	8.6	8.6
Good	9	5.1	5.1	13.7
Fair	20	11.4	11.4	25.1
Poor	52	29.7	29.7	54.9
Very Poor	79	45.1	45.1	100.0
Total	**175**	**100.0**	**100.0**	

Susceptibility to and quick recovery from errors.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	2	1.1	1.1	1.1
Good	6	3.4	3.4	4.6
Fair	26	14.9	14.9	19.4
Poor	69	39.4	39.4	58.9
Very Poor	72	41.1	41.1	100.0
Total	**175**	**100.0**	**100.0**	
Pleasant to use the design and address the set goals and objectives.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	13	7.4	7.4	7.4
Good	8	4.6	4.6	12.0
Fair	31	17.7	17.7	29.7
Poor	67	38.3	38.3	68.0
Very Poor	56	32.0	32.0	100.0
Total	**175**	**100.0**	**100.0**	
Design's functionality and full satisfaction of user needs.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	10	5.7	5.7	5.7
Good	9	5.1	5.1	10.9
Fair	24	13.7	13.7	24.6
Poor	86	49.1	49.1	73.7
Very Poor	46	26.3	26.3	100.0
Total	**175**	**100.0**	**100.0**	

The table 4.6-4 shows that hyperbolic visualization is not effective for creating young learners user interaction.This is due to itspoorquality of addressing the six basic quality components associated with usability. The minimum percentage of those in agreement

was 4.46% due to highersusceptibility and poor recovery from errors. A maximum of 13.71% was obtained in quick use of the design to perform basic tasks.

4.11 Category visualization

The respondents' comments on the appropriateness of the use of category visualization technique in creating user interface for different age groups of learners were tabulated as shown in table 4.7-1 and analyzed in table 4.7-2.

Table 0-15Category visualization results of the questionnaire respondents

AGE IN YEARS FOR THE YOUNG LEARNERS	Categoryvisualization technique				
	Strongly agree	agree	Not sure	disagree	Strongly disagree
3 – 4 YEARS	56	68	12	24	15
5 – 6 YEARS	103	60	5	5	2
7 - 8 YEARS	129	33	8	4	1
9 - 10 YEARS	158	5	9	2	1

Table 0-16 Category visualization technique appropriateness results

Learners aged 3 and 4 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	56	32.00	32.00	32.00
Agree	68	38.86	38.86	70.86
Not sure	12	6.86	6.86	77.71
Disagree	24	13.71	13.71	91.47

Strongly disagree	15	8.57	8.57	**100.0**
Total	**175**	**100.0**	**100.0**	
Learners aged 5 and 6 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	103	58.86	58.86	58.86
Agree	60	34.29	34.29	93.14
Not sure	5	2.86	2.86	96.00
Disagree	5	2.86	2.86	98.86
Strongly disagree	2	1.14	1.14	**100.0**
Total	**175**	**100.0**	**100.0**	
Learners aged 7 and 8 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	129	73.71	73.71	73.71
Agree	33	18.86	18.86	92.57
Not sure	8	4.57	4.57	97.14
Disagree	4	2.29	2.29	99.43
Strongly disagree	1	0.57	0.57	**100.0**
Total	**175**	**100.0**	**100.0**	
Learners aged 9 and 10 years				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Strongly agree	158	90.29	90.29	90.29
Agree	5	2.86	2.86	93.14
Not sure	9	5.14	5.14	98.29
Disagree	2	1.14	1.14	99.43

Strongly disagree	1	0.57	0.57	**100.0**
Total	**175**	**100.0**	**100.0**	

Table 4.7-2 shows that category visualization technique is appropriate for creating young leaners user interface. The degree of appropriateness increases with increase in age. This is an indication that both Treemaps and Iciclesvisualization are effective for the young learners and were recommended for all young learners in the interviews.

The comments on the extend of using category visualization technique in user interface design to enhance effective usability for young learners were tabulated as shown in table 4.7-3 and analyzed in table 4.7-4.

Table 0-17 Category visualization usability

S.NO	COMPONENTS	CATEGORYVISUALIZATION TECHNIQUE				
		Excellent	Good	Fair	Poorly	Very poor
1.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.	102	46	15	6	6
2.	**Efficiency**: Quick use of the design to perform basic tasks.	98	59	9	5	4
3.	**Memorability**: Ease of proficiency re-establishment.	89	70	7	6	3

4.	**Errors**: Susceptibility to and recovery from errors.	112	57	3	1	2
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.	97	61	13	2	2
6.	**Utility**: Design's functionality and full satisfaction of user needs.	105	59	5	3	3

Table 0-18 Category visualization usability enhancement results

Ease to accomplish basic tasks during the first time they encounter the design.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	102	58.3	58.3	58.3
Good	46	26.3	26.3	84.6
Fair	15	8.6	8.6	93.1
Poor	6	3.4	3.4	96.6
Very Poor	6	3.4	3.4	**100.0**
Total	**175**	**100.0**	**100.0**	
Quick use of the design to perform basic tasks.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	98	56.0	56.0	56.0
Good	59	33.7	33.7	89.7
Fair	9	5.1	5.1	94.9

Poor	5	2.9	2.9	97.7
Very Poor	4	2.3	2.3	**100.0**
Total	**175**	**100.0**	**100.0**	
Ease of proficiency re-establishment.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	89	50.9	50.9	50.9
Good	70	40.0	40.0	90.9
Fair	7	4.0	4.0	94.9
Poor	6	3.4	3.4	98.3
Very Poor	3	1.7	1.7	**100.0**
Total	**175**	**100.0**	**100.0**	
Susceptibility to and quick recovery from errors.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	112	64.0	64.0	64.0
Good	57	32.6	32.6	96.6
Fair	3	1.7	1.7	98.3
Poor	1	0.6	0.6	98.9
Very Poor	2	1.1	1.1	**100.0**
Total	**175**	**100.0**	**100.0**	
Pleasant to use the design and address the set goals and objectives.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	97	55.4	55.4	55.4
Good	61	34.9	34.9	90.3
Fair	13	7.4	7.4	97.7
Poor	2	1.1	1.1	98.9

Very Poor	2	1.1	1.1	**100.0**
Total	**175**	**100.0**	**100.0**	
Design's functionality and full satisfaction of user needs.				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Excellent	105	60.0	60.0	60.0
Good	59	33.7	33.7	93.7
Fair	5	2.9	2.9	96.6
Poor	3	1.7	1.7	98.3
Very Poor	3	1.7	1.7	100.0
Total	**175**	**100.0**	**100.0**	

The table 4.7-4 shows that category visualization the most effective for creating young learners user interfaces. This is due to its optimal quality of addressing the six basic quality components associated with usability. The minimum percentage of those in agreement was 84.57% due to the simplicity of accomplish basic tasks during the first they encounter the design. A maximum of 96.57% was obtained in low susceptibility to and fast recovery rate from errors.

4.12 The degree of effective user interface in different visualization techniques.

Both table 4.8-1 and figure 4.9 show that most of the respondents preferred the category visualization technique as the appropriate visualization technique for creating young learners interface with 41.143%. The second best technique was the tree visualization followed by the radial visualization. The least preferred visualization technique was the hyperbolic visualization with only 1.143% response rate.The effectiveness of these techniques was based on the ability of these techniques to enhance usability in creating user interface for young learners. From the In Depth Interviews it was also noted that most of the respondents preferred the category visualization techniques with 43.07% and tree visualization technique with 34.30%.

Table 0-19Degree of effectiveness

Visualization technique	Frequency	Percent	Valid percent	Cumulative percent
Tree	59	33.714%	33.714%	33.714%
Radial	42	24.000%	24.000%	57.714%
Hyperbolic	2	1.143%	1.143%	58.857%
Category	72	41.143%	41.143%	100%

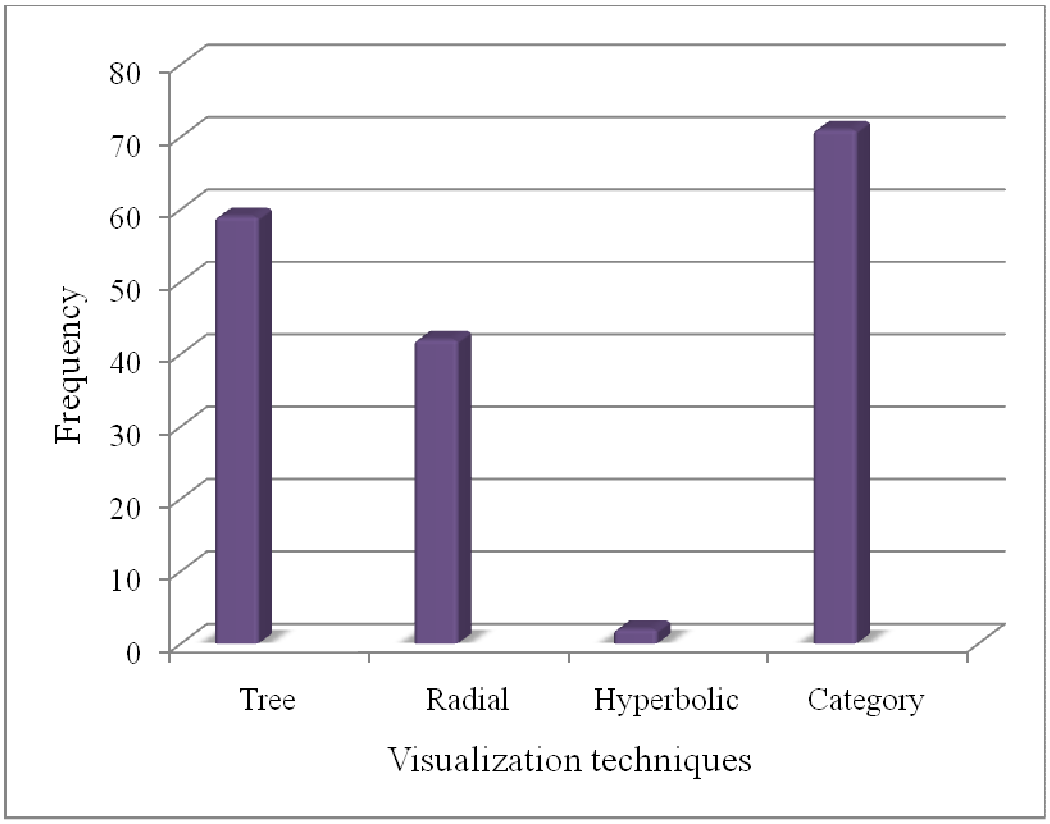


Figure 0-3 visualization technique preference chart

4.13 Integration of visualization techniques

The figure 4.8-2 shows that integrating the most preferred visualization techniques would improve the user interface through addressing the young learners' needs effectively. This is because most of the respondents recommended the integration of the visualization techniques.

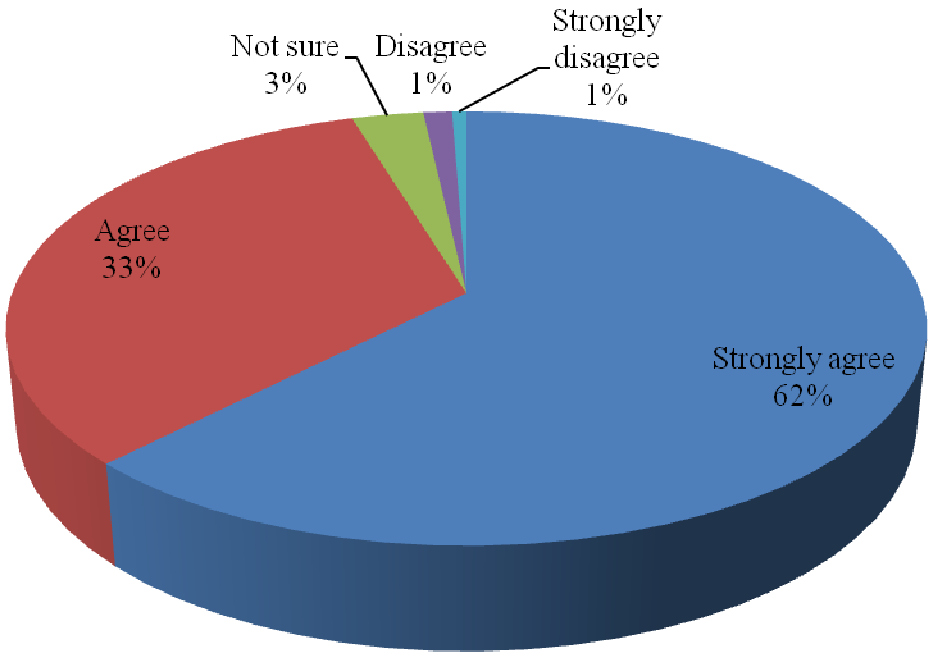


Figure 0-4Preference of integration.

4.14 Dissemination techniques

The figure 4.8-3shows that most of the respondent choose the inbuilt games to be the disseminate technique for the subject content. This is an indication that most young learners would prefer the inbuilt games for optimal concentration and the understanding of the subject matter.

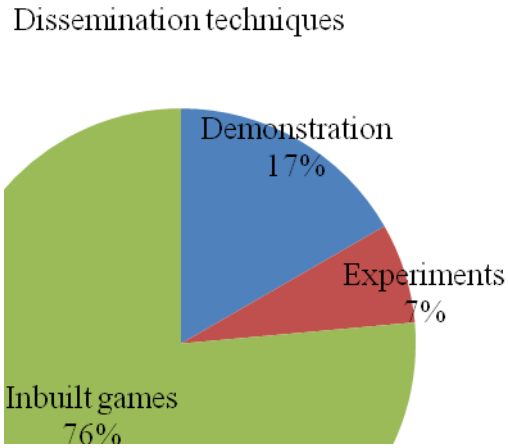


Figure 0-5 Dissemination techniques for user interface.

4.15 Proposed HCI visualization with integration

The proposed user interface was done with the integration of the tree visualization and the category visualization. Tree visualization was highly impressive in the navigation of the user interface by providing quick and easy to use links right from the class interface to subject interface and lastly the content interface where the chapters and their related content were displayed.

The category visualization technique was used in displaying the content in each interface view.The tree map technique which is classified under the category visualization technique was used for the display of the classes in different colors and sizes. The same technique is also used to visualize other view under every class. These views include the subject views and the chapter views as shown in the figure 4.9-1 and figure 4.9-2.

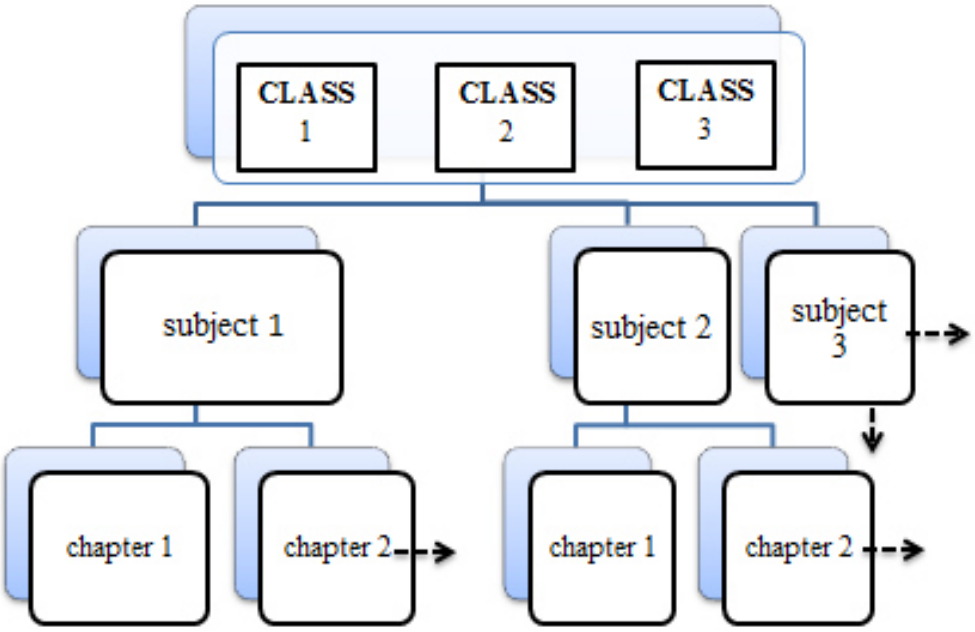


Figure 0-6 proposed user interface with visualization integrated

The figure 4.9-1 above shows the use of tree visualization techniques which is the navigation of the user interface hierarchally from top to the bottom. In such an interface the young learners were in a position to locate for the content with minimal or no assistance at all while taking the least time possible.

Figure 4.9-2 below shows the layout of the views which is using the tree maps to display the classes in blocks, different colors and sizes. In the class display there are three blocks for the class one, two and three. The subject view has all the subjects in each class displayed by a block for each subject. The chapter view has a block for different chapters displayed using the tree map technique. The content view has the blocks for an introduction, body, summary and evaluation displayed with the tree map techniques.

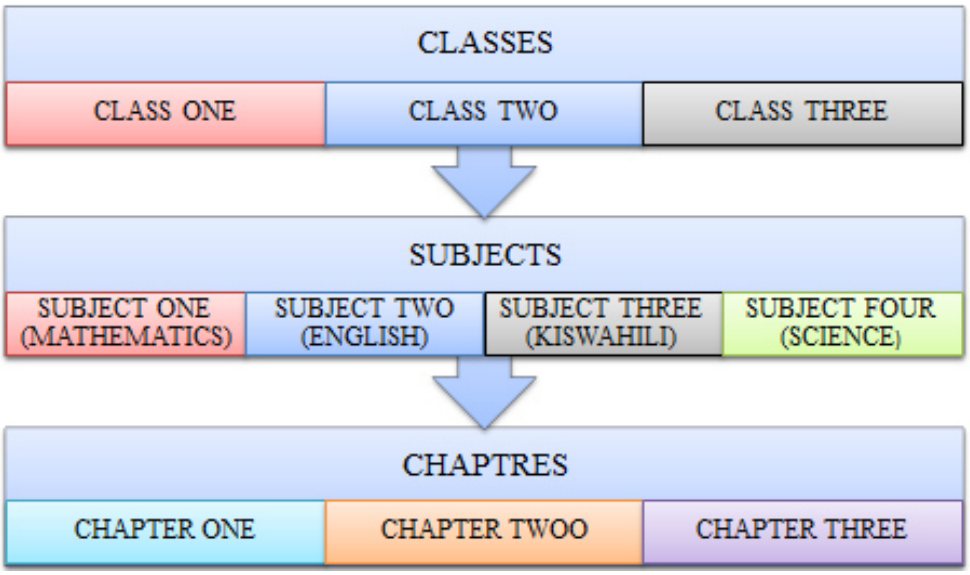


Figure 0-7 proposed user interface layout

4.16 Software requirement analysis

Requirements analysis is the first stage in the systems engineering process and software development process. During this process these three activities were carried out. They include:-

1. Eliciting requirements / requirements gathering. The task of communicating with users to determine what their requirements are was adequately done from different young learners.
2. Analyzing requirements: the act of determining whether the stated requirements are unclear, incomplete, ambiguous, or contradictory in order to resolve the resolving these issues were done.
3. Recording requirements: Requirements were documented in various forms, such as natural language documents, use cases and process specifications to enhance creation of well-documented software.

4.17 System design

4.17.1 Use case diagram

The use case diagram models the functionality of a system using actors and use cases which are services or functions provided by the interface to the young learners.

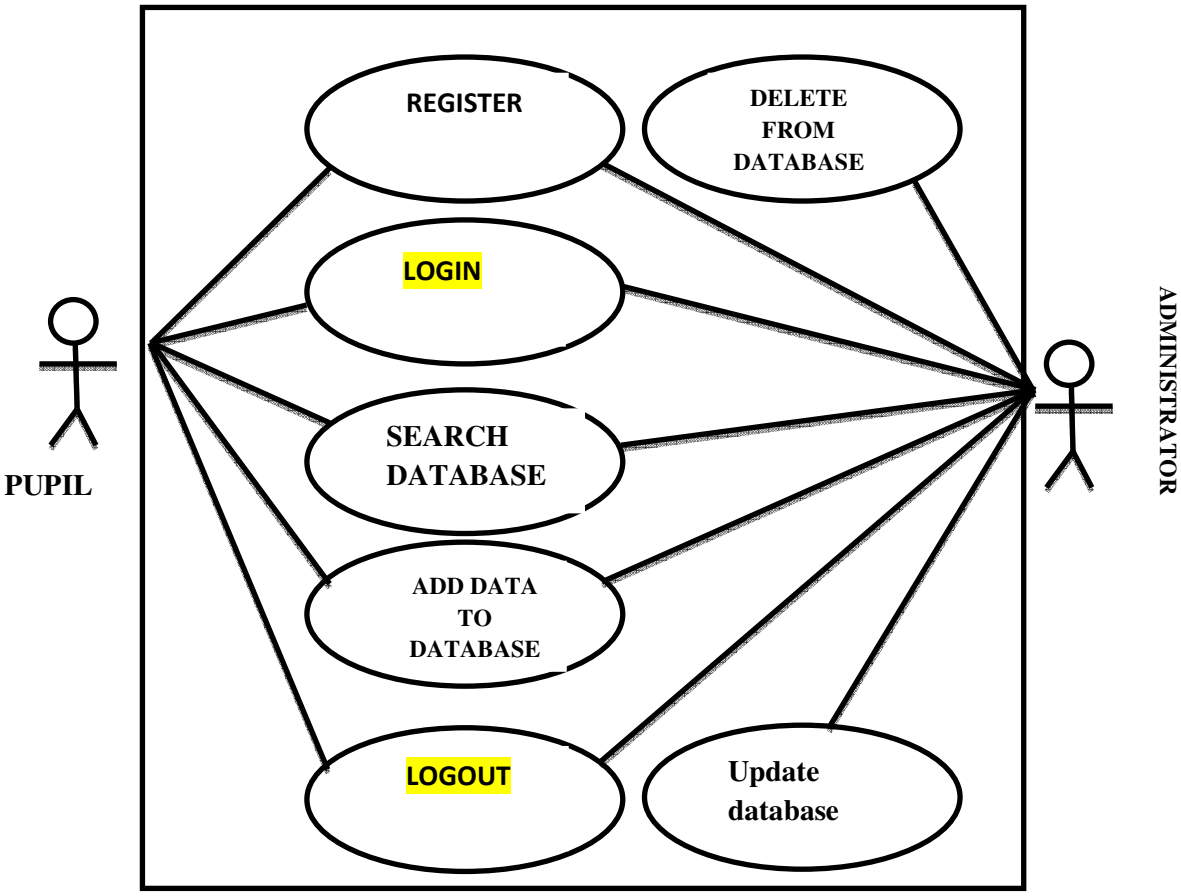


Figure 0-8 Use case diagram one

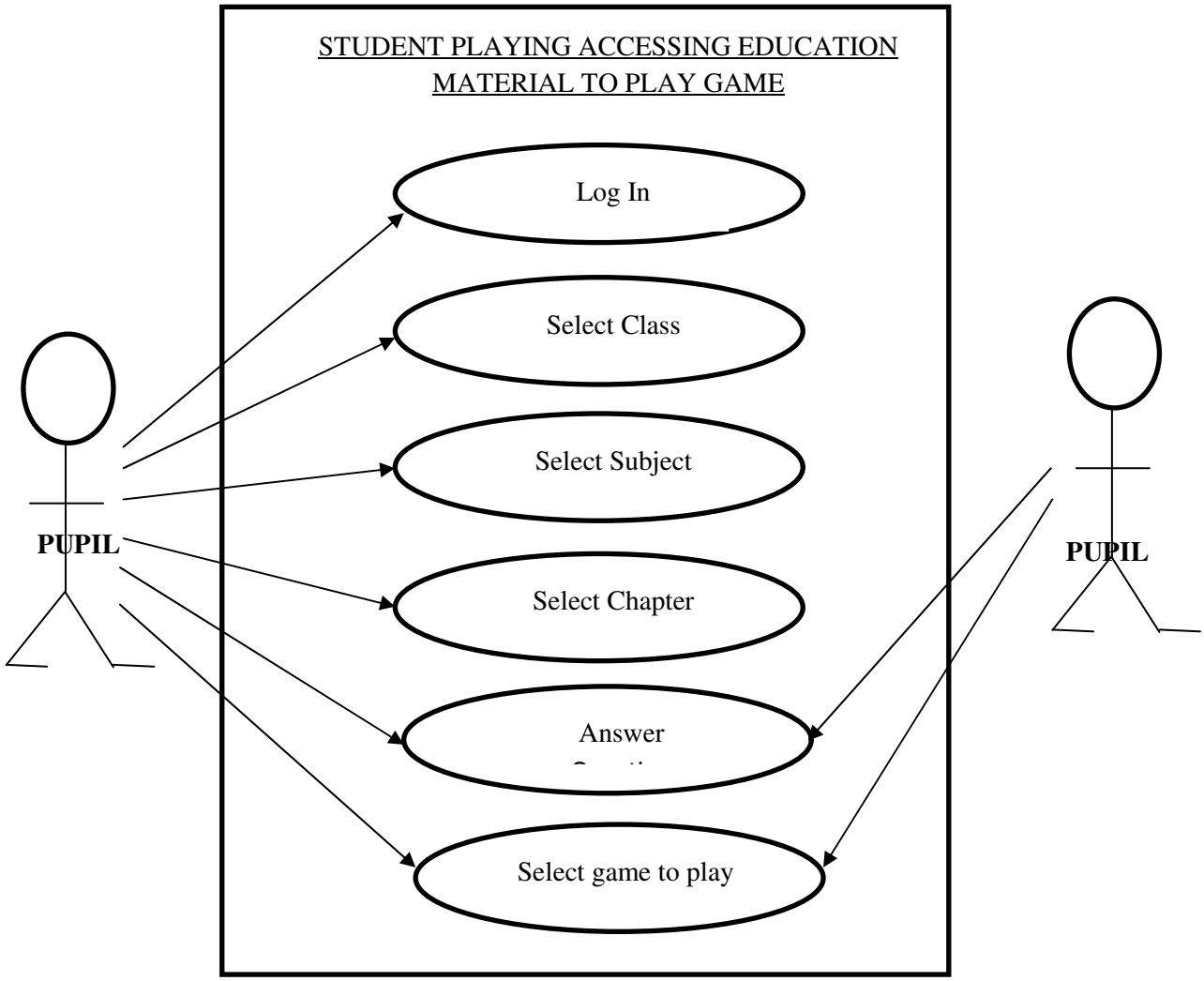


Figure 0-9 Use case diagram two

4.17.2 Class diagram

The class diagramshows the backbone of the interface whichdescribes the static structure of a young learner's user interface system.

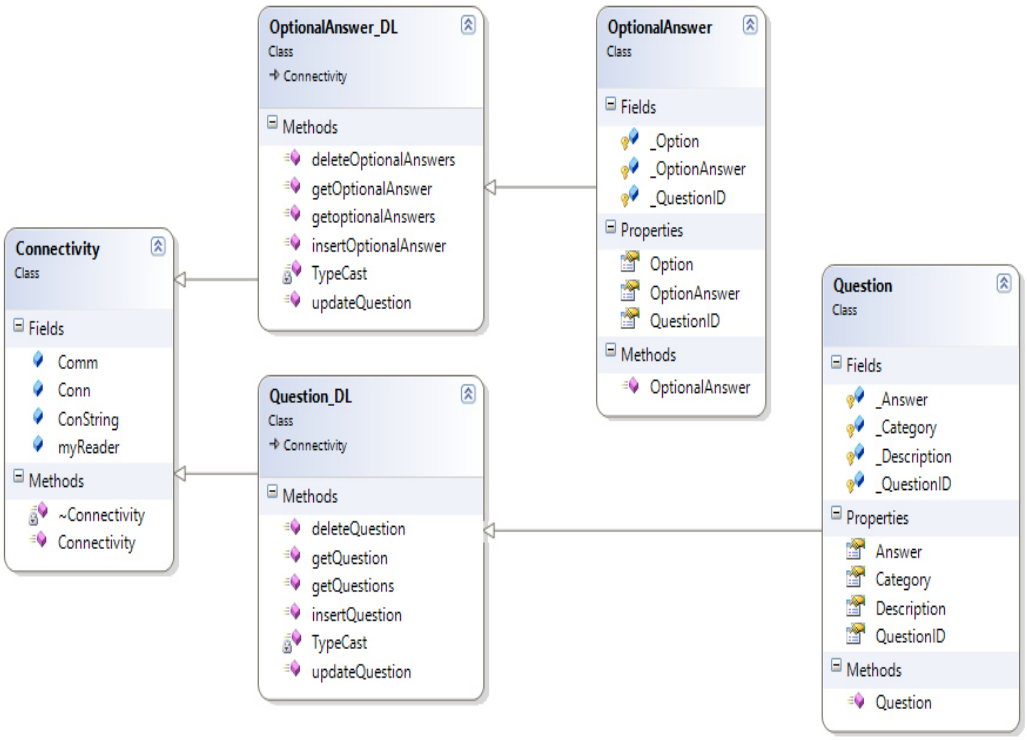


Figure 0-10 class diagram

4.17.3 ERD diagram

An entity relationship diagram (ERD) shows the relationships of entity sets stored in a database which may be one-one, one-many or many to many relationships. An entity in this context is a component of data which will combine with other components to illustrate the logical structure of databases.

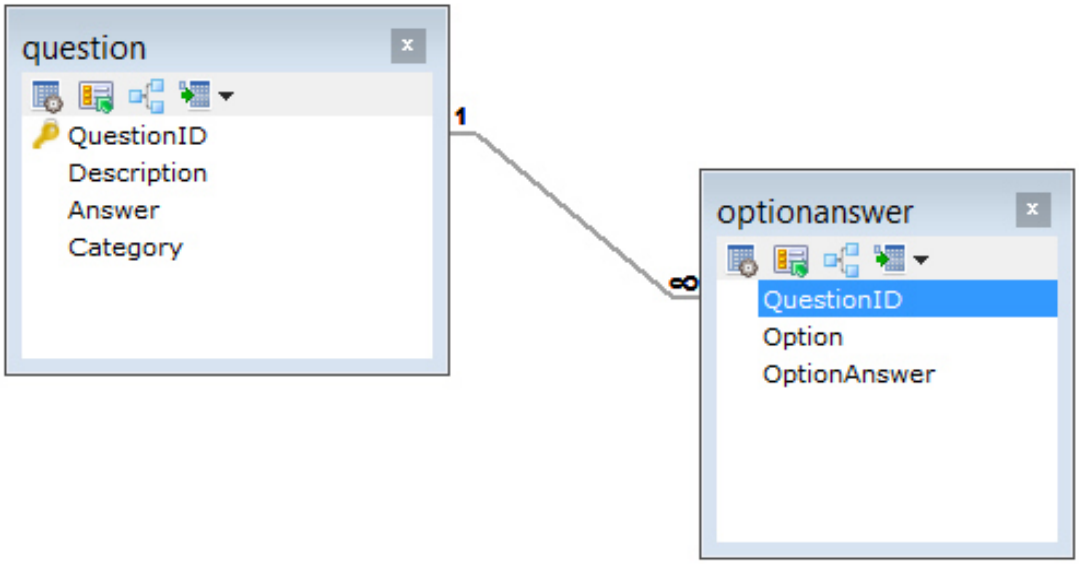


Figure 0-11 One - many relationship.

4.17.4 Sequence diagram

The sequence diagram is a form of interaction diagram which shows objects communicating with which other objects and what messages trigger those communications.

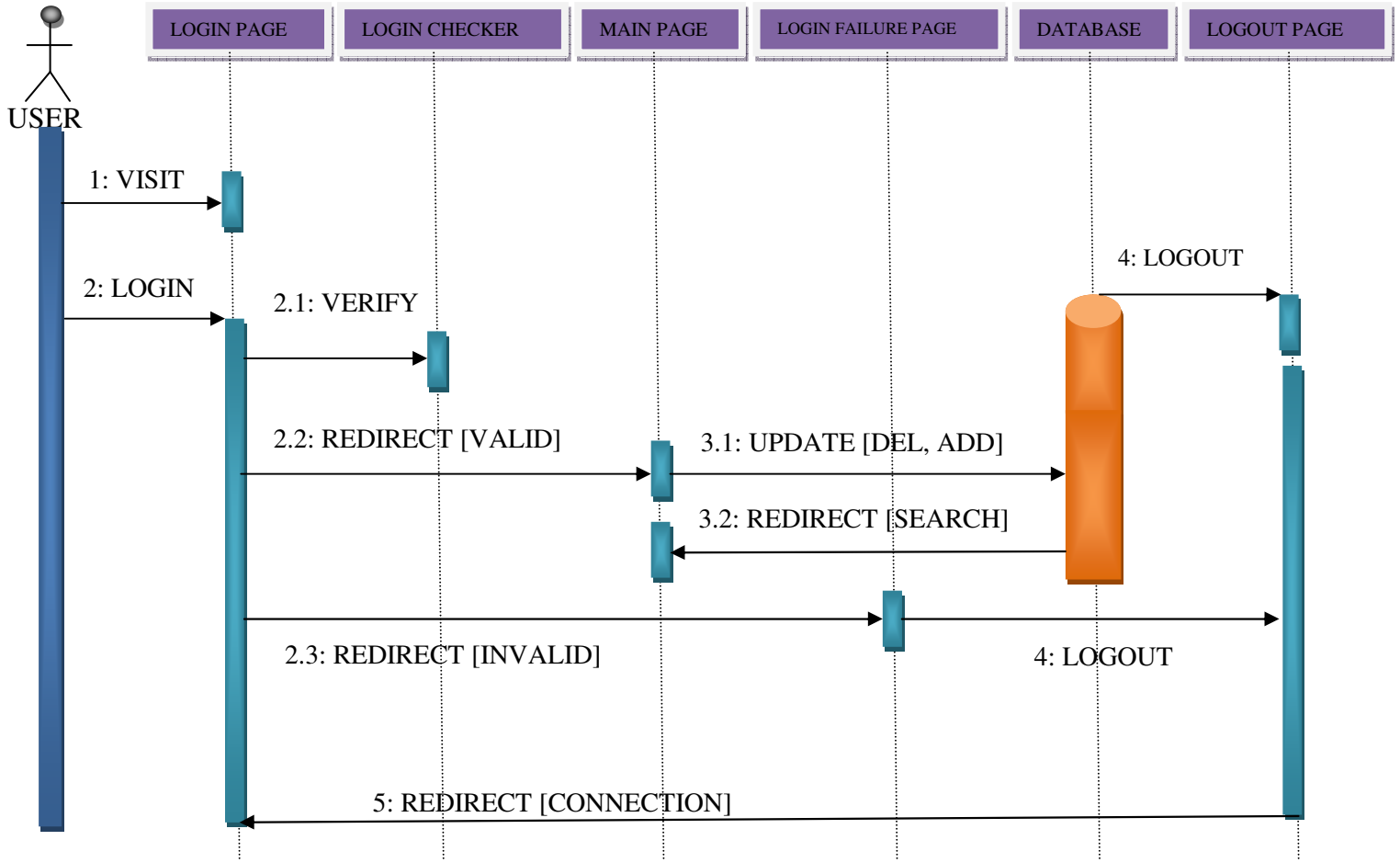


Figure 0-12 Sequence diagram

4.18 Database design

Thisthe process of producing a detailed data model of a database. The logical data model contains all the needed logical and physical design choices and physical storage parameters needed to generate a design in a data definition language, which can then be used to create a database. Many aspects were considered in the design of a piece of the database. This was done to reflect the achievement of the set goals effectively. Some of the considerations were the usability, and maintainability**.**

4.18.1 Login design

The login design has a user name and password to enhance authentication of the user and encourage accessibility to the right users only. The registration of the users will be done by the administrators who will give different rights and privileges to different system users.

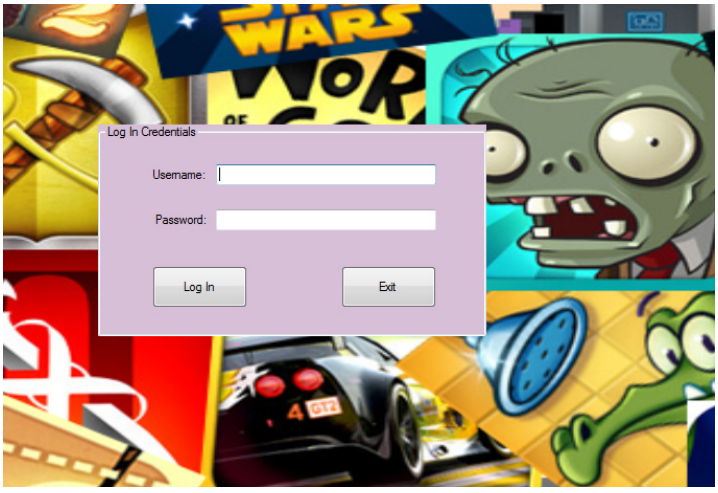


Figure 0-13The log in interface

4.18.2 Class selection design

This is the design which is used by the user to select the content he/she is to interact with during the learning process. The design enhances the selection of a particular class which the user intents to read and take a test for grading. In this design the category visualization technique is used with three categories for selection which include class one, class two and class three.

Figure 0-14The class selection interface

4.18.3 Subject selection design

The leaners will use this design to select the subject to be studied and evaluated. The user navigates through to choose a certain class by clicking on the right class category. This navigation is done through the tree visualization technique which create a link between each class and the subjects. The subjects are displayed on the screen by the use of category visualization technique.

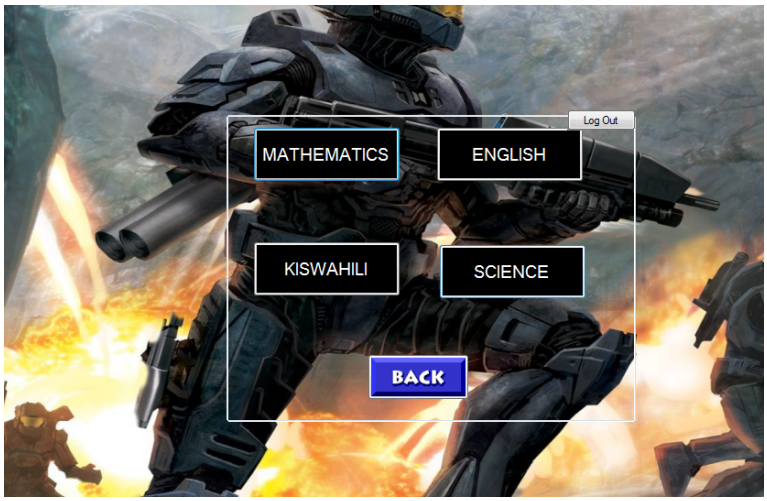


Figure 0-15The subject selection interface

4.18.4 Chapter selection design

Once the subject is selected the user has to choose on a particular topic on the subject. The chapters are displayed using the category visualization which is easy to navigate and comprehend for the young learners.Triangulation are still through the tree visualization technique.

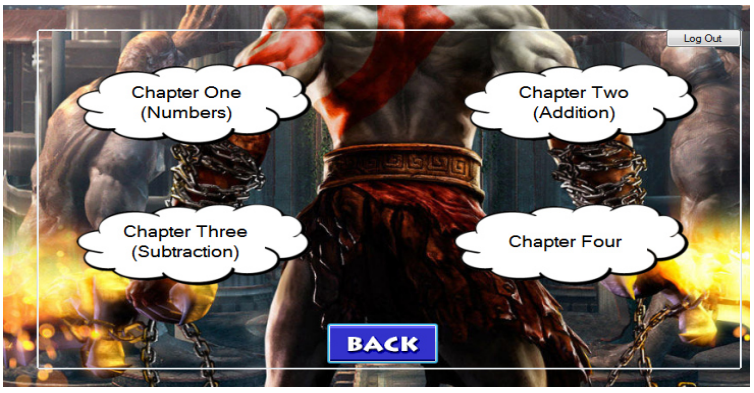


Figure 0-16The chapter selection interface

4.18.5 Quiz/content display

This navigation process through tree visualization will take you to the content interface design where one can select the introduction part using the Button 1 or the full chapter

description using Button 2 or the chapter summary using Button 3. Once this is done the user will take the quiz and get evaluated to qualify for the game selection. For one to qualify a pass mark must be attained in the attempted quiz. In case the pass mark is not attained, the user will not be in a position to play the game at all.

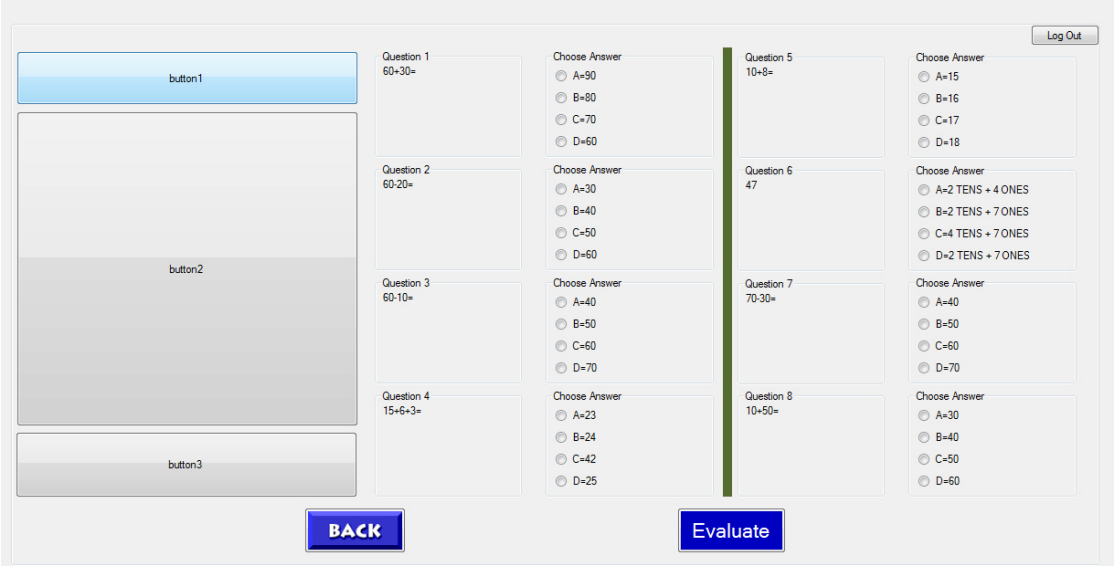


Figure 0-17 Content design

4.19 Testing

This was done to evaluating the attributes or capabilities of the system and determining that it meets its required end user expectations through providing information to the stakeholders on its quality. Through the use of coding and unit tests, software integration tests and user acceptance test techniques these considerations were adequately achieved by the software.

Usability was achieved through focusing on the time and effort used to achieve the results and the user satisfaction.The software user interface created was usable for its target users who are the young leaners. This was through developing a system which was secure and reliable. Default values for the parameters were chosen so that they are a good choice for the majority of the users. The key components of usability were

analyzed and achieved in the developed user interface with the visualization techniques integrated. They include:-

i. Learnability throughan easy to use and convenient in accomplishing the basic tasks the first time the learners encountered the design.

ii. Efficiency through a quick to learn design and learners ability to perform tasks by use of the design or any other related technology.

iii. Memorability though the ability to return to the design after a period of not using it and reestablish proficiency without fail.

iv. Error recovery from the errors which may occur while the young learners are using the system.

v. Satisfaction through a pleasant to use the design and the degree to which the system addresses the set goals and objectives.

vi. Utility by addressing the user needsthrough creating a design with all functionalitiesenhancing users' full satisfaction.

The software developed was tested on the degree of its appropriateness to be used by young learners aged between three to ten years. The data was collected from twenty one young learners selected randomly within the set age group to use both the current system without visualization techniques integrated and the system developed from the research which has techniques integrated the visualization. This was done at Kenya Institute of Curriculum Development by comparing the current system with the developed system which employed the integration of the category and tree visualization techniques.

Table 0-20 Duration of system use by young learners

Average duration in minutes (sec)	**HCI with integrated visualization techniques**	**HCI without integrated visualization techniques**
Average time taken to figure out the interface	84 Seconds	218 Seconds
Average time taken to take control of the interface	212 Seconds	350 Seconds
Average time taken to perform basic tasks	458 Seconds	624 Seconds
TOTAL TIME	**754 Seconds**	**1192 Seconds**

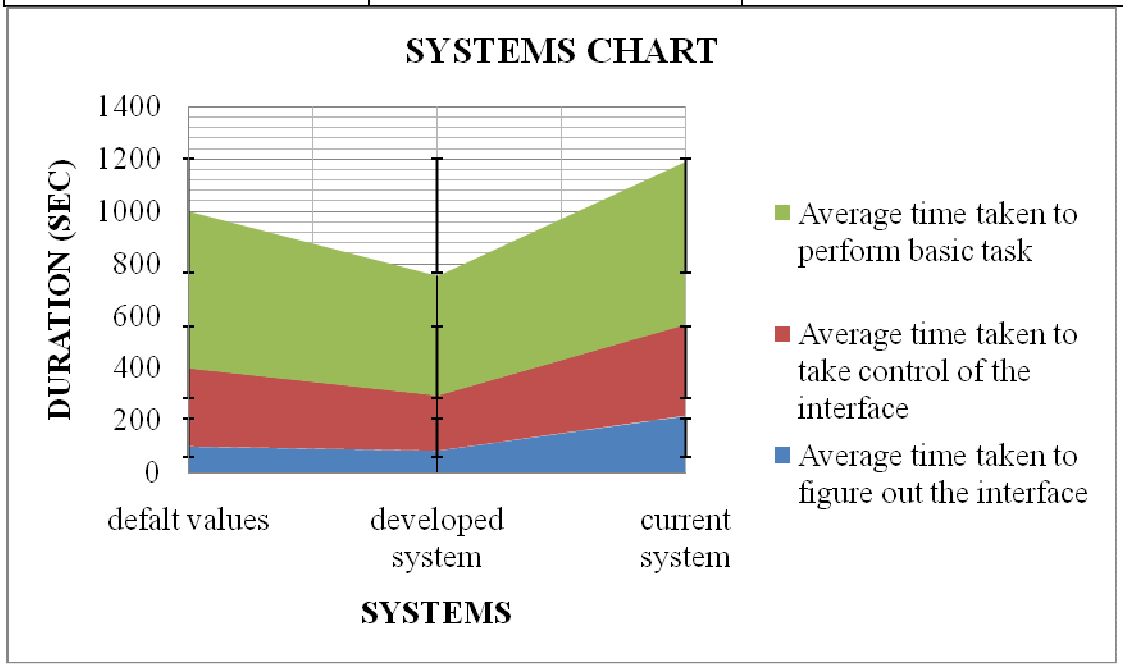


Figure 0-18System duration chart

1 represented Excellently, 2 represented Good, 3 represented Fairly, 4 represented poorly and 5 represented very Poor.

Table 0-21Analysisof HCI with integrated visualization techniques

S.NO	COMPONENTS	HCI with integrated visualization techniques				
		Excellent	Good	fair	poorly	Very poor
1.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.	17	2	2	0	0
2.	**Efficiency**: Quick use of the design to perform basic tasks.	18	2	1	0	0
3.	**Memorability**: Ease of proficiency re-establishment.	20	1	0	0	0
4.	**Errors**: Susceptibility to and recovery from errors.	19	2	0	0	0
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.	20	1	0	0	0
6.	**Total**	**94**	**8**	**3**	**0**	**0**

Table 0-22Analysis HCI without integrated visualization techniques

		HCI without integrated

S.NO	COMPONENTS	visualization techniques				
		Excellent	Good	fair	poorly	Very poor
1.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.	14	3	1	1	2
2.	**Efficiency**: Quick use of the design to perform basic tasks.	12	2	1	3	3
3.	**Memorability**: Ease of proficiency re-establishment.	13	3	1	1	3
4.	**Errors**: Susceptibility to and recovery from errors.	14	2	0	4	1
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.	10	6	2	2	1
6.	**Total**	**68**	**11**	**5**	**11**	**10**

From table 4.17-2 and table 4.17-3 it is shown that the HCI with integration has a 89.5% excellent depiction while the HCI without integration has 64.8% excellent depiction. This is an indication that the integrated approach is more efficient in dissemination of knowledge to the young learners.

CHAPTER FIVE

RECOMMENDATIONS AND CONCLUSIONS

5.1 Introduction

This chapter provides a summary of the findings on how to enhance usability through integrating the effective visualization techniques for young learners in creating efficient user interface. It also provides a summary of how research questions were answered, how objectives were achieved, and what recommendations, future research suggestions and conclusions were made.

5.2 Achievements

The research identified the effective usability visualization techniques and ways of integrating them to create an interface for young learner. These effective usability visualization techniques were integrated in creating the HCI for young learners. With integration a friendly user interface for young learners was developed and evaluated which had the potential of changing the pedagogical practices in young learners' education systems.

5.3 Future research

Future research should be carried out on the levels of appropriateness of the integration of usability visualization techniques in different subject areas. There is also need to carry out a research on appropriateness of integration ofusability visualization techniques for young learners with special needs.

5.4 Conclusions

There are several visualization techniques which can be integrated to enhance usability for different groups of learners. Based on this research the appropriate visualization techniques for young learners are the category visualization techniques and tree visualization. Category visualization will enhance usability through the visual displays

for optimal selection while the tree visualization enhances the ease of use through navigation of the interface. The integration of both category visualization techniques and the tree visualization techniques in creating young learners user interface enhances optimal information dissemination. This ensures optimal usability and effectiveness in implementing anappropriate user interfaces for young learners. All young learners user interface should be designed with integration of both category and tree visualization techniques to enhance optimal usability to change the pedagogical practices in primary schools.

REFERENCES

Babar, M. A., Brown, A. W., & Mistrík, I. (Eds.). (2013). *Agile Software Architecture: Aligning Agile Processes and Software Architectures*. Newnes.

Burch, M. and Diehl, S. (2006) Trees in a Treemaps: Visualizing multiple Hierarchies in *Proceedings of 13th Conference on Visualization and Data Analysis (VDA), San Jose, California* .

Carroll, J. M. (Ed.). (2012). *Creativity and rationale: Enhancing human experience by design* (Vol. 20). Springer Science & Business Media.

Carroll, J. M. (2014). *The neighborhood in the Internet: Design research projects in community informatics*. Routledge.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chainmanagement: moving toward new theory. *International journal of physical distribution & logistics management*, *38*(5), 360-387.

Khanh Dang, T., & Tri Dang, T. (2013).A survey on security visualization techniques for web information systems.*International Journal of Web Information Systems*, *9*(1), 6-31.

Denscombe, M. (2014).*The good research guide: for small-scale social research projects*. McGraw-Hill Education (UK).

Alonso GaonaGarcía, P., Martín-Moncunill, D., Sánchez-Alonso, S., &FermosoGarcía, A. (2014). A usability study of taxonomy visualisation user interfaces in digital repositories. *Online Information Review*, *38*(2), 284-304.

Martin-Moncunill, D., Sanchez-Alonso, S., Gaona, P., &Marianos, N. (2013).Applying visualization techniques to develop interfaces for educational repositories: the case of Organic.Lingua and VOA3R.*Proceedings of the Learning Innovations and Quality: The Future of Digital Resources, Rome*.

Grudin Jonathan, (2012) A Moving Target: The evolution of Human-computer Interaction. In J. Jacko (Ed.), Human-computer interaction handbook: Fundamentals, evolving technologies, and emerging applications. (3rd edition).Taylor and Francis.

Julia Dugglebyet *al*., (2004) Innovative practice in the use of ICT in education and training: learning from the winners: Case study. Journals of education.

Koshman, S. (2004).Comparing usability between a visualization and text-based system for information retrieval.*Journal of Documentation*, *60*(5), 565-580

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Eppler, M. J., &Lengler, R. (2007).Towards a periodic table of visualization methods.In *Proceedings of the 2007 IASTED Conference on Graphics and Visualization in Engineering*.

Mugenda O. and Mugenda M. (2003).*Quantitative and Qualitative approaches. Research methods.*African Centre for Technology Studies.

Oredo J.O. (2008) A framework for evaluating ICT use in teacher education: a case study of primary teacher training colleges in Kenya. Strathmore University.

Ramos, D. (2010). ICT-Integration in Education as a Social Practice in a Post-Conflict Setting: An Analysis of an ICT-Integration in Education Program in ARMM. Asia Pacific College.Dalumat E-Journal. Vol. 1. No. 2

Sandhya M. K. and Sunita M. (2011) Awareness Of Information And Communication Technology And Academic Performance Of Secondary Students - A Comparative Study.Online International Interdisciplinary Research Journal: Volume-I, Issue-II, Nov-Dec2011

Shaer, O. and Hornecker, E. (2010) Tangible User Interfaces: Past, Present, and Future Directions. Boston–Delft: Now Publishersinc.

Stasko, J. and Zhang, E. (2005) Focus + Context Display and Navigation Techniques for Enhancing Radial, Space-Filling Hierarchy Visualizations. Washington, DC, USA: IEEE Computer Society

Trochim, W. (2006) *Research Methods Knowledge Based*(3rd edition). Washington: Atomic Dog.

APPENDICES

APPENDICES I: LETTER OF INTRODUCTION

Date:……..

The Officer in Charge,

……..……..,

P.O Box …….

Kenya.

Dear Sir /Madam,

RE: ACADEMIC RESEARCH PROJECT

I am a master's student at the Jomo Kenyatta University of agriculture and technology conducting a study on enhancing usability through visualization techniques for young learners: a case study of the one laptop per child (OLPC) project in Kenya which will lead to the development of an effective human computer interaction for young learners in our country.

Your institution is/ [you are] among the sampled that/who are meant to facilitate the collection of necessary information for the success of the research. A questionnaire will be used to gather relevant information to address the research objectives. The purpose of writing to you is to kindly grant me permission to administer the research questionnaire to randomly sampled teachers/tutors/ICT experts.

Please note that the study will be conducted as an academic research and the information provided will be treated in strict confidence hence strict ethical principles will be observed to ensure this with no victimization.

Your acceptance will be highly appreciated. Thank you in advance.

Yours faithfully,

Nicholis Mutua.

APPENDICES II: QUESTIONNAIRE
ICT experts/ Primary school teachers' questionnaire.

Section A: General information.

1. Name of firm …….....
2. What is your gender?
   - € Male
   - € female
3. How old are you?
   - € Less than 20 years
   - € 20-34 years
   - € 35-50 years
   - € 51-60years
   - € Above 60 years
4. What is your highest qualification?
   - € Diploma and below
   - € Degree
   - € Masters and above
5. How many years have you been in the ICT/ teaching profession?
   - € Less than 1 year
   - € 1-5 years
   - € 6-10 years
   - € 11-20 years
   - € Above 20 years
6. How many years have you been using computers and related technology?

.....

Section B: Training.

7. Have you ever undergone formal training in Information and Communication Technology (ICT)?
   - € Yes
   - € No

   If **YES** what was your qualification in the training?

   ……

   ……

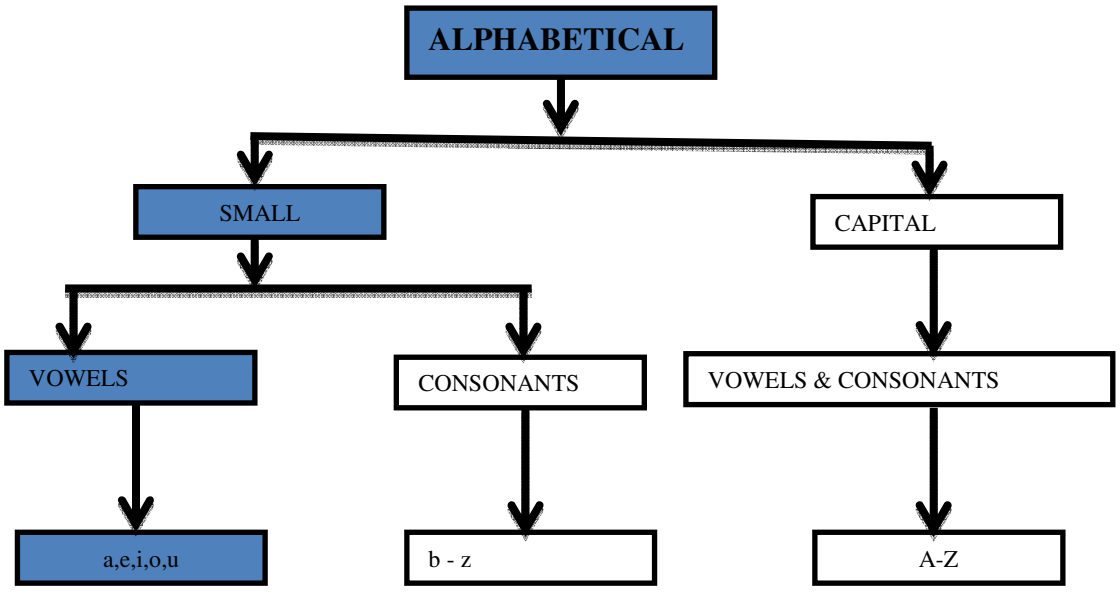
8. Teacher training on ICTs has a great influence on the implementation of One Laptop Per Child (OLPC) project in Kenya? *(Checkin one box).*

Strongly agree ☐ eeNot ☐ Dis ☐ Stror ☐ lisagree ☐

9. How many times do you access computer in a week?
   - € None
   - € 0-5 times
   - € 6-10
   - € 11-20
   - € Above 20

Section C: Tree visualization technique.

Brief introduction [*Tree visualization is a classic type of visualisation implemented to locate resources hierarchically using different level*].



10. Comment on the appropriateness of the use of tree visualization technique in creating user interface for different age groups of learners.
    1 Strongly agree 2Agree 3Not sure 4Disagree 5 Strongly disagree
    Tick the appropriate code (√**).**

AGE (YEARS)	**Tree visualization technique**				
	1	2	3	4	5
3 – 4 YEARS					
5 – 6 YEARS					
7 - 8 YEARS					
9 - 10 YEARS					
Above 10 YEARS					

11. To what extend can these quality components be addressed by the use of tree visualization technique in user interface design to enhance effective usability for young learners.

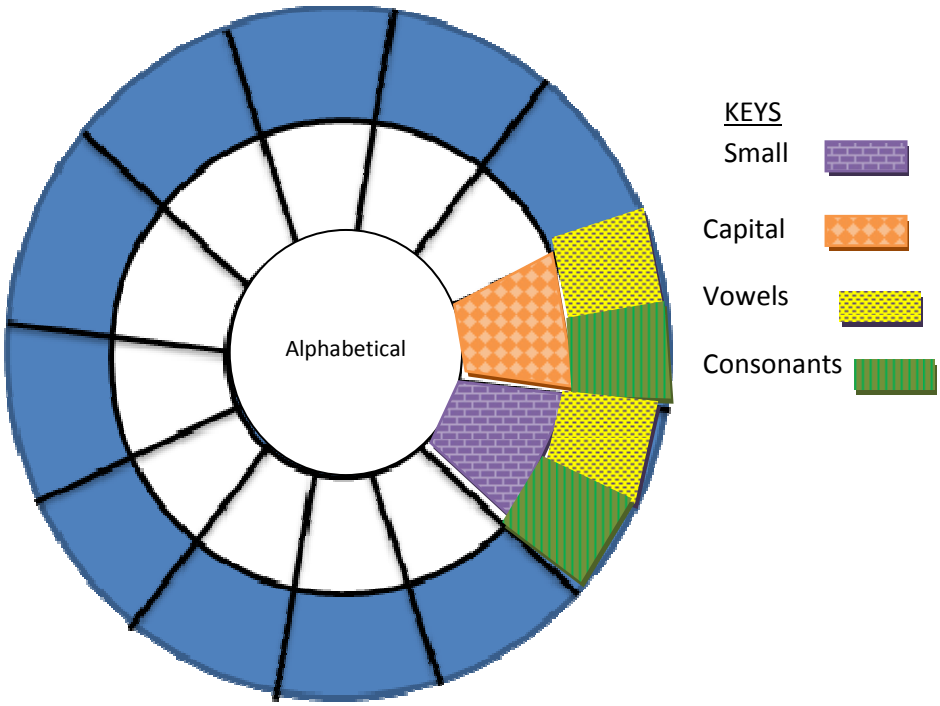
Tick the appropriate code (√) ***[1represents Excellently, 2 represents Good, 3 represents Fairly, 4 represents poorly and 5 represents very Poor.]***

S.NO	**COMPONENTS**	**TREE VISUALIZATION TECHNIQUE**				
		1	2	3	4	5
7.	**Learnability**: Ease to accomplish basic tasks during the first time they encounter the design.					
8.	**Efficiency**: Quick use of the design to					

	perform basic tasks.					
9.	**Memorability**: Ease of proficiency re-establishment.					
10.	**Errors**: Susceptibility to and recovery from errors.					
11.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.					
12.	**Utility**: Design's functionality and full satisfaction of user needs.					

Section D: Radial visualization technique.

Brief introduction [*Radial visualization is a representation using links that identify a navigation structure according to a previously defined classification and placing visual elements along a circle, ellipse, or spiral on the screen.].*



12. Comment on the appropriateness of the use of Radial visualization techniquein creating user interface for different age groups of learners.
1 Strongly agree 2 Agree 3 Not sure 4 Disagree 5 Strongly disagree
Tick the appropriate code (√).

AGE (YEARS)	**Radial visualization technique**				
	1	2	3	4	5
3 – 4 YEARS					
5 – 6 YEARS					
7 - 8 YEARS					
9 - 10 YEARS					
Above 10 YEARS					

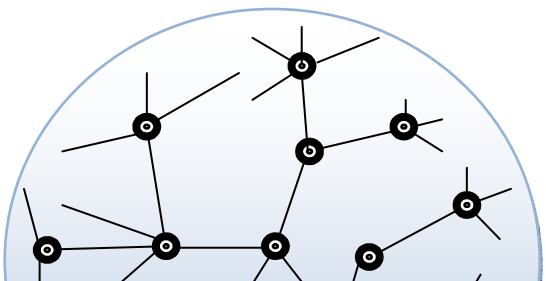
13. To what extend can these quality components be addressed by the use of radial visualization technique in user interface design to enhance effective usability for young learners.

Tick the appropriate code (√).*[**1represents Excellently, 2 represents Good, 3 represents Fairly, 4 represents poorly and 5 represents very Poor.**]*

S. NO	COMPONENTS	RADIAL VISUALIZATION TECHNIQUE				
		1	2	3	4	5
1.	**Learnability**: Ease to accomplish basic tasks during the first they encounter the design.					
2.	**Efficiency**: Quick use of the design to perform basic tasks.					
3.	**Memorability**: Ease of proficiency re-establishment.					
4.	**Errors**: Susceptibility to and recovery from errors.					
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.					
6.	**Utility**: Design's functionality and full satisfaction of user needs.					

Section E: Hyperbolic visualization technique.

Brief introduction [*Hyperbolic visualization interface are radial type structures which emphasize on the use of focus and context techniques based on hyperbolic geometry for visualizing and manipulating large hierarchies.In this visualization technique the nodes in focus are placed in the center and given more room, while the nodes which are out-of-focus are located near the boundaries. During navigation, focusing on a different node brings it and its children to the center of the disk, while uninteresting portions of the tree are compressed again towards the boundaries*].



14. Comment on the appropriateness of the use of hyperbolic visualization techniquein creating user interface for different age groups of learners.
    1 Strongly agree 2 Agree 3 Not sure 4 Disagree 5 Strongly disagree

    Tick the appropriate code (√)**.**

AGE (YEARS)	**Hyperbolic visualization technique**				
	1	2	3	4	5
3 – 4 YEARS					
5 – 6 YEARS					
7 - 8 YEARS					
9 - 10 YEARS					
Above 10 YEARS					

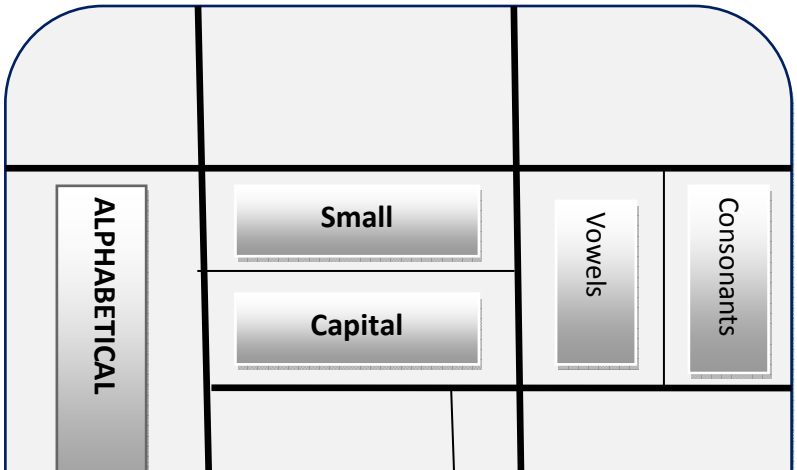
15. To what extend can these quality components be addressed by the use of hyperbolic visualization technique in user interface design to enhance effective usability for young learners.

Tick the appropriate code (√).***[1represents Excellently, 2 represents Good, 3 represents Fairly, 4 represents poorly and 5 represents very Poor.]***

S. NO	COMPONENTS	HYPERBOLIC VISUALIZATION TECHNIQUE				
		1	2	3	4	5
1.	**Learnability**: Ease to accomplish basic tasks during the first they encounter the design.					
2.	**Efficiency**: Quick use of the design to perform basic tasks.					
3.	**Memorability**: Ease of proficiency re-establishment.					
4.	**Errors**: Susceptibility to and recovery from errors.					
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.					
6.	**Utility**: Design's functionality and full satisfaction of user needs.					

Section F: Category visualization technique.

Brief introduction [*Category interface technique display the hierarchical structure of all available spaces on screen by using rectangular slices and displays information hierarchically based on a recursive subdivision workspace rectangular layout*].



16. Comment on the appropriateness of the use of Category visualization techniquein creating user interface for different age groups of learners.

1 Strongly agree 2 Agree 3 Not sure 4 Disagree 5 Strongly disagree

Tick the appropriate code (√)**.**

AGE (YEARS)	Category visualization technique				
	1	2	3	4	5
3 – 4 YEARS					
5 – 6 YEARS					
7 - 8 YEARS					
9 - 10 YEARS					
Above 10 YEARS					

17. To what extend can these quality components be addressed by the use of category visualization technique in user interface design to enhance effective usability for young learners.

Tick the appropriate code (√). ***[1represents Excellently, 2 represents Good, 3 represents Fairly, 4 represents poorly and 5 represents very Poor.]***

S. NO	COMPONENTS	CATEGORY VISUALIZATION TECHNIQUE				
		1	2	3	4	5
1.	**Learnability**: Ease to accomplish basic tasks during the first they encounter the design.					
2.	**Efficiency**: Quick use of the design to perform basic tasks.					
3.	**Memorability**: Ease of proficiency					

	re-establishment.					
4.	**Errors**: Susceptibility to and recovery from errors.					
5.	**Satisfaction**: Pleasant to use the design and address the set goals and objectives.					
6.	**Utility**: Design's functionality and full satisfaction of user needs.					

18. Which visualization techniques would you recommend to enhancing an efficient user interface for young learners in implementing the One Laptop Per Child (OLPC) project in Kenya?
    - € Tree visualization technique.
    - € Radial visualization technique.
    - € Hyperbolic visualization technique.
    - € Category visualization technique.

19. Integration of the efficient visualization techniques will enhance usability in creating young learners user interface for the OLPC project in Kenya. *(Checkin one box).*

Strongly agree ☐ eeNot ☐ Dis ☐ Stron ☐ lisagree ☐

20. How would you disseminate the subject content using the selected visualization techniques?
    - € Through demonstrations.
    - € Through experiments.
    - € Through inbuilt games.

Others (state them)
……
……..……..