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

NicholisMutisyaMutua*

Dr. Wilson cheruiyot*

Dr. Stephen Kimani*

Abstract

The idea of combining the effective visualization techniques to enhance usability among young learners is becoming a problem in human computer interface (HCI). Several visualization techniques have been established for effective user interfaces development. The research is focused on coming up with the effective usability visualization techniques for integration in young learners user interface. A detailed survey research was carried out in all past researches on the usability visualization techniques according to information dissemination. This enhanced identification of the appropriate visualization techniques for young learnersthereby integrated them to develop an efficient user interface for the One Laptop Per Child (OLPC) project in Kenya. The use of questionnaires and interviews were employed to collect primary data in order to supplement the best practices.

Keywords: visualization, techniques, usability, user interface, one laptop per child, information dissemination

* School of Computing and Information Technology; Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya

1. Introduction

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 will focus on the information visualization which deals with the semantic networks of treemaps on information in an HCI setting. Four basic strategies will be used to classify visualization techniques according to hierarchical representations of categories.

2. Structure

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 Human Computer Interaction (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. 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 and 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 (Zehra et al, 2010). Different developing countries have adopted different HCI usability strategies of the OLPC project which have led to partial addressing of their objectives. Kenya is on its first stages of implementing the OLPC project and the success in the project will depend on the adoption and integration of effective and relevant usability visualization techniques.

3. 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. Makueni County 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. In this research, two methods of surveys were conducted. They include questionnaires and interview surveys.

4. Related work

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 HCI. 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 finding and the general scrutiny of these will be put in to 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 the current Kenyan government will be analyzed in order to come up with the best implementation skills to ensure smooth transition from the current systems to the planned ICT equipped systems.

4.1 Usability

According to Carroll, J.M. (2012) 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 and activity provides data to its users for performing their activities without using any specific procedures.

The emergence of collaboration, mobility, and new types of user devices and interactions is a major themes driving HCI beyond the desktop, Shaer and 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).

4.2 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 Alonso (2013) design of interfaces according to visualization techniques can be classified in to four divisions. They include tree which is a classic type of visualisation implemented to locate resources hierarchically using different level, radial which is a representation using links that identify a navigation structure according to a previously defined classification (Herman *et al*., 2000), hyperbola interface displays are radial type structures, whose difference lies in the use of focus and context techniques based on hyperbolic geometry for visualizing and manipulating large hierarchies (Lamping and Rao, 1996) and category type of visualisation is appropriate for handling hierarchies and classifications. According to Yang, *et al*., (1999) the main purpose of this visualisation technique is to solve problems of semantic interoperability.

4.2.1 Tree visualization technique

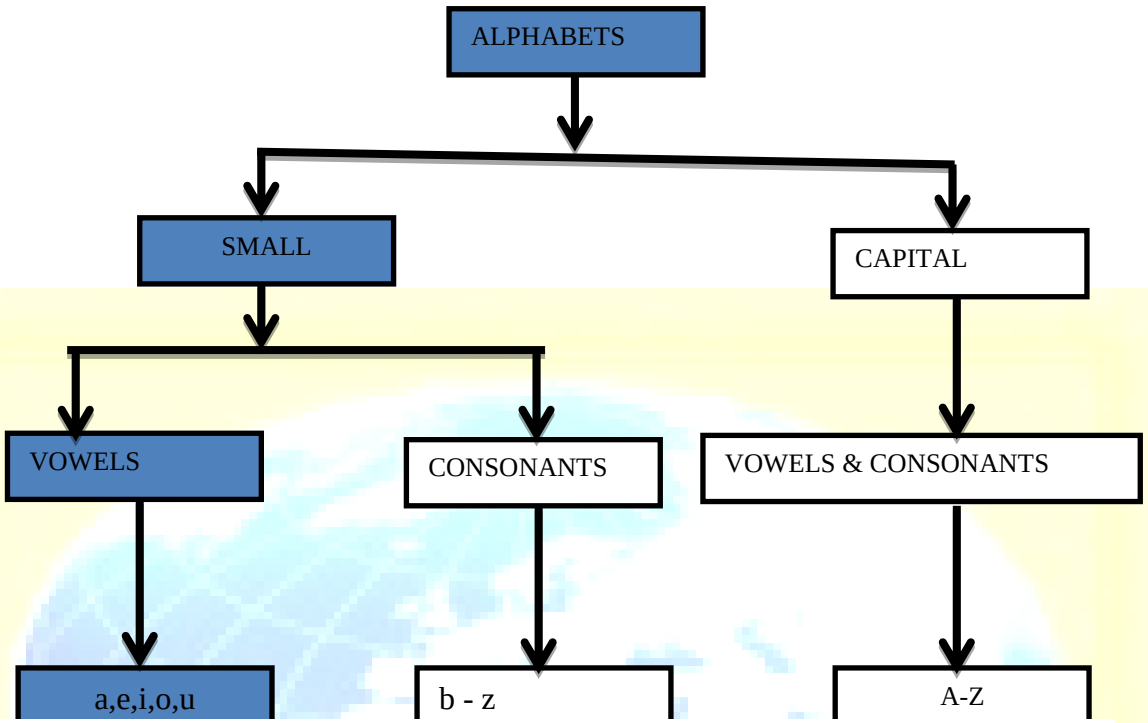

Figure 1 Tree visualization technique

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., 2013). 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 M. and Diehl S. 2006).

4.2.2 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 (Herman *et al.*, 2000). 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. According to (Garcia et al., 2013) this technique can be grouped in to three divisions. They include:-

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 and Sugiyama, 1990) presents nodes in concentric circles according to their depth.

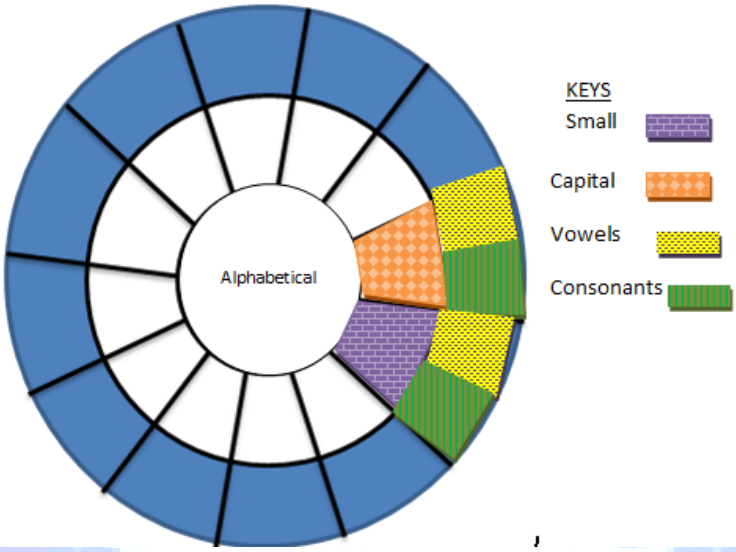

Figure 2 Radial visualization techniques

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.

Relation interface technique is a radial visualisation 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 J. and Zhang E. 2005).

4.2.3 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., 2013). It can be sub divided into two visualisation subtypes:-

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.

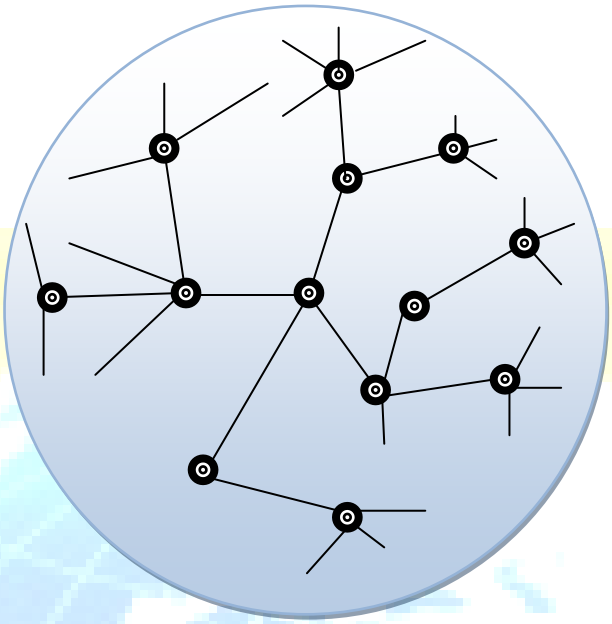

Figure 3 Hyperbolic visualization technique

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. 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 J. and Zhang E. 2005).

4.2.4 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., 2013). It can be divided into two subtypes:-

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.

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.

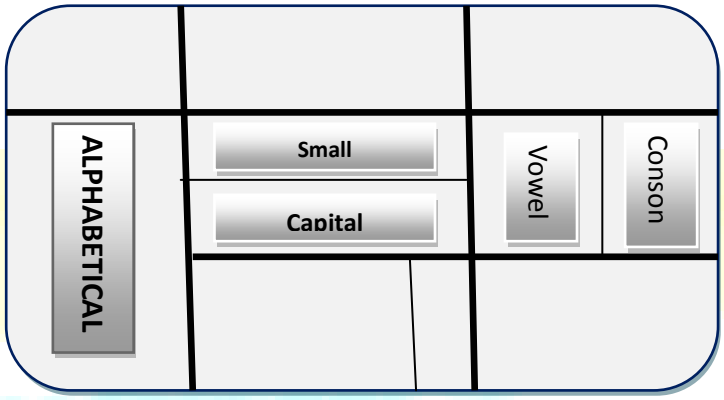

Figure 4 Category visualization technique

Because visualization outputs are used directly by human users, users study is 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 will bring forth the integration of the most effective techniques to create an efficient interface for the young learners.

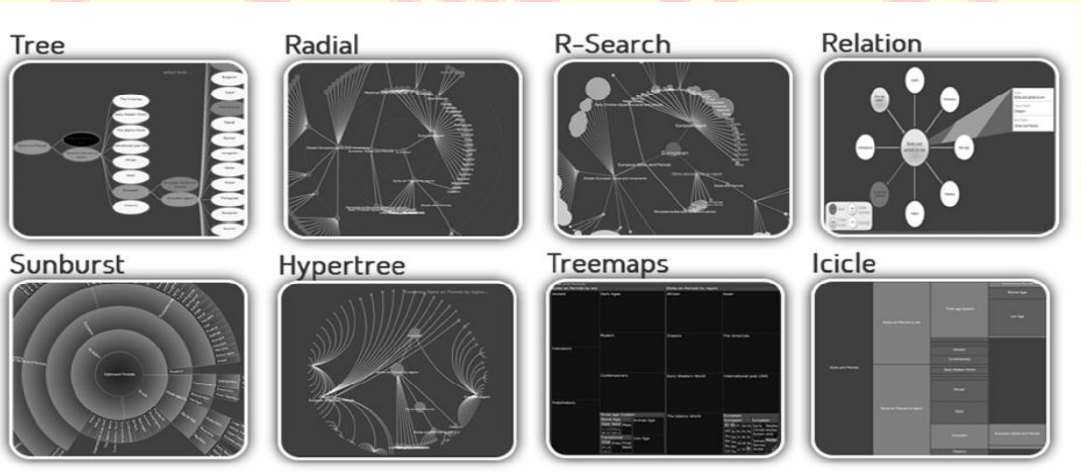

Figure 5 Design of interfaces by Garcia et al., 2013.

5. Integration approach

The degree of effectiveness in user interface createdfrom different visualization techniqueswas tabulated intable 1 and figure 6which shows 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.

Table 1degree 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%

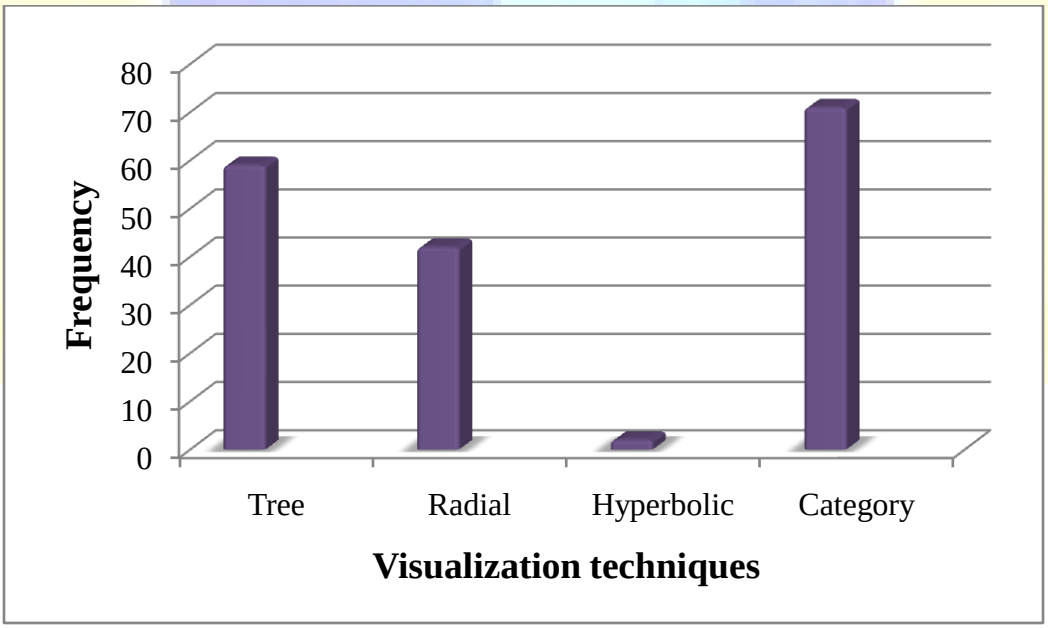

Figure 6Visualization technique preference chart

Conclusions and future work

To go by the results shown by our research the integration of both category visualization techniques and the tree visualization techniques in creating young learners user interface enhances optimal information dissemination. This concept enhances usability and effectiveness in implementing the proposed OLPC project in Kenya. Future work will focus on the effective visualization techniques for other learners and the idea of addressing learners with special needs.

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