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A REVIEW ON USER INTERFACE DESIGN PRINCIPLES TO INCREASE SOFTWARE USABILITY FOR USERS WITH LESS COMPUTER LITERACY

Ali Darejeh and Dalbir Singh

Research Center for Software Technology and Management (SOFTAM),
Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, Malaysia

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ABSTRACT

This article presents a review on how software usability could be increased for users with less computer literacy. The literature was reviewed to extract user interface design principles by identifying the similar problems of this group of users. There are different groups of users with less computer literacy. However, based on the literature three groups of them need special attention from software designers. The first group is elderly users, as users with lack of computer background. The second group is children, as novice users and the third group is users with mental or physical disorders. Therefore, this study intends to focus on the mentioned groups, followed by a comparison between previous researches in the field, which reveals that some commonalities exist between the needs of these users. These commonalities were used to extract user interface design principles such as (a) reducing the number of features available at any given time, (b) avoiding using computer terms, (c) putting customization ability for font, color, size and (d) using appropriate graphical objects such as avatar or icon. Taking these principles into account can solve software usability problems and increase satisfaction of users with less computer literacy.

Keywords: User Interface, Amateur and Novice Users, Elders Software Learnability, Children Software Learnability, Software Usability

1. INTRODUCTION

Software development companies need to release a new version of their products periodically to ensure survivability. However an important issue is whether there is any significant differences between the features of the newer version in comparison with the previous version. It can be said that the most significant changes are on the interface rather than features as it has an important role in software marketability. One of the best examples that could illustrate the influence of user interface on the product marketability is reflected on Microsoft Windows and Microsoft Office. Smith (2010), compared Microsoft Office 2010 with its prior versions and found no significant difference in their abilities and tools. In addition, Grabham (2012) and Paul's study on Windows 7 with Windows 8 showed the same results. It can be concluded that designing user interface is one of the most important aspects in software development process.

These days most people need to work with computer and a large group of them are users with less computer literacy. These kinds of users are users who do not have computer background and working experience with computer. This lack of exposure can be because of users' life-style and age especially among children and elders or because of disabilities that hinder people from working with computer. Lack of computer background can make many learnability difficulties for them in understanding computer software. Therefore, if we want

Corresponding Author: Dalbir Singh, Research Center for Software Technology and Management (SOFTAM),
Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, Malaysia

to expand our computer users to all groups of people we need to consider this important group in software design process. According to Wagner (2002) if the software interface is designed without paying attention to users' ability, it makes users to become confused and creates many difficulties for them to build up a correct conceptual model. It means they cannot understand software structure and they are not able to work with it completely. Therefore, it can be said the software is not usable for them (Wirtz *et al*., 2009). According to Nielsen (2003) a good user interface designer has to try to decrease the complexity of software and produce an environment which makes it easy, efficient and enjoyable to work with. This study consists of four parts: The first part reviews researches on elderly users, as users with lack of computer background. The second part studies researches on children, as novice users and the third part focuses on the user interface design for people with mental and physical disorders. Finally a comparison between the previous researches is performed to extract the user interface design principles for users with less computer literacy.

1.1. Relationship Between Age and Software Interface Preferences

There is a strong relationship between age and software preferences. Each age group has specific needs and specific understanding of software environment. Therefore, we have to discover the needs of each age group and consider their limitations in understanding and working with software. In this part, the characteristics and needs of elder people and children as users with lack of computer background will be analyzed.

1.2. Designing User Interface for Elder Users

This section reviewed the characteristics and user interface design needs of elder people. **Table 1** shows key points of user interface design for elder people.

According to findings of Xie (2003) about elder adults' interactions with computer and the internet, elder people cannot adapt themselves to every user interface design since they do not have any prior experiences in computer from their childhood and learning age, so we should not expect them to learn software like young people with computer background. According to Welie *et al*. (1999) when people grow older, some cognitive changes occur that affect various aspects of their life (Wirtz *et al*., 2009). The changes such as "intelligence, information processing and memory" (Wirtz *et al*., 2009). According to Wirtz *et al*. (2009) elder users need more text support to identify software components and prevent potential errors. Without appropriate feedback, they cannot complete complex tasks successfully on their own. In addition, linguistic messages can help them when they do a complex operational sequence that has some sub-steps.

According to Demiris *et al*. (2004) there is no evidence that elder people resist new technologies. However, they would be more willing to use them if software designers try to design more appropriate interface (Goodman and Lundell, 2005).

Dickinson *et al*. (2005) carried out a study for increasing number of elder internet users, above 60 years old. They conducted the study by developing an email system for elder novice computer users. This system has some characteristic including "simplified interface, reduced clutter on the screen, reduction of terminology, clear and simple navigation paths and a particular type of Help". Their system tries to attract users and encourage them to explore feature and hide the complexity of the functions. From this study, they concluded that to encourage elder people into the computing world, we have to develop an easy user interface while taking into account the above mentioned characteristics.

Sayago and Blat (2010) undertook a research on designing a better e-mail systems and interactive technologies for elder people (above 65 years old). They analyzed needs and cognitive difficulties of elder people and grouped the interaction barriers of an email systems for elder people into five categories. (a) inappropriate and excessive functionality, (b) managing attachments and e-mails, (c) emails organizing problem, (d) perceiving visual input and difficulties remembering steps, (e) terms and icons. Based on these barriers, researchers concluded that elder people need new interface design that is adapted to their learning style and can solve their problems. For example creating an easy layout, using large font, proper icons and easy terms can solve some of their problems.

Table 2 shows elder users' issues and user interface design solutions for solving each respective issue.

1.3. Designing User Interface for Children

This section reviewed the characteristics and user interface design needs of children. **Table 3** shows key points of user interface design for children.

Table 1. Key points of user interface design for elder people

Researchers	Points
(Sayago and Blat, 2010)	Solving elders' problems by creating an easy layout, using large font, proper icons and easy terms.
(Wirtz *et al*., 2009)	In older ages some cognitive characteristics such as intelligence, information processing and memory changes. These changes will be considered in user interface design.
(Dickinson *et al*., 2005)	Designing an appropriate interface for elders by: "Reducing clutter on the screen, reducing terminology, clear and simple navigation paths and particular type of help".
(Demiris *et al*., 2004)	There is no evidence that elder people resist new technologies and do not like to use them. An appropriate interface of software can encourage them to use computer.

Table 2. Elder users' issues and solutions

Elders issues	User interface design solutions
Lack of computer background	• Putting a basic users' guide and help in the software • Reduction of terminology
Cognitive changes	• Reduced clutter on the screen • Clear and simple navigation paths
Memorizing difficulties	• Using similar functions for doing different jobs • Putting descriptive texts and guidelines for tools

Table 3. Key points of user interface design for children

Researchers	Points
(Fang *et al*., 2011)	The best methods for increasing children's concentration is using tangible user interface such as touch devices or using Microsoft Kinect.
(Nielsen, 2010)	(a) Children like animation and sound, (b) Children prefer to see texts with 14 point font size, (c) Children do not like to read text, (d) Children like to try many options.
(Nam, 2010)	(a) Reduce the amount of text, replacing it with a simple picture, icon or voice (b) Reduce the number of components and increase their size (c) Put brief tutorial in software or web site.
(Markopoulos and Bekker, 2003)	An appropriate user interface design is needed to satisfy computer needs of children because they, like adults often use the technology to perform their tasks.
(Grammenos *et al*., 2001)	In user interface design for children, designers should: (a) Use highly visual menus and icons (b) Use animation, sound and message boxes (c) Create an environment that has many guidelines to prevent errors.

According to Markopoulos and Bekker (2003) Children, like adults, often use the technology to perform their tasks. They believe an appropriate user interface design is needed to satisfy computer needs of children. Furthermore, based on the principle of user centered design, there is no proper design for all groups of users. Therefore, designers should develop software based on target user's cognitive ability and considering children as a special group of users (Bekker and Antle, 2011). According to Hutchinson and Bederson (2005) the biggest problem of children is that, all children software are developed by adults and most of them are not familiar with children's skills and their preferences. Therefore, the applications may not be user friendly for children and they may even make some learning difficulties for them.

According to Nielsen (2010), because children's interaction with technology is different depending on their age and cognitive ability, so we must distinguish between young (3-5), mid-range (6-8) and older (9-12) children. His study was carried out by considering childrens between the age of 3 to 12 years old for specific web sites such as Games sites, Media sites, Educational sites, Toys sites and gave them certain specific tasks. The findings of the study showed (a) children like animation and sound, (b) children prefer to see texts with 14 point font size, (c) children do not like to read text, (d) children like to try many options.

Grammenos *et al*. (2001) conduced a research on designing user interface for children by focusing on interaction design process to design dairy software for

kids between 4-8 years old. Their study approved the following claims by previous researchers: (a) we have to use highly visual menus and icons for children to understand the software since young children cannot read (Wilson, 1989; Grammenos *et al*., 2001). (b) "Create an open learning system which can be adapted to children preferences and cultural background" (Jonassen *et al*., 1993; Grammenos *et al*., 2001). (c) Create interactive user interface by using animation, sound and message boxes. (Norman, 1990; Grammenos *et al*., 2001). (d) Create an environment that has many guidelines and can control their input to prevent errors. (e) Design software in a way that it does not need combination keys of mouse and keyboard.

Nam (2010) conducted a research to find out how children would interact with a user interface that let them watch video clips and play interactive games online. Based on the results of the study, he categorized the barriers of working with web site for children between 3 to 5 years old: (a) it is difficult for children to use the web site when page needs scrolling (b) Children do not like to type and prefer to use a mouse, trackball, or track pad rather than the keyboard (c) Doing drag-and-drop function is difficult for children. Based on the children barriers, he gave some suggestions: (a) reduce the amount of or eliminate text, replacing it with a simple picture, icon or voice (b) reduce the number of components and objects like buttons and other clickable elements and increase their size to ensure children can easily click on them (c) design navigation such that, it does not need the arrow keys on the keyboard (d) put some brief tutorial for helping them learn how they have to work with the software or web site.

In contrast, Donker and Reitsma (2005) believe children can use a mouse and we can design software for them like elder people. According to the study, they found young children between ages 6-7 are clearly capable of using a computer mouse. Children can click very accurately on targets of 7mm wide and 12mm tall. In addition, children can do drag-and-drop and it is easier for them to move objects than click-move-click.

According to Fang *et al*. (2011) because children's understanding is limited to understanding the abstract concepts, we should not design a complex user interface for them. We can use some elements like Avatar and 3D objects to increase their attention; also, it is a better idea to use multi-media than single modal for interacting with them. They suggested one of the best methods for increasing children's concentration is using tangible user interface like using Microsoft Kinect.

Table 4 shows children's issues and user interface design solutions for solving their problems.

1.4. Designing User Interface for Solving Accessibility Problems for Users with Physical/Mental Limitations

This section reviewed the accessibility problems of users with physical/mental limitations and interface design solution to help them. **Table 5** shows a key points of user interface design for users with physical/mental limitations.

According to Chapman *et al*. (2009), software or a web page is accessible if it is usable by everybody, irrespective of any physical or mental limitations. Kavcic (2005) categorized accessibility problems into four groups of Mobility impairments, Visual impairments, Hearing impairments, Cognitive impairments. Solving the usability problems of mobility impairment users require special hardware where else users with hearing impairments can use software normally. Therefore, in the following part only the previous researches on Visual and Cognitive impairments will be described since they can be solved with interface design solutions.

1.5. User Interface for People with Visual Impairments

Stephanidis *et al*. (1998) and Chiang *et al*. (2005) gave a number of solutions for alleviating visual impairments problems. These solutions can be used separately or in combination: (a) creating software in the way that could be read easily by screen reader software, (b) putting the ability of zoom in our software, (c) putting speech recognition for interacting with software and (d) Putting customization abilities in software for tailoring font size and color.

Dijana *et al*. (2010) conducted a research on people with disturbance of vision. They focused on color-distinguishing problems and after examining educational software; they suggested that for increasing usability of software for these kinds of users the best solution is using a combination of colors that is distinguishable for these people. Furthermore, designers should not use similar colors next to one another.

Table 4. Children software issues and solutions

Children Issues	User interface design solutions
Limitation for understanding the abstract concepts	Avoid design a complex user interface and try to introduce software tools clearly to children
Reading problem	Reduce the amount of or eliminate text and replace it with a simple picture
Cognitive limitation	• Put tutorial, especially visual tutorial • Clear and simple navigation paths
Mouse controlling problem	Designing software component a little bigger than normal

Table 5. Key points of user interface design for users with physical/mental limitations

Researchers	Points
(Giraud *et al*., 2011)	For blind people each link, button and element on website must have an audio function
(Dijana *et al*., 2010)	Using combination of colors that is distinguishable for color blind people
(Madiah and Hisham, 2010)	Customizable user interface is required for users with partially sight and general design guidelines are not suitable for these people
(Turunen *et al*., 2010)	Combination of speech input and multimodal gestures provides a more efficient and accessible input method than traditional methods for visually impaired users
(Fryia *et al*., 2009)	The best solution for helping people with cognitive disabilities is reducing the number of features available at any given time
(Grynszpan *et al*., 2008)	Patients with autism can learn from a multimedia system if the interface does not need investigation for finding software elements
(Stephanidis *et al*., 1998; Chiang *et al*., 2005)	Solving the problems of visually impaired users by adding a) screen reader and speech recognition for interacting with software, b) Putting customization abilities for font size and color

Madiah and Hisham (2010) carried out a research on people with partially sighted vision, they conducted the study by a prototype of reading application; they examined four types of fonts at various sizes and colors on different background colors. The results of the study indicated that partially sighted children have their own preferences for font type, font size and foreground and background color depend on their vision problem and visual acuity. A good user interface has to consider their preferences and give them some options for selecting font and color. From the findings of this study, they concluded that specific interface design guidelines or a customizable user interface is required and general design guidelines are not suitable for these people.

Turunen *et al*. (2010) carried out a research on multimodal media center interface for people with different levels of visual impairment. For making system accessible, they used a combination of features such as speech input and output, gestures, haptic feedback and a zoom-able graphical interface. To help the blind users, they used both speech output and haptic feedback. They also created zoom-able focus-plus-context interface and combined it with speech output for solving the problem of low vision users. They found that combination of speech input and multimodal gestures provides a more efficient and accessible input method than traditional methods for visually impaired users. The method was justified by the aid of a research carried out by Rice and Fels (2004) who claimed that because it is not possible to define common solutions suitable for all users with vision problems, the interface must be highly Customizable (Turunen *et al*., 2010).

Giraud *et al*. (2011) conducted a research on solving web site usability problems for blind people. Since blind people cannot see web pages elements, they suggested that putting an audio site map could solve their problem. Furthermore, they suggested that each link, button and element on website must have an audio function and must introduce itself to these kinds of users.

Baguma and Lubega (2008) presented a Web Design Framework for improving web site accessibility for blind People. Their framework was based on the three components of Web applications: content, navigation and user interface. In their suggested framework, they suggested that developers have to consider some points for designing a web site for blind people. The most important points are: "(a) Designing web site as text only version (b) text alternative for visual elements (c) synchronized text alternatives for videos (d) descriptive titles/names for web pages, links and headings in relation with their purpose (e) divide long pieces of content into sections with section headings". Furthermore,

Leuthold *et al*. (2008) concluded that for blind users the Enhanced Text user Interface (ETI) is more usable than the Graphical User Interface (GUI).

1.6. User Interface for Solving Cognitive and Learning Disability Problems

Cognitive and Learning Disability (CLD) includes mental retardation, autism, traumatic brain injury, aphasia, dyslexia, alzheimer's disease and attention deficit disorder. According to Friedman and Bryen (2007), "people with CLDs often exhibit deficiencies in attention, memory, perception and problem-solving, which affect the manner in which they interact with computers".

Fryia *et al*. (2009) worked on designing an e-learning system for people with cognitive disabilities, they suggested that for increasing accessibility of these kinds of software the best approach is eliminating features that could cause unnecessary stress and frustration that can create a negative effect on system usability. They reduced software complexity by reducing the number of features available at any given time and by rearranging them to accommodate full functionality. According to Grynszpan *et al*. (2008), a rich interface should try to reduce the complexity of software and increasing users' attention to software abilities. He conducted a research on designing multimedia interface for patients with autism. Results showed that patients with autism can learn from a multimedia system if the interface of a system is simple and do not need investigation for finding elements. **Table 6** shows issues of people with disorders and user interface design solutions for solving their problems.

1.7. Critical Analysis

Comparing previous researches in the area of user interface design reveals that there exists some similarities between the user interface needs of all users with less computer literacy. From these similarities seven principles can be extracted for designing user interface for these users:

- Eliminating features that could cause unnecessary stress and frustration and reducing software complexity by reducing the number of features available at any given time
- Designing interface such that it does not need investigation for finding tools
- Using larger components such as large buttons, combo boxes. Furthermore, using bigger icons and fonts for showing key fucntions of the software
- Avoiding using computer terms and the names that are not familiar to all of users for naming tools
- Putting customization ability for font, color and size, especially for elders, children and people with visual impairments
- Using enough descriptive texts, especially for helping elder and blind people
- Using appropriate graphical objects like avatar or icons for increasing software attraction, especially for children and also for attracting the attention of people with cognitive problems

Although the problems of users with less computer literacy are different but the main similarities between elder, children and people with mental disorders are based on cognitive issues. Therefore, applying these principles could help all the three groups. Putting these principles into action, we can solve software learnability problems and increase satisfaction of users with less computer literacy.

Table 6. Disorder people issues and solutions

Disorders	User interface design solutions
Visual impairments	• Creating software in a way that could be read easily by screen reader software
	• Putting the ability of zoom in software
	• Putting speech recognition for interacting with software
	• Putting an audio map
	• Text alternative for visual elements
Color blinds	• Using a combination of colors that is distinguishable for color blind people
	• Not to use similar colors
	• Putting customization abilities in software for color
Cognitive disability	• Eliminating features that could cause unnecessary stress
	• Reduce software complexity by reducing the number of features available at any given time

2. CONCLUSION

Literature helped to extract principles for users with less computer literacy in the field of user interface design through identifying their similar problems and finding solutions to their usability problems. These principles are: (a) reducing the number of features available at any given time, (b) designing interface such that it does not need investigation for finding tools, (c) using larger components and bigger icons for showing key fucntions of the software, (d) avoiding using computer terms, (e) putting customization ability for font, color and size (f) using enough descriptive texts and (g) using appropriate graphical objects like avatars or icons. Taking these principles into account in software design process can help users with less computer literacy to understand software and web site structure and increase their interest in working with computers. It can be concluded that with considering user interface design principles based on the target users' needs and cognitive abilities, we can solve learnability related problems for different groups of users.

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