EFFECT OF ICON STYLES ON COGNITIVE ABSORPTION AND BEHAVIORAL INTENTION OF LOW LITERATE USERS

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Abstract

Information and communication technologies (ICT) are being considered as one of the most potential medium for bringing more efficient and sustainable solution for many problems faced by different communities belong to the middle of economic pyramid of developing countries. Mobile phone based applications can offer many potential solutions for such problems. Existing solutions which are quite successful at the top of the pyramid user population often prove itself ineffective at the middle of the pyramid naïve low-literate users. In this context interface designers also face considerable challenges due to lack of consolidate icon design methodology which can be adapted for the target user sections. Therefore we propose an empirical study to address the requirement of concrete icon design methodology. Grounded in 'Cognitive Absorption' and 'Theory of Metaphor' we propose a concrete design guidelines specifically for designing icons to ensure instant learning, usage and adaptation of the system for daily usage. A mobile pest management system is developed to bring the real context on which design methodologies and the role of cognitive absorption and metaphor can be examined to identify the most appropriate one. Our preliminary study suggests a comprehensive icon design methodology and its effect on cognitive absorption as well as behavioral intention for low literate novice users.

Keywords: *Iconic Interface, Metaphoric icon, Idiomatic icon.*

1 INTRODUCTION

Information and communication technology brings opportunities and challenges for the emerging market in different developing nations (Heeks 2002).Technological advancement and its multifold proliferation in the form of mobile phone started discovering new user segments and market opportunities instantly (Kumar et al. 2008). As market is targeting more and more low-literate communities of developing countries who initially have very limited exposure to ICT, new challenges are coming up for the interface designers for designing interfaces which ensures instant learnability and use. Although studies have mentioned the importance of interface screen characteristics to user performance and user behavioral intention Hong et al.(2002) indicated the need for testing specific interface characteristics and elements. Especially for novice users with limited text reading capacities, and have no initial exposure to mobile base interactive system, icon base interfaces are very important (Gatsou et al. 2011).

According to Caplin (2001) the advantage of using icons lies in the fact that they are thought to be able to communicate large amount of information quickly and concisely. Icons have more information density as they are more space efficient (Pappachan & Ziefle 2008) than texts. Other potential advantage of icons is they have the capability to cut across language barriers (Bocker1993). Finally icons provide more information about the scope, the action component involved and the consequences of the invoked menu option than text (Arend et al. 2007). Most of the previous research regarding icon design, primarily focused on the visual depiction (Wang et al. 2007) and inherent style (Barr et al. 2002) related to user perception (Chanwimaiueng & Kasemsan 2011; Schroder & Ziefle 2008). There were few parallel studies related to icons which addressed the influence of cultural differences on perception and performance (Kim & Lee 2005; Pappachan & Ziefle 2008).

1.1 Research Objective

There exists very little work which tries to examine the effect of icon characteristics on cognitive absorption in the context of naive low literacy users. It is necessary to close this gap by conducting research which will find out the effect of different icon characteristics on cognitive absorption and finally the possible effect on the target users behavioral intention of using such systems. This provides our current research objective which tried to answer the research question: How does characteristics of icons (metaphoric and idiomatic icons) for different functions in mobile application effects the behavioral intention of naive low literate users through different cognitive absorption dimensions ?

1.2 Theoretical and practical implications

Our study makes four major theoretical contributions. First based on Carroll and Thomas's (1982) theory of metaphor we developed icon design guidelines for low –literacy community belong to the developing countries and identify possible effect of specific interface elements on behavioral intention of use. Second, we are expected to reveal the relationships that exist between icon characteristics and different dimensions of cognitive absorption. Third, we advocated for metaphor driven icon design methodology for designing icons for the low literate target users. Grounded in the theory of metaphor metaphoric icons provide better learnability, usability and understandability of application system which can be crucial for adaptation of new systems by low-literate users. Forth, we decided low-literacy farmers' community as the target users segment. As most of the theoretical work focuses on educated users and their work context who belong to top of economic pyramid.

We also make four major practical contributions. First, our study suggests concrete design methodologies for designing interface icons for the low–literate user. Second we offer clear understanding of key dimensions of cognitive absorption for product managers and interaction designers to look at while designing and delivering successful products for low literate users. Third,

we offer clear design strategies for crafting coherent sequence of effective user interactions which will facilitate self-initiated learning and usage of mobile base application. Forth, our study insights is expected to offer a more efficient icon based input system, alternative to the conventional text based input system which poses a significant challenge for that particular user segments (Medhi et al.2011).

Our paper is organized as follows. We first describe the unique characteristics of low-literate middle of the pyramid farming community and mention prime challenges associated with designing icons for such users. We then present an overview of our research model and elaborate on the main components. A preliminary description of the icon sets is then portrayed. We conclude with a summary of our research contribution and potential future directions.

2   BACKGROUND

Farming communities of developing countries constitute a considerable portion of people who belong to the middle of economic pyramid (World urbanization prospects 2007; Seshagiri et al. 2007: Prahalad 2004). For developing countries almost 57% of the population stays in the rural areas (World urbanization prospects 2007). For a country like India, 71% of the population stays in rural areas and a vast portion of this population is semiliterate and illiterate (World urbanization prospects 2007). As most of these people do not have access to computer but have access to the mobile phone, mobile based information system empowered with relevant content can be significantly beneficial to them (Kumar et al. 2008, Chang et al. 2011). Two characteristics of such user segment should be taken into consideration when designing mobile interfaces for them. First, users who belong to this particular cross-section generally have very limited exposure to information technology application. As a result of that they face significant difficulties in learn new concepts, ideas and as well as actions which are quite essential for the successful use of these technologies to achieve some practical goals (Medhi et al. 2011; Parikh et al. 2003; Dhakhwa et al. 2007). Second, this low literate user can hardly able to use hierarchical model oriented text based navigational structures (Medhi et al. 2011; Parikh et al. 2003). It was suggested that navigation and action based elements were best represented through the careful use of highly representational identifiers such as icons and pictures (Medhi et al. 2007; Rege & Nagarker 2010; Wiedenbeck 1999).

To address these issues the interface need to be designed in a manner that make interface icons highly intuitive for the user to learn and perform the required action from the beginning (Rege & Nagarker 2010). Although a lot of research study strongly recommended (Thatcher et al. 2005) icon base graphical user interface there is hardly any empirical study which was aimed to suggest a concrete icon design methodology which interface designer can rely on. The research gap can be fulfilled by empirically testing different sets of icons designed by following different icon design methodology. Secondly as icon plays both utilitarian and hedonic role in its usage context there is a requirement to judge their effect on behavioral intention of use in the light of both functional and aesthetical dimensions (Weniger & Leobbecke 2011).

Research related to icon and icon designs so far were concentrated either on functional efficiencies or on the effect of culture in their perceptions and recognitions (Gatsou et al. 2011; Chanwimaiueng & Kasemsan 2011; Schroder & Ziefle 2008). Most of the research related to icon in the context of low – literacy user segment focused on the utilitarian role of icons related to their performance (speed and accuracy of search and select). There is a requirement to judge the utilitarian and hedonic role of icons together to identify specific construct which affect the behavioral intention of users (Marcus 1998; Blackwell 2006; Feinstein 1982). Our study aims to fulfill this gap by advocating a design framework based on the 'theory of metaphor' (Carroll & Thomas 1982; Carroll & Mack 1999) and 'cognitive absorption' (Weniger & Leobbecke 2011; Agarwal & Karahanna 2000; Benyon & Imaz 1999).
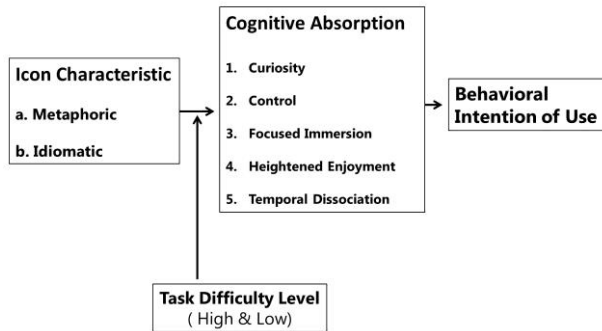
Figure 1.   Research Framework

3   COGNITIVE ABSORPTION AND THREORY OF METAPHOR

We used cognitive absorption (CA) theory in the context of naïve low–literate users of farming community for the same reason suggested by Agarwal and Karahanna (2000): cognitive absorption combines affective and cognitive components and address the whole process. Cognitive absorption by its very nature involves multidimensional conceptualization and it combines affective and cognitive components (Weniger & Leobbecke 2011). This multidimensional nature of CA makes CA most suitable theory on which our study can be grounded. While control, curiosity, temporal dissociation and focused emersion represent the cognitive dimension, heightened enjoyment represents the affective dimension (Weniger & Leobbecke 2011). In another manner as the development of the CA constructs and its position within research models is grounded in research on technology acceptance (Weniger & Leobbecke 2011; Agarwal & Karahanna 2000; Fagan et al. 2008) and it also matches objectives of our study very well. The strength of CA theory comes from its multi-dimensional constructs. For our study we adapted the five constructs offered by Agarwal and karahanna (Agarwal & Karahanna 2000) in their CA research model.

According to Agarwal and karahanna (2000) CA creates perception of a lower cognitive burden because of the individual is experiencing pleasure from the activity and will to expand more effort on it. Even though most of the research report a positive effect of CA on behavioral intention mediated by perceived ease of use and perceived usefulness, we would like to see the direct relationship between CA and behavioral intention of use like Saade and Bahli (2005) and Chandra et al (2009). Though Saade and Bahli (2005) and Chandra (2009) detect that CA positively influence the intention to use the respective IS, very few studies was directed to find out the possible effect of particular dimensions (control, curiosity, temporal dissociation, focused immersion and heightened enjoyment) of CA on behavioral intention specifically for naive low literate user context. Thomas (2006) is one of the few who studied effects of particular CA dimensions on perceived usefulness. For the development of a precise icon design guidelines it is quite essential to identify key CA constructs which might have significant effect on behavioral intention of use. It will help interface designer to prepare precise design strategies for developing and tuning the user experience as the study is expected to reveals the relationship between icon styles and CA measures of different dimensions.

3.1   Dimensions of Cognitive Absorption

In our research we incorporated five–dimensions of CA namely control, curiosity, temporal dissociation, focused immersion and heightened enjoyment as developed by Agarwal and Karahanna (2000).

- Temporal dissociation as the inability to register the passage of time to register while being engaged in interaction.
- Focused immersion derives from the experience of total engagement where other demands are ignored.
- Heightened enjoyment captures the pleasurable aspects of the interaction.
- Control refers to the user's perception of being in charge with the interaction.
- Curiosity describes the extent the experience arouses an individual's sensory and cognitive curiosity.

3.2 Task Difficulty

Previous research found that a person's skill and difficulty of task interact to result in different dimensions of cognitive absorption (Csikszentmihalyi 2008).When the task is too hard as per users skill sets users tend to become anxious and that affects different dimensions of cognitive absorption adversely. Tasks which involve clear goals with and involve actions that fit with user's capability affects different dimensions of cognitive absorption differently than the tasks which does makes those things implicit. In our study user skills were controlled (all the users are naïve low-literate with very similar skillset relevant to the experiment) while the task difficulty level is manipulated (low and high difficulty). Users are best to understand and apply relevant information to a task when there is congruency between the task and available information. As metaphoric and idiomatic icons provide different level of information it can also be expected they will impart different effect on cognitive absorption based on different level of task difficulty.

3.3 Icon Characteristics

For defining our independent variables 'icon characteristics' we adopted two different design methodologies namely metaphoric and idiomatic. In this regard we adapted the theory of metaphor and cognitive representation developed by Carroll and Thomas (1982). According to this theory when people try to understand something new, they put it onto the conceptual framework of something else that already they know about (Carroll & Thomas 1982; Carroll & Mack 1999). A contextual metaphor, metaphor can provide a way of giving the new user an overview of what the system does which is a crucial aid to understand and can help motivate new user (Benyon & Imaz 1999; Blackwell 2006; Feinstein 1982).

The other design methodology that we adapted for icon design is idiomatic in nature, where icons play the role of visual idioms which users have to learn while using the application (Cooper et al. 2007).We hypothesize that interface comprise of metaphoric icon set will have more significant effect on cognitive absorption operationalize through five different dimensions and finally through these dimensions metaphoric icons will impart comparatively more significant effect on behavioral intention of use than idiomatic icon based interface.

Function	Idiomatic	Idiomatic
New Report		
Alert		
Advice		
Search		

Timeline			
Profile			

Table 1.   Icon sets

3.4   Behavioural Intention of Use

As defined in the original theory of reasoned action 'behavioral intention' is the individual's intention to perform a given behavior (e.g. usage). Intentions are assumed to capture the motivational factors that influence the behavior. The role of intention, as a predictor of behavior (e.g. usage) is crucial and well explored in human-computer interaction and many other related disciplines (Ajzen 1991; Taylor and Todd 1995). Many researchers already studied individual acceptance of technology by using behavioral intention as the dependent variable (Compeau and Higgins 1995; Davis et al. 1989). As a general rule the stronger the intention to engage in a behavior the more likely should be the performance (actual usage). The wide acceptability and applicability of 'behavioral intention of use' (Venkatesh 2000; Davis et al. 1992) make it the quite obvious to choose as dependent variable in our study.

4   EXPERMENT EVALUATION

Our objective is to test the hypothesis using prototypes. The effectiveness and the effect of different icon sets on cognitive absorption and behavioral intention of use will be tested in a series of real life environment and laboratory experiments. In our preliminary study, we conducted a field experiment with two between subjects' factors: Icon characteristic (metaphoric and idiomatic) Task difficulty level (low vs. high). Thus, we employed a counterbalance, full factorial design which includes a total of four combinations (Table 2).

Six tasks were chosen for the experiment. Out of them three was of low difficulty level while the other three was of high difficulty. The criteria for setting the levels of difficulty involved the number of page need to be visited, the number of clicks need to be applied, number of icons need to be clicked, length of the navigational path to reach goals and finally the number of decision points involved. Tasks chosen for the experiment were those which are expected to be performed most frequently and involved complete comprehension and usages of different icons for multiple times.

5   MEASUREMENTS

As mentioned earlier we used the five dimensions of cognitive absorption namely control, curiosity, temporal dissociation, focused immersion and heightened enjoyment to find out their relative role in mediating the effects of different icon characteristic base interfaces (Metaphoric and Idiomatic) on users behavioral intention. In this regard we used the same measures developed by Agarwal and Karahanna (2000) after making minor adjustments for contextualization. The behavioral intention of use is one of the most widely used dependent variable and in our study we used the same measures developed by Davis et al.(1989).

6   RESEARCH DESIGN

We develop a mobile base pest management system for the farming communities who belong to middle of economic pyramid of developing countries to evaluate metaphoric and idiomatic icon sets which represents different functions of the application. Based on two distinct interface design methodology we designed several version of icon set which represents six different functions of the application. Based on the preliminary test results two sets of six icons were finalized for the final field

testing with representative users. Each of these set contains six icons which represent six different functions of the application and each set also represent one of the category metaphoric or idiomatic. The pest management system aims to gather information from individual farmers, conduct sense-making to analyze pest infestation patterns and disseminate information to help farmers take timely actions.

Fifty Eight novice low literate farmers from middle income group were recruited from six different villages of Maharashtra; India randomly assigned one of the four experimental conditions (Table 2). Through a role based scenario participants were told to complete three different tasks either low or high difficulty level like report a recent pest problem on his farm and find suggestions recommended by system etc. Before they started the task, participants were asked to complete a pre-test questionnaire about the demographic information and prior experience with the mobile usage. After this pre-test questionnaire based survey, subjects were given a brief introduction to pest management system prototype by the moderator. Next the participants were instructed to navigate and locate information on specific functions to become familiar with the system layout and its various features.

Task Difficulty Level	Metaphoric Icon Set	Idiomatic Icon Set
Low Task Difficulty	Metaphoric Icon Based Interface with Low Task Difficulty	Idiomatic Icon Based Interface with Low Task Difficulty
High task difficulty	Metaphoric Icon Based Interface with High Task Difficulty	Idiomatic Icon Based Interface with High Task Difficulty

Table 2.   Experimental Conditions

Next each participants were instructed to perform three consecutive tasks (low or high difficulty level) like - generating a report about a recent pest problem on their farm, locating and reading the suggestions provided by the system regarding the problem they reported etc. The system was developed on Android mobile phones. To minimize the potential impact of confounding factors such as environment and mobility on user performance during the experiment, participants were asked to perform the exploration and tasks inside a predefined field setting. Lastly the participants were required to fill a post–test questionnaire, which included manipulation checks measurement of dependent variables. Currently this research is in progress and data analysis is being conducted to validate the hypotheses.

7   CONCLUDING REMARKS

This paper aims to suggest a concrete icon design methodology for mobile base interface for the naïve low literate user segment that belong to the middle of economic pyramid of developing countries. It also tries to identify the key constructs under cognitive absorption which may have significant effect on behavioral intentions of low literate users. Our theoretical contribution is to reveal the relationships that exist between icon characteristics and different dimensions come under cognitive absorption. We advocated for metaphor driven icon design methodology for designing icon design interface for the low literate target users who belong to middle of economic pyramid of developing countries. As practical contribution we offer clear design strategies for crafting coherent sequence effective user interactions which will facilitate self-initiated learning and usage of mobile base application. In future we will conduct both laboratory and field experiments to test the effectiveness of our icon design guidelines for other usage contests of low literate novice user communities.

8   ACKNOWLEDGEMENT

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