Icon Types, Extrinsic and Intrinsic Motivations and Behavioral Intention of Use for Semi-literate Users

Completed Research Paper

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Abstract

Different types of icons can trigger different amount of extrinsic and intrinsic motivation to semi-literate users. The different motivational variables are also expected to have different amount of effect on the behavioral intention of the use of such users. Our study approaches these issues from two theoretical perspectives. Based on the theory of metaphor, we argue that an interface which comprises of metaphoric icons can benefit semi-literate users by significantly effecting users' intrinsic and extrinsic motivation. From 'Motivational' theory perspective, our research attempts to determine the capacity of four extrinsic and intrinsic motivational variables in predicting the behavioral intention of using a new mobile application by semi-literate users. Our results confirm the superiority of metaphoric icon set over idiomatic icon set for both extrinsic and intrinsic motivational aspects. The most surprising outcome of our study is 'enjoyment' becoming the sole significant contributor of 'behavioral intention of use' for semi-literate users.

Keywords

Semi-literate user, extrinsic motivation, intrinsic motivation, metaphoric icon, idiomatic icon

Introduction

The semi-literate rural communities that belong to the middle of the economic pyramid of India are gradually becoming one of the main targets of emerging technologies (Kumar et al. 2008). The recent multifold proliferation of mobile phone in this particular cross-section of the population makes many entities interested in providing a mobile platform based service (Donner 2008; Medhi et al. 2011).

In this regard, general interface design guidelines often fail to satisfy the requirements of this particular user population. One of the reasons is that this particular user population has varying level of formal education (Medhi et al. 2010). Along with that underdevelopment of different cognitive skills, attention related skills and vigilance, etc. hinder effective use of information and communication technology (ICT) applications (Medhi et al. 2010). This directs us to the question of how we can design mobile interface elements such that semi-literate users can learn and use any advanced services instantly when they are provided with the same.

In this context, the use of icons is steeply increasing as researches showed the effectiveness of graphical user interface (GUI) for more successful task completion and better usability (Grisedale et al. 1997; Medhi et al. 2011). In our study, we compare the performance and perception of two different types of icons namely metaphoric and idiomatic. The reason behind choosing these two particular icon types is their inconsistent performance in the different context of utilization as described by researchers (Arend et al. 1987; Benyon and Imaz 1999; Blackwell 2006). Metaphoric icons are those which use relatively familiar visual metaphors that suggest a direct or implied relationship with the function that it represents (Markus 1998). The idiomatic icons are like visual idioms which users' have to learn while using the system. They depict no obvious or close relationship with the function they represent.

Metaphoric icons adopt an analogical learning process, based on the users' current level of knowledge (prior knowledge). Idiomatic icons adopt a procedural learning process (learning while using) based on users' conscious effort of relating the function with the corresponding icon form and then memorization (Arend et al. 1987; Cooper et al. 2007). As the semi-literate users can have different levels of visual literacy, the icons that will provide maximum help to users for learning and using a system easily and efficiently remains as a crucial question (Griffin and Gibbs 1993).

We have two research questions that we have addressed in our study. How do different types of icons in mobile application interface affect the extrinsic and intrinsic motivation of semi-literate users? Which of motivational variables affects the behavioral intention of the use of such semi-literate users and to what extent?

The contribution of this study is manifold. Theoretically, it shows the superiority of the metaphoric icon type over the idiomatic one in terms of significant differences in intrinsic and extrinsic motivational constructs based on the theory of metaphor and cognitive representation (Carroll and Thomas 1982). The prime theoretical contribution of this work is to identify intrinsic motivational construct 'enjoyment' as the key contributor to the usage intention of semi-literate users. This leads to one of the most important theoretical implications - the limitation or inapplicability of the previously suggested boundary condition 'nature of the system' (Heijden 2004) for semi-literate users. Practically, our study suggests a specific type of icon for semi-literate users to ensure their high extrinsic and intrinsic motivation and behavioral intention of using a new mobile application. By identifying the influence of 'enjoyment' on users' behavioral intention, it finds out the preference of semi-literate users. Therefore, to ensure better acceptance of a system, the delivery managers and interaction designers can build up strategies which let in more 'enjoyment factors'.

Related Work

Semi-literate Users

To design interface elements like icons for semi-literate users, certain characteristics of this population need be considered carefully. Firstly, users who belong to this particular cross section of rural India have very little exposure to information technology applications (kumar et al. 2008). New services designed for this population typically involves functions that imply significant learning challenges for semi-literate users to use them effectively (Heeks 2002). They also face significant difficulties in learning abstract concepts and functions which are quite essential for the successful use of these technologies (Parikh et al. 2003; Medhi et al. 2011). Lack of prior knowledge, cognitive and metacognitive skills restricts their learning and making the learning path very steep (Medhi et al. 2010). Therefore, it was suggested that navigation and function related interface elements would be best represented through the careful use of highly representational identifiers such as icons and pictures (Gatsou et al. 2011).

Icon Type

In our study we compared two fundamentally different types of icons, the metaphoric and the idiomatic. The reason behind choosing these two particular icon types is their inconsistent performance in the different context of use as reported by researchers (Arend et al. 1987; Benyon and Imaz 1999; Blackwell 2006). Metaphoric icons are those which use relatively familiar visual metaphors that suggest a direct or implied relationship with the function that it represents (Roger 1989; Markus 1998). Metaphoric icons use a typical object to represent a general class of object (Wang et al. 2007). The idiomatic icons are like

visual idioms (Cooper et al. 2007) which have no intuitive connection between the icon and the referent (Wang et al. 2007). Idiomatic icons are generally made up of unfamiliar geometric shapes, lines, arrows, etc.

In the context of instant comprehension and use for task accomplishment we rely on the 'theory of metaphor' forwarded by Carroll and Thomas (1982). According to the theory of metaphor (Carroll and Thomas 1982) - "people explore metaphors in learning about computer systems; the designers of those systems should anticipate and support likely metaphorical constructions to increase the ease of learning and using the system". Therefore the related prior knowledge becomes a metaphor for the materials being acquired (Carroll and Mick 1999). For idiomatic icons, the meanings and the operation of the functions have to be learned by trying it out (Cooper et al. 2007). It requires a conscious learning effort by the user to learn about idiomatic icons. There is no close or obvious relationship that exists between the idiomatic icon and the system function it represents. Therefore the user has to allocate more cognitive effort for the creation of new mental categories.

Icon Types and User Motivation

Most target users generally become motivated for using a new system by some combination of intrinsic and extrinsic motivation (Carroll and Thomas 1982). Extrinsic motivation refers to the performance of an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as task performance, efficiency, saving, social and economic profit (Vroom 1964; Mitchell and Biglan 1971). Intrinsic motivation refers to the performance of an activity for no apparent reinforcement other than the process of performing the activity per se (Berlyne 1966; deCharms 1968).

To account for the extrinsic motivation we choose two different measures of efficiency to capture the effect of icon types on extrinsic motivation. In our study, we used 'task completion rate' and 'mean task completion time' as measures of extrinsic motivation. 'Task completion rate' is measured as the number of the tasks each participant is able to complete successfully with respect to the total number of tasks allotted to him. As icons of different types supply different amount of information and through that exert different effects on comprehensibility, it is expected that they are also going to produce different task completion rates.

'Mean task completion time' is defined as the average time taken by participants to complete all the tasks allotted to him. 'Task completion time' is widely used as a quantitative measure of efficiency for extrinsic motivation (Venkatesh 2000; Schroder and Ziefle 2006). In our study, we use mean task completion time as a measure of extrinsic motivation. Time to comprehend the right meaning of the icon, which represents the system function, will subsequently affect the task completion time. Participants who are able to comprehend the meaning of icons quickly will be able to finish the tasks earlier.

Based on the theory of metaphor and cognitive representation, we hypothesize that:

H1 The task completion rate will be higher for the participants who used mobile interfaces comprised of metaphoric icons than those participants who used interfaces comprised of idiomatic icons.

H2 Mean task completion time will be lower for the participants who used mobile interfaces comprised of metaphoric icons than those participants who used interfaces comprised of idiomatic icons.

Previous researches (Davis et al. 1992; Heijden 2004) suggested that the role of intrinsic motivation is as important as the role of extrinsic motivation. To find out the effect of different types of icons on participants' intrinsic motivation we choose 'curiosity' and 'enjoyment' as constructs of intrinsic motivation. Enjoyment refers to the extent to which the activity of using the system is perceived to be enjoyable in its own right apart from the performance consequences that might be anticipated (Deci 1971; Malone 1981). Curiosity describes the extent the experience arouses an individual's sensory and cognitive curiosity (Agarwal and Karahanna 2000).

Theory of metaphor predicts a positive effect of metaphor to facilitate learning and improved performance, which eventually affects the intrinsic motivation of the user in a positive manner (Carroll and Thomas 1982). Therefore, we predict that metaphoric icon based interface will have a significant positive effect on 'curiosity' and 'enjoyment' in comparison to idiomatic icon based interface. This leads to our third and fourth hypotheses-

H3 Curiosity will be higher for the participants who used mobile interfaces comprised of metaphoric icons than those participants who used interfaces comprised of idiomatic icons.

H4 Enjoyment will be higher for the participants who used mobile interfaces comprised of metaphoric icons than those participants who used interfaces comprised of idiomatic icons.

Considering the fact that users become motivated for using a system by some combination of intrinsic and extrinsic motivation (Deci 1971; Carroll and Thomas 1982), we expect that all the different effects of the measures of extrinsic and intrinsic motivational constructs on behavioral intention of use will be significant. It is also predicted that they will remain significant even in the presence of each other.

Based on the theory of motivation and its role in prediction of behavioral intention we hypothesize that-

H5 The participants' behavioral intention of use can be predicted significantly based on task completion rate.

H6 The participants' behavioral intention of use can be predicted significantly based on mean task completion time.

H7 The participants' behavioral intention of use can be predicted significantly based on curiosity.

H8 The participants' behavioral intention of use can be predicted significantly based on enjoyment.

Behavioral Intention of Use

As defined in the theory of reasoned action, 'behavioral intention' is the individual's intention to perform a given behavior (e.g. usage) (Ajzen 1991). Intentions are assumed to capture the motivational factors that influence the behavior. It is one of the crucial indicators of user's motivations in order to perform a behavior (Venkatesh 1999). The role of intention, as a predictor of behavior is crucial and well explored in information systems and many other related disciplines (Ajzen 1991; Taylor and Todd 1995). As a general rule, the stronger the intention to engage in a behavior, the more likely should be the performance of the activity (actual usage). The wide acceptability and applicability of 'behavioral intention of use' (Davis et al. 1992; Venkatesh 2000) make it quite an obvious choice for the dependent variable in our study.

Methodology

We developed a high fidelity prototype of an agricultural pest management application for mobile platform to test two different sets of icons. Figure 1 shows some of the interface screens for both metaphoric and idiomatic icon sets.

Experimental design

Our experiment employed between subjects a single factorial design wherein icon types were manipulated as independent variables. Participants were assigned to one of two interfaces that differed only in terms of icon sets. Two different sets of icons (metaphoric and idiomatic) representing six different functions of a mobile application were designed. Metaphoric icons were developed by following different visual images of objects, actions, examples, instances of contextual objects, which metaphorically represent the concept of the functions suggested by eight representative users.

Idiomatic icons were developed by developing guidelines based on visual idioms, while keeping in mind the application domain (agriculture). These visual idioms were more like a visual signage system which consists of basic geometric shapes and other generic elements. An expert team of visual designers consisting of four team members checked the 'metaphoric-ness' and 'idiomatic-ness' of both the sets to ensure high representativeness of icons in their respective categories. Each judge was presented with a randomly sorted list of icons consisting of twelve icons. They were then told to classify each icon in either of the two categories. The sorting was mostly consistent with our classification, the resultant hit ratio was 0.83 and Cohen's Kappa was about 0.83 (Cohen 1960).

For the measurement of 'curiosity' and 'enjoyment' the same items of 'curiosity' and 'heightened enjoyment' developed by Agarwal and Karahanna (2000) were used, after making minor changes for

contextualization. The participants' behavioral intention of use was measured through binary choices (Yes/No).

Fig. 1. Interface Screens of Metaphoric and Idiomatic Icon Sets

Participants

Fifty-six participants were recruited with the help of a non-profit organization from six different villages of Maharashtra, India. All the participants had no prior exposure to any kind of mobile based application and used mobile phone primarily for synchronous voice communication.

Participants have three common background traits: 'functional semi-literacy', 'low level of formal education (highest education attained being schooled up to seventh grades)' and 'completely inexperienced with personal computers'. Apart from these commonalities, we also collected data regarding other demographic parameters like age, participants' experience with mobile phone, etc. Along with the mentioned common traits we also balanced age, varying levels of experience with mobile phone usage across the two experimental groups to avoid possible confounds.

Our participants were typically farmers who owned 1 to 3 acres of land. They ranged in age from 35 to 65 with a mean age of 43 years. Family incomes of our participants ranged from 180USD to 350USD per month. The participants' primary languages were Marathi and Hindi. All of them have seen computers in person (but again, none of them ever used it). There were strong preferences for voice calls in comparison to texting.

Procedure

As mentioned earlier, each participant was assigned to any one of the two interfaces. Out of 56 participants 28 participants used metaphoric icon based interface to complete the tasks. The rest of the participants (28) were allotted idiomatic icon based interface to complete their tasks.

Based on predefined guidelines a 5-10 minute brief introduction was provided by the moderator before the participants set out with the tasks. After which, participants were asked to complete a pre-test questionnaire. The pre-test questionnaire was used to collect different demographic information, information related to their prior experiences with mobile phone usage and educational level, etc. After that, participants were assigned Android OS (2.2) based touch phones (Samsung Galaxy S II) with pre-installed application. Participants were asked to explore the experimental application for 5 to 7 minutes to become familiar with the navigational structure.

Then the role based scenario was introduced which embedded all three different tasks. The scenario which was used to link the three tasks sequentially was designed in a manner to reflect situations that were frequently encountered by farmers regarding agricultural pest management. The time limit set for completing each task was 4 minutes and the total time limit for completing three tasks was 12 minutes. The tasks were considered incomplete if the participants failed to accomplish it within the time limit. Lastly the participants were required to fill a post–test questionnaire.

For each participant the whole task performance sessions were recorded in video format and they were analyzed by using a video editing tool to find out all objective measures. A task was considered to be

successfully completed if the user was able to navigate correctly to the screen where the desired information was displayed. All the participants were asked to perform the same three tasks in exactly the same order. The entire experiment was designed to take between 30 and 35 minutes to complete.

Results

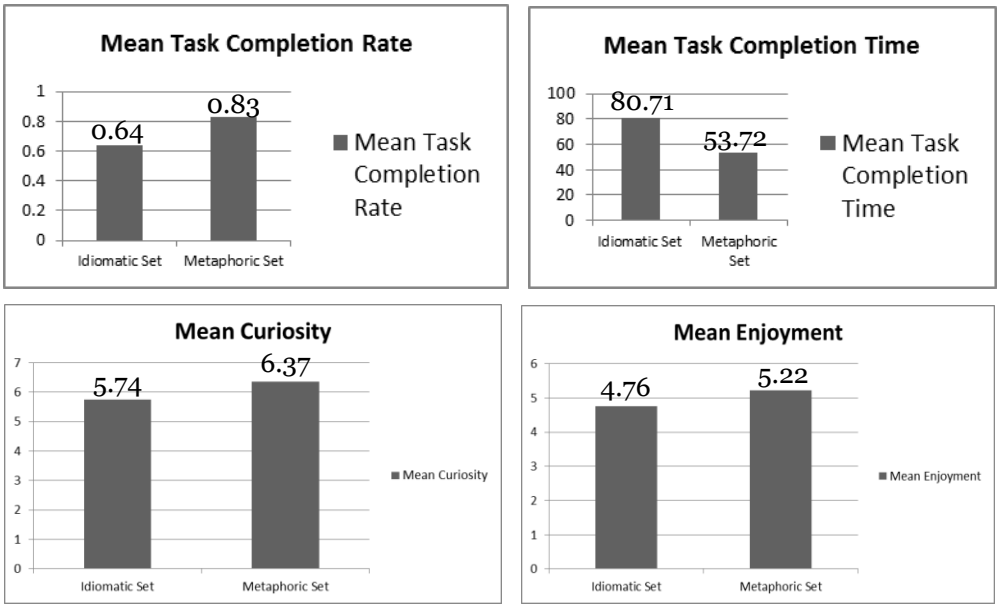

Fig. 2. Descriptive Statistical Results

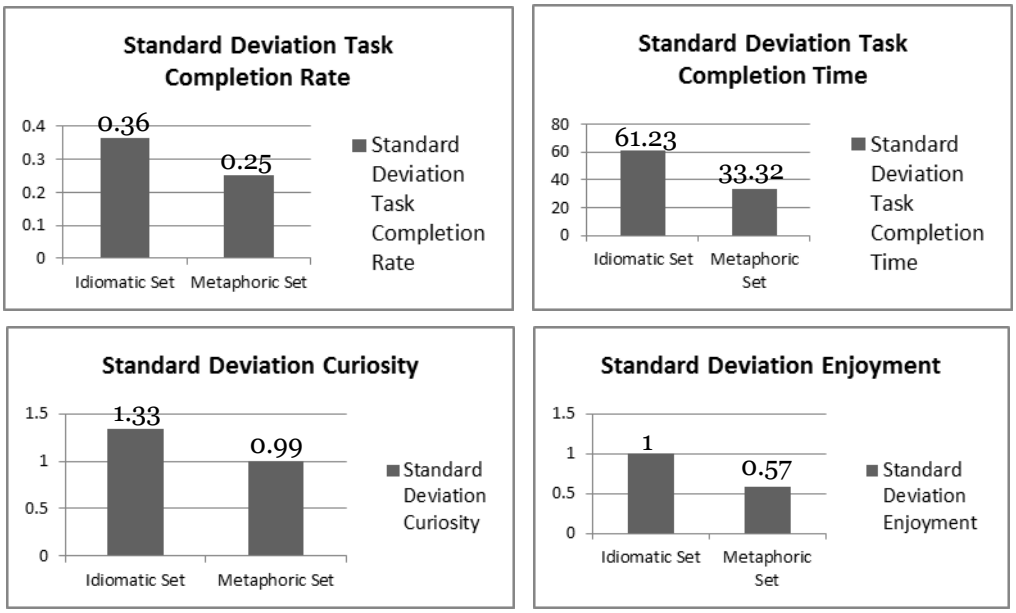

Fig. 3. Descriptive Statistical Results

To test H1, H2, H3 and H4 we conducted between subjects ANOVA, while to test H5, H6, H7 and H8 we estimated a logistic regression model with 'behavioral intention of use' as dependent variable and 'task completion rate', 'mean task completion time', 'curiosity' and 'enjoyment' as predictor variables.

Hypothesis	Mean Value Metaphoric, Idiomatic	F	df	p	Hypothesis Support
H1	0.83, 0.64	5.239	54	0.026	Supported
H2	53.72, 80.71	4.196	54	0.045	Supported
H3	6.379, 5.748	4.009	54	0.049	Supported
H4	5.223, 4.768	4.350	54	0.042	Supported

Table 1. ANOVA Test Results for Hypotheses 1, 2, 3 and 4.

The descriptive statistical results for mean and standard deviation are summarized in Figure 2 and Figure 3. Table 1 summarizes all the results of ANOVA tests for H1, H2, H3 and H4.

We do find support for H1. The results indicate that successful task completion rate was significantly higher for metaphoric icon based interface (mean rating: 0.83) than idiomatic icon based interface (mean rating: 0.64; ANOVA: $F(54) = 5.239$, $p<.05$). The results also indicate that the mean task completion time was significantly lower for metaphoric icon based interfaces (mean rating: 53.72 Sec) than idiomatic icon based interfaces (mean rating: 80.71 Sec; ANOVA: $F(54) = 4.196$, $P<.05$). Therefore H2 is also supported.

The ANOVA result shows clear evidence in support of H3. It indicates that 'curiosity' was significantly higher for the participants who used metaphoric icons (Mean rating: 6.37) to perform the allotted tasks than the participants who used idiomatic icons (Mean rating; 5.74, ANOVA $F(54) = 4.009$, $P<.05$). In a similar manner we also find support for H4 which predicts significantly higher rating of 'enjoyment' for the participants who used the metaphoric icons (mean rating= 5.22) than the participants who used the idiomatic ones (mean rating: 4.76; ANOVA $F(54) = 4.350$, $P<.05$).

We have proposed four hypotheses (H5, H6, H7 and H8) that predict the effects of extrinsic and intrinsic motivation on behavioral intention of use.

		B	S. E.	Wald	df	Sig.	Exp(B)	Hypothesis Support
H5	Task Completion Rate	-1.350	1.444	.874	1	.350	.259	Not supported
H6	Mean Task Completion Time	-.013	.009	2.131	1	.144	.987	Not supported
H7	Curiosity	-.216	.304	.506	1	.477	.806	Not supported
H8	Enjoyment	1.668	.536	9.693	1	.002	5.300	Supported

Table 2. Logistic Regression Model Test Results for Hypotheses 5, 6, 7 and 8.

To test hypotheses 5, 6, 7 and 8 (H5, H6, H7, H8) we estimated a logistic regression model with behavioral intention of use measured in the form of binary choices as the dependent variable (coded as 1=yes and 0= no) and task completion rate, mean task completion time, curiosity and enjoyment as the predictor variables.

Table 2: gives coefficients, Wald statistics, associated degrees of freedom and probability values for each of the predictor variables.

The result of this analysis does not provide any support for H5. There is no statistically significant effect of task completion rate on behavioral intention of use ($R^2 = 0.356$; $B = -1.350$, Wald= 0.874, $P>.05$). We find no significant effect of mean task completion time on behavioral intention of use ($B = -0.013$, Wald = 2.131, $P >.05$). Therefore, we do not find any support for H6.

While we did not find any support for H7 ($B = -.0216$, Wald =0.506, $P>.05$) we do find support for H8. H8 makes the prediction of a significant positive effect of enjoyment on behavioral intention of use ($B=1.668$, Wald=9.693, $P<.05$) of participants. This result indicates that intrinsic motivational construct enjoyment

significantly accounts for the semi-literate users' behavioral intention of using a new mobile application in the presence of other three independent variables.

Discussion of Experimental Results

Overall, the results of the experiment indicate that metaphoric icons have a significantly higher effect on all four motivational constructs in comparison to idiomatic icons. Among all four motivational constructs only 'enjoyment' has a significant effect on behavioral intention of use.

As previous research already establishes that the intrinsic motivation can influence extrinsic motivation and can compound its effects, the vice versa is also quite possible. In our study, most of the users' have their first exposure to high end smart phone and mobile based application. The application provides some opportunity to do the current mundane and time consuming activity of crop monitoring and agricultural pest management through few touches on mobile phone. Participants first wondered and then felt delighted after exposure to our mobile based system. This situational condition might be responsible for the result that we obtained.

As our system only provides limited help regarding the most hectic process of crop surveillance the user might consider the system quite hedonic or 'game like' in comparison to the utilitarian system they expected. Previous researches suggested that 'if the user is not completely aware of the existence of real value while using a technology' the locus of causality can reside on the intrinsic motivational measure like 'enjoyment' (Deci 1975; Venkatesh 2000). The icon based simplified way of interaction might facilitate such interpretation by participants. The farming community that, we targeted was expecting for the mobile application to be helpful in some manner as they were not quite sure of the capability of a mobile application. They expected a time consuming elaborate process which required a lot of cognitive effort from them and might require exhaustive training. They didn't expect the process to be enjoyable. Participants might experience a sense of freedom which demonstrates itself in high scores of enjoyment (Csikszentmihalyi 1977).

Sometimes the objective of using a system, irrespective of nature (hedonic or utilitarian) of the system depends on users' intention. People are increasingly spending time on computers or such digital systems. They are expecting for it to be a pleasurable experience despite the fact that the system was not necessarily built from the 'Joy angle' (Vallerand and Bissonuette 1992). Therefore a primarily utilitarian system like ours can also be perceived as 'game like' and sometime used to enjoy the process specifically at the early stage of use.

Another important aspect which possibly influences the result is the use of the application in a general 'multipurpose' environment. Most of the previous researches reported the users' behavioral intention of using a new technology in their workplace environment (Davis et al. 1992). In our study the distinction between workplace environment and home environment is not that pronounced. Many a time, farmers involves in activities at home, which is directly related to his farm and crop. Sometimes the residential place of the farmer itself is inside the farm. Therefore, based on users' motivational requirements 'enjoyment' can become a stronger predictor of behavioral intention of use than the usability related predictors.

Theoretical and Practical Implications

Theoretically, this work shows the effect of different types of icons on users' different extrinsic and intrinsic motivational constructs. Our empirical evidence suggests that, metaphoric icons impart more significant effect on users' extrinsic and intrinsic motivation than the idiomatic icons. Secondly, our study also identifies the role of 'enjoyment', as a strong predictor of behavioral intention of use for semi-literate users. The study reveals the relationships that exist between icon types and four different constructs that come under extrinsic and intrinsic motivation. It clears out the role of different extrinsic and intrinsic motivational constructs in context of icons that can successfully predict the participants' behavioral intention of using such systems. Finally, our research reveals all these insights in the context of semi-literate users. As this user segment possesses its own unique characteristic our study results question the applicability of 'boundary condition' by revealing the role of enjoyment in predicting the behavioral intention of adopting a new mobile based ICT solution which can be considered as utilitarian in nature.

Practically, interface designers who are trying to design interface icons for mobile based system which targets different communities who are semi-literate like rural farming communities, vehicle drivers, fishermen, small scale packers and movers etc. of developing countries, can have an icon design strategy to start with. It is expected to reduce the number of iterations and prototypes they are required to develop to ensure required acceptance. Previous works done in this area mostly suggests the usage of icon's structural styles and not a concrete icon type specifically for semi-literate user communities. By specifically pointing out the motivational construct 'enjoyment' which accounted for the users' behavioral intention of use, our study helps both the interface designers and product managers to develop product interaction strategies to motivate semi-literate users of developing countries.

Limitation and Future Work

We should note that this study has certain limitations, as is the case with any exploratory study in a relatively new research domain. Although the study focused on agriculture as the context for developing icons, the findings could also be used as a reference for icon design in other contexts. As the participants of this study were only male, the findings obtained cannot be generalized for female participants. We justify our stand by deriving partial support from the fact that in the rural Indian context of Maharashtra, agriculture related decisions are mainly taken by the adult male members of the family. Therefore, we believe it was a considerably fair approximation to involve only the male participants because of the context 'agriculture' (Mahelaqua et al. 2013). Future research is thus required to involve the female participants and different semi-literate communities of India to generalize the results.

So far, our study strongly indicates an advantage for the metaphoric icon set. However, it is the first exposure to the application that influences the learnability aspects of the application rather than long term retention and performance. Our study was not designed to answer the question of the long term utility of different types of icon sets because such thing could only be possible if the users decided to continue with the system for some time. An exciting direction for the future work will be to compare our results with those of a long-term longitudinal study. It will be interesting to evaluate whether the results remain similar after participants have used metaphoric and idiomatic icon sets for a while.

Most of the contemporary research suggested that the effect of different interface elements on behavioral intention of users' generally mediated by users' perception of ease of use and usefulness of the system. Future research also required to be channelized in that direction to find out the possible mediating role of perceived usefulness in the context of semi-literate users.

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