EXAMINING COGNITIVE ABSORPTION PROCESS ON MOBILE INFORMATION VISUALIZATION: A CONCEPTUAL FRAMEWORK

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Abstract: *As the use of visualization becomes more wide-spread, a study in mobile information visualization in assisting cognitive absorption for knowledge exploratory and certain mobile information visualization model concerning to the subject area must be developed. Information Visualization (InfoVis) is an important asset in this set of tools. The effective delivery of abstract information is an important but challenging task in the design of effective mobile learning environments. Hence, the purpose of this study is to examine the effectiveness of mobile information visualization in expediting cognitive absorption in knowledge exploratory. This study uses experimental design to examine the effects of cognitive absorption in mobile information visualization towards learning outcome and to examine the efficiency of mobile information visualization in optimizing learning outcome. Finally it uses the experimental result and literature review to develop a theoretical framework of mobile information visualization that support cognitive absorption in optimizing learning outcome. Results of this study would include new knowledge on mobile information visualization. These results are expected to leads towards the development of theoretical model for mobile information visualization that support cognitive absorption in optimizing learning outcome. After the introduction of background problem, this proposal will present the literature on mobile information visualization, cognitive absorption and e-learning outcome and describe the research methodology before presenting the expected results. This study contributes in mobile information visualization modeling. It will accelerate the cognitive absorption in*

knowledge exploration in optimizing learning outcome through mobile information visualization.

Keywords: *Information visualization, Mobile visualization, Mobile learning, Mobile information visualization.*

INTRODUCTION

E-learning systems have become important in higher education, especially in universities. With the evolution of computer network and wireless network technologies, learning has evolved from face-to-face learning, distance learning, to mobile learning (Robert Yu-Liang Ting, 2002). The latest mobile technologies that support mobile learning, combined with easy access to content, allow learners to experience new situations outside of the classroom (Sharples, 2007). With mobile communication technologies, the time and physical boundaries of the traditional classroom are expanded (Abfalter et al., 2004; van't Hooft & Swan, 2007). A mobile learning environment provides students and teachers with the opportunity to obtain any material on their mobile computers. Furthermore, mobile learning is not simply learning through portable devices, but also learning across contexts (Sharples, 2007). Therefore, the demand is to have efficient mobile interface that can effectively display information and efficiently utilize the small size mobile screen (H. Y. Yoo & S. H. Cheon, 2006). Thus, based on the characteristics of mobile devices and the nature of mobile learning, content needs to be easily accessible to students with a wide range of academic abilities. Information visualization can be of aid in this endeavor. (Park, H., 2008)

Information visualization is widely acknowledged as a powerful way of helping users make sense of complicated data, and a great number of methods for visualizing and working with various types of information have been presented (S. Björk, L. E. Holmquist, J. Redström, 1999). Information visualization helps us deal with large amounts of information. When incorporated into the learning process, information visualization can enable users to comprehend information better, to receive information more quickly, and to make more reasonable and relevant decisions (Park, H., 2008). According to Gerson and Eick (1997), visualization links the two most powerful information processing systems known—the human mind and the modern computer. This process transforms data, information and knowledge into a visual form, exploiting a person's natural strength in rapid visual pattern recognition. Moreover, Zhang (1996) has defined it as process of transforming large quantities of data and information, which are not inherently spatial, into a visual form that allows users to visually perceive the meaning of the information instead of trying to figure it out cognitively.

In addition, Card, Mackinlay and Shneiderman define information visualization (InfoVis) as "the use of computer-supported, interactive, visual representations of abstract data to amplify cognition". Cognitive learning theory explains how mental processes transform information received by the eyes and ears into knowledge and skills in human memory. Clark and Mayer (2004) have described how visual lessons and auditory information are briefly stored in a visual and auditory sensory memory, then enter the working memory, and are

finally stored in permanent, long-term memory. Sweller (2002) supports that there is a need to visualize information because human cognition includes a working memory of limited capacity and duration with partially separate visual and auditory channels, and an effectively infinite long term memory that holds many schemas that can vary in their degree of automation. Visual structures contribute to 'intactness' of the information and is encoded into the memory organization of the map without exceeding the capacity limits of our working memory (Larkin & Simon, 1987).

LITERATURE REVIEW

INTRODUCTION

Figure 1 depicts the proposed framework for determining the cognitive absorption of mobile information visualization in knowledge exploratory in optimizing learning outcome. Three main variables had been figure out based on the research objectives in the framework. The first variable is the set of cognitive absorption which adopted by the previous study by Agarwal & Karahanna (2000). The next variable is the list of e-learning outcome studied by Eom (2010). Finally is the component of mobile information visualization by Pombinho, P., Carmo, M. B., Afonso, A. P. (2011).

MOBILE INFORMATION VISUALIZATION

Schilit et al. (1995) define context as about where you are, who you are with, and what resources are nearby. In (Ryan et al. 1997) context is defined as the user's location, environment, identity and time. In addition, Chen and Kotz (2000) state that context-aware computing is a mobile computing paradigm in which applications can discover and take advantage of contextual information (such as user location, time of day, nearby people and devices, and user activity. One of the most adopted definitions of context in the field of mobile information visualization is the one from Pombinho, et al. (2011):-

a) Computation Context

According to Pombinho, et al. (2011) the knowledge of the characteristics of the device may enable the application to proceed with different types of adaptation. Mobile processing power has been greatly improved with the enhanced hardware. However, the limitation of display screen size may remain as an important issue to present information on mobile devices (Kris Luyten, Karin Coninx 2001). Information visualization methods had been studied in various forms and are developed for desktop. Though these visualization methods adopted from desktop and apply to mobile device, the restrictions like limited calculation ability, limited screen size & small memory volume still remain (Staffan Björk et al. 2000).

b) User Context

Concerning the user profile, characteristics such as age, language, nationality, user need & capabilities, social & cultural elements may influence the visualization used (Pombinho, et al., 2011). He further added user context comprises characteristics directly related with the

user, including his profile, spatial attributes and current task. Study done Schilit et al. (1995) describe user context, such as the user's profile, location, and people nearby, even the current social situation.

c) Physical Context

According to Pombinho, et al. (2011) physical context consists on the light and noise surrounding conditions, climatic conditions and neighborhood environment. Schilit et al. (1995) define physical context, such as lighting, noise levels, traffic conditions, and temperature.

d) Temporal Context

Temporal Context defined by the current date and time (Pombinho, et al., 2011). According to Chen and Kotz (2000) time context defines as time of a day, week, month, and season of the year.

e) Historical Context

Historical context encompasses logs from previous uses of the application (Pombinho, et al., 2011). In addition, study done by Chen and Kotz (2000) defines user a physical contexts recorded across a time span.

COGNITIVE ABSORPTION

Card et al. (1999) defined visualization as "the use of computer-supported, interactive, visual representations of data to amplify cognition". Cognition is the acquisition or use of knowledge and the main objective of visualizations are insight not pictures and the goal of insight is discovery, decision making and explanation. Visualizations are important when there is a need to present massive amounts of information very quickly (R. Sousa., et al. 2009). In the study conducted by Agarwal and Karahanna (2000) cognitive absorption (CA) has been found to be an important factor influencing behavioral intention of use of information technologies (IT) which are stimulating and absorbing for the user. In the context of information systems (IS), CA can be defined as the state of deep involvement or holistic experience with the underlying technology (Agarwal and Karahanna, 2000).

a) Temporal Dissociation

Temporal Disscociation refers to individual's inability to notice the passage of time while engaged in software usage (Agarwal and Karahanna, 2000). According to Shang, Chen and Shen (2005), is the individual incapacity to perceive time passage during the interaction. It is qualified by Novak et al (2000) as time distortion.

b) Focused Immerse

Focused immersion, means the total focus or engagement in software usage, when everything else around is ignored (Agarwal and Karahanna, 2000). A study done by Shang, Chen and Shen (2005) reveal that the individual attention is entirely devoted and absorbed by the activity where other intentional demands is ignored.

c) Heightened Enjoyment

Heightened enjoyment means the pleasurable aspects of the usage (Agarwal and Karahanna, 2000). Enjoyment refers to the extent to which the activity of using a computer system is perceived to be personally enjoyable in its own right aside from the instrumental value of the technology (Ryan and Deci, 2000). The intrinsic pleasure of the activity is the own motivation of the individual.

d) Control

Control means the user's experience being in charge of the software usage (Agarwal and Karahanna, 2000). This dimension refers to the user's perception of being in charge of the interaction with the commercial website (Shang R.A., et al., 2005).

e) ***C**uriosity*

Curiosity refers to the curiosity that the usage arouses in individual (Agarwal and Karahanna, 2000). According to Depue (1996) and Spielberger & Starr (1994), they posit that curiosity is an important motivational component (but not the only one) that links cues reflecting novelty and challenge (internal or external) with growth opportunities. It taps into the extent the experience excites the individual curiosity (Shang R.A., et al., 2005).

E-LEARNING OUTCOME

Learning is a complex process and there could be many different factors influencing the learning outcome. Some of them are cognitive skills to take full advantage of the Web medium (Trumbull, Gay & Mazur 1992). Computer and communication skills, ability in analysis, synthesis, problem solving and evaluation as well as thinking critically and creatively are some examples of learning outcomes (Mundia, 2012). In order to succeed and excel in the education market, universities must pay more attention to their students' satisfaction and learning outcomes. Student satisfaction plays an important role in developing students' skills and knowledge that is a significant predictor of enhancing the students' learning outcomes (Letcher & Neves, 2010; Eom, 2009; Tam, 2007). Furthermore, evaluation of student learning outcomes is vital because it indicates the level of institutional effectiveness (Hou, 2010; Astin et al., 1996). Indeed, this evaluation reflects whatever is essential for improving the quality of the university (Scott, 2011). Accordingly, if universities plan to be marketized continually, they should introduce themselves to the market and their

stakeholders (students, parents, employers and governments) by exposing their evaluation of learning outcomes (Hou, 2010).

a) *System Use*

System use is an important measure of system success (Chang and Cheung, 2001; DeLone and McLean, 1992; Lucas 1978; Van der Heijden, 2004). The system use construct has also been measured as a "possible to use" and an "intend to use" construct (DeSanctis, 1982). Delone and McLean (2003) suggest that the nature, quality, and appropriateness of system use are important outcomes, and a simple measure of time spent on the system is inadequate. System use is considered a necessary condition under which systems/technologies can affect individual (learning) performance. Such research highlights the importance of use for evaluating a system in terms of its success.

b) *System Quality*

In this study, service quality refers to the support delivered by ICT technical staff. Measures for service quality include responsiveness, effectiveness and availability of technical support personnel (Delone and Mclean, 2004).

c) *Information Quality*

Information quality in this study referred to the quality of course content delivered through the course management system. Course content quality is the, "judgment by (the students) of the degree to which course content management systems are provided with valuable content, concerning the defined needs of the students" (Adeyinka and Mutula, 2010). Measures of information quality includes personalization, completeness, easy to understand, security, timeliness, availability, relevance, and format of course contents delivered through the e-learning systems. Previous studies have shown that information quality has significant positive impacts on perceived usefulness of e-learning systems (Chen, 2010; Cheng, 2012).

d) *Self-Efficacy*

Self efficacy is an individual's belief about his or her capacity to mobilize the resources requisite for successful task performances (Bandura, 1986). Mathieu, M. et al., (1993) found that individual antecedents of self efficacy (initial performance, achievement motivation and choice) influence self efficacy development. In this context, Mbarek (2011) found that self efficacy influences trainees' reactions and performance improvement during training. Hill, T. et al. (1987) examined the relationship between self efficacy and the readiness to use computers. Results indicated that efficacy beliefs predict the behavioral intentions related to learning about computers.

e) *Self-Managed Learning Behavior*

According to Eom (2010) e-learning systems placed more responsibilities on learners than traditional face-to-face learning systems. A different learning strategy, self-regulated learning, is necessary for e-learning systems to be effective. Self-regulated learning requires changing roles of students from passive learners to active learners. Moreover, students should be able to self manage the cognitive and affective processes in order to successfully complete academic tasks (Corno and Mandnach, 1983). In e-learning environment, the majority of the students who failed to pass an online course are procrastinators. Self-regulation refers to self-managing behavior, motivation, and cognition (B. J. Zimmerman, 1995).

f) *User Satisfaction*

User satisfaction is a perception of satisfaction a user has with a system in relation to what the user expected upon first use of the system (Seddon, 1997). Measures of satisfaction include adequacy, effectiveness, relevance, dependability and usefulness (Urbach and Müller, 2012). Various studies have established that user satisfaction has a significant positive relationship with continual usage intention of e-learning systems (Chen, 2010; Cho et al., 2009; Lee, 2010; Lin and Wang, 2012; Roca et al., 2006; Wang and Chiu, 2011).

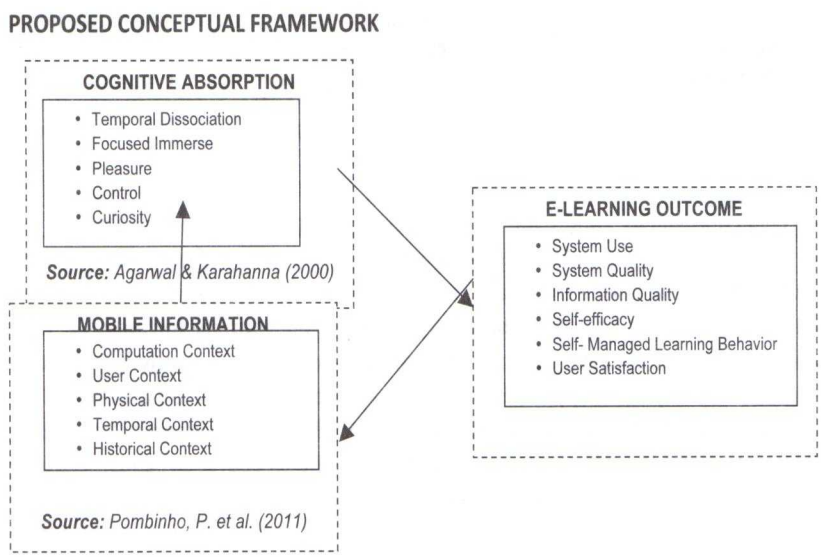

Figure 1: Proposed Conceptual Framework

METHODOLOGY

Experimental design has been documented for thousands of years with simple experiments done in order to provide evidence in various physical and natural settings (Levy and Ellis, 2011). Furthermore the use of experiments over the years increased in various fields of science including physical science, life science, social science and applied science. (Cohen and Whiteman, 1999). The quasi experiment, also known as field experiment is a type of experimental design in which the researcher has limited leverage and control over the selection of study participants. Specifically, in quasi-experiments, the researcher does not have the ability to randomly assign the participants and ensure that the sample selected is as homogeneous as desirable. (Levy and Ellis, 2011). In order to establish the information visualization framework, an exploration approach will be carried out within the selected institution settings. This is to ensure the development of the framework will understand and take into account people who will use the tools in the future (Denzin, 2000; Myers, 2009)

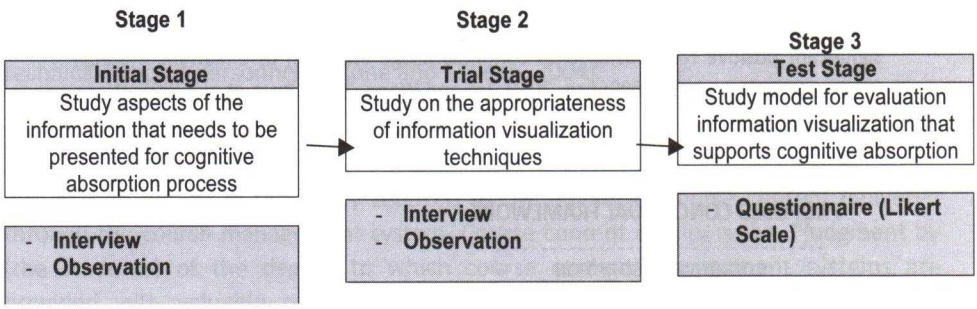

Figure 2.0: Research Design

The data collection will be conducted with at least three groups, each consisting at least ten students and led by the researcher. The research will involve three phases as shown in Figure 2.0. Activities occurring during the phases such as interview, document analysis, observation and questionnaires (likert scale) will be used whichever appropriate for analysis. The initial stage will study the perspective of what and how information is currently being used in the knowledge exploratory that support the cognitive absorption process by Group A (the actual group). The tentative models that are developed after reconsidering the information explored before the initial stage begins, such as looking into course syllabus; lecture notes, test paper, assignment etc become the basis of the investigation models on the initial stage. After the initial stage, the trail model (the refined tentative model) will be developed and used in the second stage by Group B (the trial group). The second stage will study the appropriateness of the use of the trial model by Group B in their cognitive absorption process. The information that has been collected in this stage will be used to design the test model (the refined trial model) for the final stage. In the final stage, two groups will be involved, which is Group A (the actual group) and Group C (the control group). The Group A will use the test model to support their cognitive absorption process while Group C will not

supported by the test model. The use of the control group will help to determine the advantages provided by the test model.

CONCLUSION

This paper has discussed the elements of mobile visualization for cogbnitive absorption for mobile learning that consists of 3 aspects: mobile information visualization, cognitive absorption aspects and e-learning outcome. The discussion also leads to the development of the conceptual framework of a study on the cognitive absorption and mobile information visualization. The conceptual framework will be guide to the researchers to conduct study further. The next phase of the study is employing the research methodology and analyzing data before coming to a conclusion and presenting a model as the research outcome. The finding of the study should be interest to both mobile learners and educators while larger education implications will be reflected upon.

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