

## Applied the Technology Acceptance Model to Survey the mobile-learning adoption behavior in Science Museum

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**ABSTRACT:** The concept of mobile learning was proposed by Revans from England in 1982 which has been more than 25 years (Revans, 1982). Revans offers an iterative model, successively alternating experience and preparation/reflection, which is a useful paradigm for mobile learning (McDermott et al., 2000). However, scholars perceive mobile learning in different ways. The following section contributes to various explanations of mobile learning by international scholars: m-learning is e-learning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone (Quin, 2001). Mobile learning is a context-based learning by using mobile technology medium and is learner-centered. The flexibility of mobile learning in a proper location allow learners to interact with other learners and instructors and conduct technology-learning, content learning or context-based learning that is proactive, instant, distant /approximate, individual or group-centered. Moreover, learner will experience meaningful knowledge construction through this process (Young et al., 2005). Mobile learning is defined as any educational provision where the sole or dominant technologies are handheld or palmtop devices (Traxler, 2005).

**KEYWORDS:** Technology Acceptance Model, mobile-learning, Science Museum.

### 1 INTRODUCTION

The concept of mobile learning was proposed by Revans from England in 1982 which has been more than 25 years (Revans, 1982). Revans offers an iterative model, successively alternating experience and preparation/reflection, which is a useful paradigm for mobile learning (McDermott et al., 2000). However, scholars perceive mobile learning in different ways. The following section contributes to various explanations of mobile learning by international scholars: m-learning is e-learning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone (Quin, 2001). Mobile learning is a context-based learning by using mobile technology medium and is learner-centered. The flexibility of mobile learning in a proper location allow learners to interact with other learners and instructors and conduct technology-learning, content learning or context-based learning that is proactive, instant, distant /approximate, individual or group-centered. Moreover, learner will experience meaningful knowledge construction through this process (Young et al., 2005). Mobile learning is defined as any educational provision where the sole or dominant technologies are handheld or palmtop devices (Traxler, 2005).

The following definition of m-learning are proposed based on the aforesaid theories regarding the application of mobile device in museums. In this project we came up with the following definition of m-learning : The so called mobile learning refers to mobile instant learning which must be a portable, light-weighted mobile device with wireless internet feature. The content of the device must contain multimedia systems to provide sufficient messages and allow visitors to search for information of exhibit items when necessary, transmit related information and experience real-time interaction with museum staff.

About the m-learning study area at present which can divide into two directions: one is focusing on the education level. The scholars are applying the tradition education theory with the m-learning environment, and try to discovery the learning effectiveness. Another is focusing on the learning technology system and emphasis system platform function as consideration

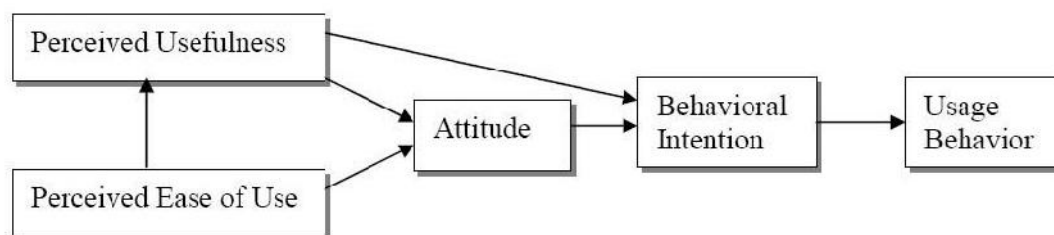
foundation. So when planning to develop m-learning system, you should consider the different goal for education learning theory and learning technology and satisfy the need of mobile learner. After all, facing the m-learning environment, the learner is the most important and direct one who can feel. So understanding the learner's factors for learning technology which includes accepting level, cognition factor, learning motivation, learning attitude and learning satisfaction will be the successful key point in the future. According to the above, this study bases on the Technology Acceptance Model and tries to modify the external variables according to the m-learning. We try to establish the evaluation model structure for the degree of m-learning satisfaction and can supply the need of m-learning industry and academy for planning and construction learning system.

The primary goal of this work was to enhance our understanding of user acceptance of m-learning in museum. This study addressed the ability to predict museum visitors' acceptance of m-learning in terms of individual difference as stipulated by the extended technology acceptance model (TAM2). The TAM2 is to explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes. Because m-learning technology is still in its development stage in museum, the crucial motivational variables that affect its adoption by museum visitors need to be explored.

## 2 RELATED LITERATURE

### 2.1 TECHNOLOGY ACCEPTANCE MODEL

The Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new software package, a number of factors influence their decision about how and when they will use it, notably: Perceived usefulness (PU) - This was defined by Fred Davis as "the degree to which a person believes that using a particular system would enhance his or her job performance". Perceived ease-of-use (PEOU) - Davis defined this as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989).



*Technology Acceptance Model (Davis, 1989)*

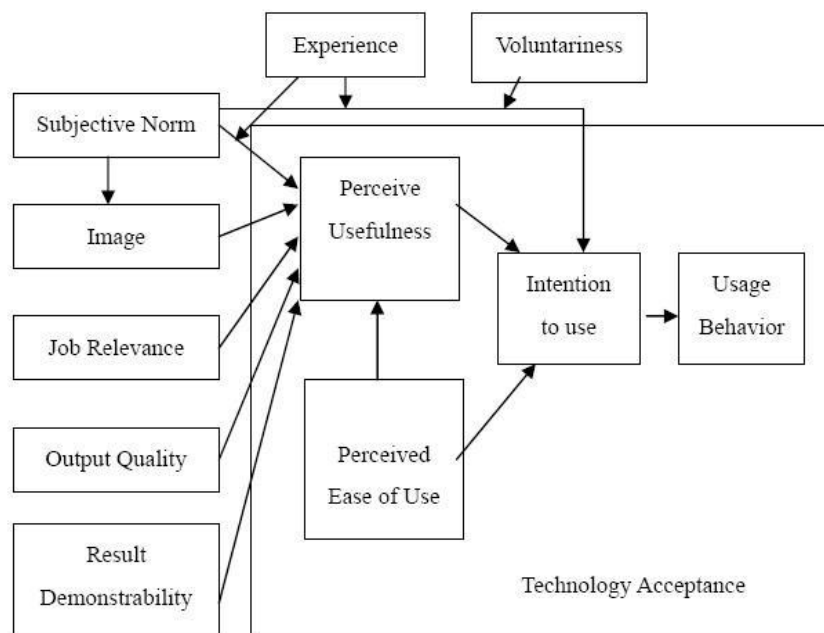
TAM is one of the most influential extensions of Ajzen and Fishbein's theory of reasoned action (TRA) in the literature. It was developed by Fred Davis and Richard Bagozzi (Bagozzi et al., 1992; Davis et al., 1989). The theory of reasoned action says that a person's intentions are the best guide to behavior. If a person intends to do a behavior then it is likely that the person will do it. Moreover a person's intentions are themselves guided by two things: the person's attitude towards the behavior and the subjective norm. To put the definition into simple terms: a person's voluntary behavior is predicted by his/her attitude toward that behavior and how he/she thinks other people would view them if they did the behavior. A person's attitude, combined with subjective norms, forms his/her behavioral intention. TAM replaces many of TRA's attitude measures with the two technology acceptance measures— ease of use, and usefulness. TAM has discovered strong relationships between individual differences and IT acceptance (Agarwal and Prasad, 1999; Venkatesh, 1999). The Technology Acceptance Model (TAM) has served as basis for past researches on IS dealing with behavioral intentions and usage of IT (Adams et al., 1992; Davis et al., 1989; Gefen and Straub, 1997; Amoako-Gyampah and Salam, 2004).

As a well-recognized theoretical basis for studying user acceptance, TAM (e.g., Davis, 1989) proposes that user's perceptions of a system's ease of use and usefulness can influence how quickly and efficiently users will adopt the new technologies. Thus, according to TAM, the easier a technology is to use, and the more useful it is perceived to be, the more positive the user's attitude and intention towards using the technology. Consequently, the usage of the technology increases. Recently, researchers have explored personal and situational factors that influence users' perceptions. One such factor is the user's perception of his/her computer self-efficacy, i.e., proficiency at using technology (Igarria and Iivari, 1995; Compeau and Higgins, 1995; Venkatesh and Davis, 1996; Venkatesh, 2000).

2.2 THE EXTENDED TECHNOLOGY ACCEPTANCE MODEL (TAM2)

While users' perceptions of computer self-efficacy have been shown to be important in their system perceptions, knowledge workers need both computer and task proficiency to apply a workplace system efficiently and effectively in performing their jobs. Thus, their perceptions of self-efficacy related to both computer technology and the underlying task are likely to affect their perceptions about the system and their intentions to use it as intended by the system developers. Earlier research on the diffusion of innovations also suggested a prominent role for perceived ease of use. Tornatzky and Klein (1982) analyzed the adoption, finding that compatibility, relative advantage, and complexity had the most significant relationships with adoption across a broad range of innovation types. Several researchers have replicated Davis's original study (Davis, 1989) to provide empirical evidence on the relationships that exist between usefulness, ease of use and system use (Adams, Nelson & Todd, 1992; Davis et al., 1989; Hendrickson, Massey & Cronan, 1993; Segars & Grover, 1993; Subramanian, 1994; Szajna, 1994). Much attention has focused on testing the robustness and validity of the questionnaire instrument used by Davis. Adams et al (1992) replicated the work of Davis (1989) to demonstrate the validity and reliability of his instrument and his measurement scales. They also extended it to different settings and, using two different samples, they demonstrated the internal consistency and replication reliability of the two scales. Hendrickson et al (1993) found high reliability and good test-retest reliability. Szajna (1994) found that the instrument had predictive validity for intent to use, self-reported usage and attitude toward use. The sum of this research has confirmed the validity of the Davis instrument, and to support its use with different populations of users and different software choices. Segars and Grover (1993) re-examined Adams et al's (1992) replication of the Davis work. They were critical of the measurement model used, and postulated a different model based on three constructs: usefulness, effectiveness, and ease-of-use. These findings do not yet seem to have been replicated.

Venkatesh and Davis extended the original TAM model to explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes. The extended model, referred to as TAM2, was tested in both voluntary and mandatory settings. The results strongly supported TAM2 (Venkatesh and Davis, 2000).



TAM2(Venkatesh and Davis, 2000)

2.3 EXTERNAL VARIABLES

Although TAM is a model applicable to a variety of technologies (Adams et al., 1992; Chin and Todd, 1995; Doll et al., 1998), it has been criticized for not providing adequate information on individuals' opinions of novel systems (Mathieson, 1991; Moon and Kim, 2001; Perea y Monsuwe et al., 2004). Davis (1989, p. 985) observed that external variables enhance the ability of TAM to predict acceptance of future technology. In other words, the constructs of TAM need to be extended by

incorporating additional factors. Choosing additional factors depends on the target technology, main users and context (Moon and Kim, 2001). Job relevance and result demonstrability seemed to play important role, but there were also cases where these were not perceived. Result demonstrability seemed to be extremely important when judging whether or not to continue using system. Subjective norm did not present itself in the form it was introduced in TAM2, but when superior did suggest experimenting using web based course tools it did take place at least in one case. Image and output quality were noticeable, but seemed not to be critical factors. All factors introduced in TAM2 were noticeable at least in some degree, but in none of the cases were all factors clearly present at the same time. These findings suggest that there seems to be personal differences in approaches towards technology. Wang et al. (2003) noted that variables relating to individual differences play a vital role in the implementation of technology. To understand user perception of M-learning, this study integrated four individual difference variables and try to set up the first level constructs, namely "learning motivation, job relevance, learning efficiency and user characteristics" into the proposed TAM2 model. Those four constructs are captioned behind.

**Learning Motivation :** Mobile Learning is not only a technology that has to be introduced but a whole concept which also requires changes in the museum exhibition to work fast and efficiently. Especially in combination with assured information delivery and just in time learning there is no clear dividing line between intranet-knowledge management systems and mobile learning environment. There are many theories of learning, some apparently more applicable to informal learning in general and to museums in particular, some seemingly more relevant to the use of digital technologies. Many of the best-known models provide useful insights, at least into identifying issues worthy of consideration. According to Falk and Dierking (1998) individual interest is one of the major factors that influence a visit to a museum. "Personal history and values play a major role in museum-going as well". The individual interest is seen as an example of intrinsic learning motivation, and it has been found to influence user acceptance importantly.

**Job relevance:** Effects of this new technology and a way of work and learning have not earned as much attention as they might deserve. Computing technology has been a major force for change in organizations for over 30 years and throughout that time there has been little evidence that developers of user applications are able to predict or plan organizational outcomes (Eason 2001). One can not deny that when implementing a new system into organization, it quite likely produces consequences which could not be predicted. About the m-learning system in museum, we try to understand whether the factor have the important effect to accept the novel technology.

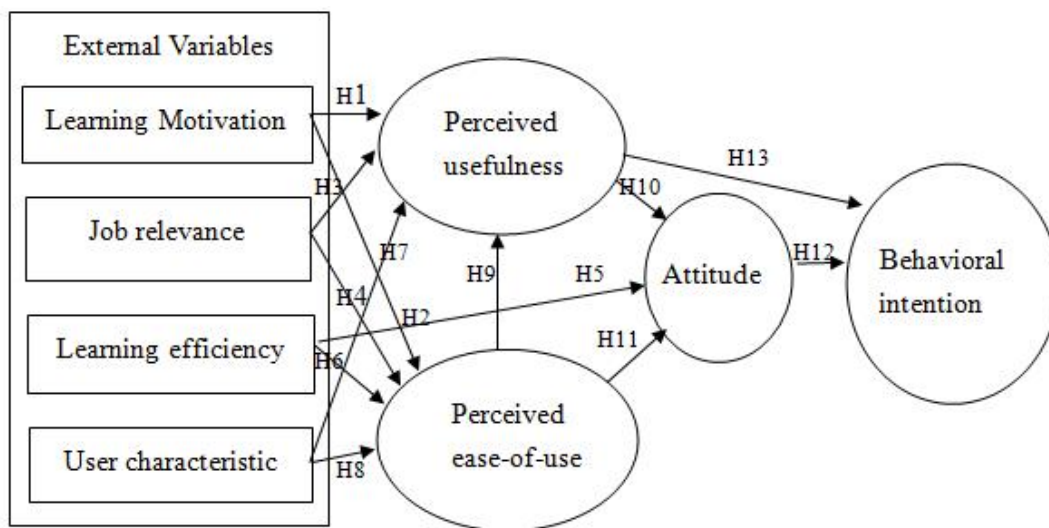
**Learning efficiency:** The most valuable function of mobile device is to provide the description content of the exhibit items. Mobile device also allows the visitor to record the content they previously viewed and provide the apparatus of self-reflection and recall memories. It is evident that internet search engine and interactive Q&A will allow the visitors to self-examine the learning efficiency in museums. Hiebert, Gallimore and Stigler's(2002) assert that 'teachers rarely draw from a shared knowledge base to improve their practice' nor do they routinely use research-based knowledge to inform their work, and concurrently draw attention to the assumption that researcher's knowledge could be of value to teachers in its generalized and trustworthy character whilst the knowledge teachers use is often considered craft knowledge, characterized more by its concreteness and contextual richness than its generalization ability and context independence. One viewpoint from the cognitive learning theorist is that new knowledge is learned by the merging of previous knowledge with new information (Hannafin & Peck, 1988). In a similar view, Brandt (1997) agrees that learners construct knowledge by making sense of experiences in terms of what is already known. So this study treats learning efficiency as a new variable in the TAM2.

**User characteristic:** When looking the results using theoretical framework from TAM, it can be quite unarguably said that perceived usefulness does play more important role than perceived ease of use. Venkatesh and Morris (2000) did suggest that this is a male dominant way of thinking, but this study does not make that clear difference between genders and personal priority knowledge of mobile device. This is quite obvious when listening stories about difficulties encountered when taking m-learning systems into use for the first time. This study treats genders and personal priority knowledge as a new variable

### 3 RESEARCH METHOD AND HYPOTHESES

This study is to discover the m-learning system user's attitude and behavior in museum. The issue includes the application of information technology and education theory. Therefore, except for integrating the TAM2 into the base of study, we also synthesis related education theory to study and evaluate the learning attitude and satisfaction level for m-learning users. Meanwhile, the mediate variables will accord to the factors of Perceived usefulness (PU) and Perceived ease-of-use (PEOU) which mentioned in TAM2. However, the both of factors of information technology and education theory are inclined to the learning cognition and ignore the subject factors. So this research will include the learning motivation, job relevance, learning efficiency and user characteristics to build the relationship between the Perceived usefulness and Perceived ease-of-use. As shown in figure 3, the proposed TAM2 includes four external variables. These four constructs may significantly affect existing

TAM variables. In addition, other relationships between the constructs by the TAM2 are also presented (Venkatesh and Davis, 2000). The next section describes in detail all hypotheses concerning the relationships among the variables in the model.



The Extended TAM model

### 3.1 LEARNING MOTIVATION

Learning Motivation has not been tested previously, but it relates to users’ personal awareness of mobility value. Mobility enables users to receive and transmit information anytime and anywhere (Anckar and D’Incau, 2002; Coursaris et al., 2003; Hill and Roldan, 2005; Ting, 2005). The mobility associated with time-related needs will encourage users to adopt mobile technology since enhanced accessibility in the museum is expected to affect hands-on interaction exhibition and high levels of engagement. Hence, visitors who perceive the value of mobility also understand the uniqueness of M-learning in museum and have a strong perception of its usefulness. In other words, perceived mobility value has a positive effect on the perceived usefulness of M-learning. Therefore, this work treats Learning Motivation as a direct antecedence of perceived usefulness and perceived easy-of use.

H1. Learning Motivation has a positive effect on perceived usefulness.

H2. Learning Motivation has a positive effect on perceived easy of use.

### 3.2 JOB RELEVANCE

The concept of Job relevance adapted from Davis et al. (2000) means that users feel helpful for their work from the instrumental value of using M-learning. Prior studies on technology acceptance behavior examined the effects of Job relevance on perceived ease of use (Venkatesh, 2000; Venkatesh et al., 2002; Yi and Hwang, 2003).

H3. Job relevance has a positive effect on perceived usefulness.

H4. Job relevance has a positive effect on perceived ease of use.

### 3.3 LEARNING EFFICIENCY

There is a causal relationship between Learning efficiency and attitude. When users feel that M-learning is easy of use, it will in turn enhance their perception of M-learning. Some research showed that attitudinal outcomes, such as happiness, pleasure, and satisfaction, result from the enjoyable experience (Childers et al., 2001; Moon and Kim, 2001; van der Heijden, 2003; Yu et al., 2005). These findings indicate that Learning efficiency highly correlates with the users’ positive attitudes.

H5. Learning efficiency has a positive effect on attitude.

H6. Learning efficiency has a positive effect on perceived ease of use.

### 3.4 USER CHARACTERISTIC

User Characteristic of gender and priority knowledge has not been tested previously, but it relates to user difference and ability to new technology.

H7. User Characteristic has a positive effect on perceived usefulness.

H8. User Characteristic has a positive effect on perceived ease of use.

### 3.5 PERCEIVED EASE OF USE, PERCEIVED USEFULNESS, ATTITUDE, AND BEHAVIORAL INTENTION

TAM delineates the causal relationships between perceived usefulness, perceived ease of use, attitude and behavioral intention to explain users' acceptance of technologies. Perceived ease of use is hypothesized to be a predictor of perceived usefulness. Additionally, attitude is determined by two salient beliefs, namely perceived usefulness and perceived ease of use (Davis, 1989). Finally, behavioral intention is determined by perceived usefulness and attitude.

The influence of perceived ease of use on perceived usefulness, TAM posits a strong direct link between perceived ease of use and perceived usefulness. If all other factors are equal, users are likely to consider a technology to be more useful if they perceive that it is easier to use (Brown and Licker, 2003; Bruner and Kumar, 2005; Hu et al., 1999; Igbaria and Livari, 1995). Therefore, perceived ease of use is likely to have a direct effect on the perceived usefulness of the construct.

H9. Perceived ease of use has a positive effect on perceived usefulness.

### 3.6 THE INFLUENCE OF PERCEIVED EASE OF USE AND PERCEIVED USEFULNESS ON ATTITUDE.

The attitude toward using a given technology is the overall evaluation that predicts a user's likelihood of adopting that emerging technology. Past research indicates that attitude is influenced by both Perceived ease of use and Perceived usefulness components (Childers et al., 2001; Dabholkar and Bagozzi, 2002; Mathieson, 1991; O'Cass and Fenech, 2003). Thus, that attitude is positively influenced by Perceived usefulness and Perceived ease of use is proposed here.

H10. Perceived usefulness has a positive effect on attitude.

H11. Perceived ease of use has a positive effect on attitude.

### 3.7 THE INFLUENCE OF PERCEIVED USEFULNESS AND ATTITUDE ON BEHAVIORAL INTENTION.

In TAM, behavioral intention is influenced by both Perceived usefulness and Attitude. This relationship has been examined and supported by many prior studies (Adams et al., 1992; Davis et al., 1989; Hu et al., 1999; Venkatesh and Davis, 1996, 2000). Therefore, this study presents the following hypotheses.

H12. Attitude has a positive effect on behavioral intention.

H13. Perceived usefulness has a positive effect on behavioral intention.

## 4 RESULT AND ANALYSIS

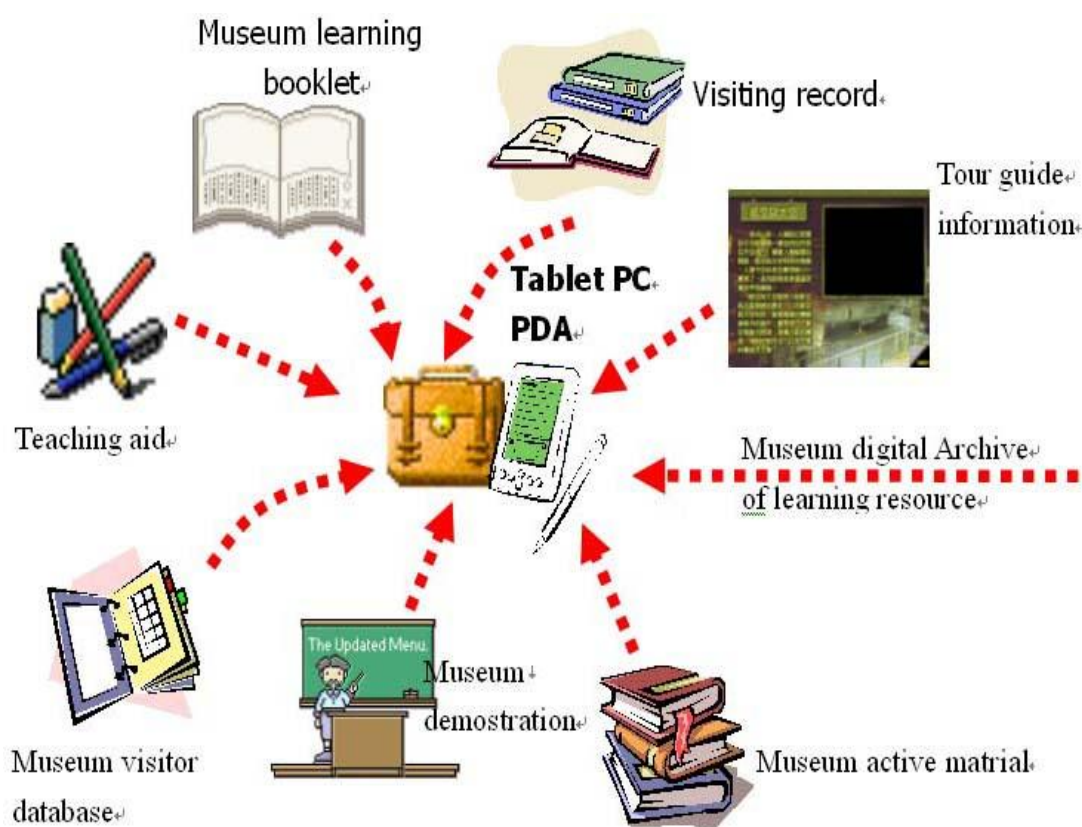
Interviews showed that people adapt and use technology in different ways. Original reasons for taking unfamiliar new technology into use did also vary. The heterogeneity of users was quite evident, although there were no real borders between different disciplines in adapting new technology. There might have been some special requirements for the actual ways of technology use in teaching though (Jyri, 2004). The pilot study is trying to construct the new extended technology acceptance model for m-learning in museum. Until now, we have the study model and will design the questionnaire for investigate the items used to construct each variable which were mainly adopted from the study.

Museums now use digital technology that contain not only sound and picture, but also the interactive device of multimedia, allowing the visitors to have more flexibility and more freely select their desired route and pace while visiting (Hawkey, 2005). In the future, mobile learning shall take the following elements into consideration:

- things to know when using mobile learning device
- Quick search and efficient learning efficiency
- the use of operation interface and accessibility
- value-added of the learning context

As the learning device provides service through wireless technology in creating a learning environment that will not be restricted by space, time and any form of mediums, it is essential that a light, easy-to-carry and reader-friendly mobile tool to optimize mobile learning (Chao, 2005) .

When people think about education and learning, they often think about information. They ask questions like: What is the most important information for people to know? What are the best ways to transmit that information from one person (a teacher) to another (a learner)? What are the best ways to represent and display information so that it is both understandable and learnable? There are so many kinds of information and activities in the museum. For examples, there are visitor records, museum tour guide, museum visitor information, museum education activity information, museum exhibition information, museum learning list, museum demonstration information, museum digital collection, and so on. So we try to integrate those informations into the structure of the mobile learning system for the museum. The chart of the system structure can be shown as follows:



*Mobile Learning System model for museums*

**5 CONCLUSION**

In the past, the learning method in museums is to present a real object or a model to the audience. However, the learning stops after visitors leave the museum. The advanced internet technology gives birth to online virtual museums which present the exhibit items digitally, distinguishing it from traditional museums which feature exhibitions, education, research and archive. Online museums thus allow learners to browse and learn through computers at home with no time limit but are restrained by the immobility of the bulky computers. Nevertheless, the development of small size mobile device, along with wireless internet technology, the assistance provide by mobile device further extends the functions of museums regardless of the location and significantly enhances learning efficiency.

The pilot study is trying to establish the relationship between the external variables and user’s attitude and behavior in the museum. The study is still under constructure and later we will do the investigation in our museum for the m-learning system exhibition which will be opened in Febuary, 2008. After that, we will finish the final in our paper to show the detal relationship between the external variables and user’s attitude and behavior.

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