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Evaluating the users' continuance intention and learning achievement toward augmented reality e-learning with user experience perspective

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Abstract:
Nevertheless Augmented Reality (AR) has been applied to various e-learning systems, the study related to learning achievement and discontinue using anomalies are still insufficient, former meaning learner's learning achievement may decline with AR e-learning system, the latter denotes learner discontinue using e-learning after initially accepting it. Emerging design approach: User eXperience Design (UXD) could provide learner with great user experience to alleviate the above issues. This paper synthesizes the Information System Success Model (ISSM) and the Expectation–Confirmation Model (ECM) to established an extension model based-on user experience perspective to discovery what critical factors affected the users' learning achievement and users' intentions to continue using e-learning. Preliminary results of this study have shown our questionnaire reached good convergent and discriminate validities. In next steps, the model will be empirically tested with e-learning through various AR designed courses.
Keywords: augmented reality, e-learning, expectation-confirmation model, information system success model, user experience design

1. Introduction

E-learning has been attracted a lot of interest among academics and practitioners from the mid-2000s. Owning flexible and economic benefits, e-learning has attracted the attention of users and developers. Augmented Reality (AR) as a technology adopted to construct a three dimensional (3D) object of vocabulary (Fred D Davis, 1989; Fishbein & Ajzen, 1975; Gefen & Straub, 1997). Recently, integrating e-learning system with AR is a promising research direction in the education fields; however, most studies aimed on the adoption of AR learning system (ARLS) rather than the learning anomaly phenomenon.

The learning anomaly phenomenon often occurs when learner learning through ARLS. The anomalies may be roughly divided into two parts: learning achievement inconsistence and discontinue using intention. Former implies learners' learning achievement may decline when they are learning through AR, latter means that learner discontinue using e-learning after initially accepting it. Emerging design approach: User eXperience Design (UXD) may alleviate the above issues, because the well-designed AR courses with UXD may provide learner with greater user experience, and then improving the learner's learning achievement and continued intention to use ARLS. Thus, based-on user experience perspective, this paper proposed an extension-model which synthesized the information system success model (ISSM) and the expectation–confirmation model (ECM) to discovery what critical factors affected the users' learning achievement and users' intentions to continue using e-learning.

In section 2, we review previous ISSM and ECT, and modify them by integrating characteristics of ARLS. The research methodology and the instrument of questionnaire are introduced in section 3; section 4 contains discussions about preliminary results. Finally, the contribution and future research are concluded in final section.

2. Research Model and Hypotheses

Pervious study Nirit (Yuviler-Gavish, Yechiam, & Kallai, 2011) indicated that learner's learning achievement were inconsistent while they learning through multimodal training, the results of the study suggested that the abundant use of multimodal training in AR applications should be re-evaluated. We suggest that UXD may alleviate the problem, the results of Baird (Baird & Fisher, 2005) have shown that integrating user experience design strategies, social networking and other media can support neomillennial learning styles, promote the formation of learning communities, improve student engagement and reflection. Müller (Müller, Law, & Strohmeier, 2010) evaluate a set of theory-grounded User Experience (UX)-related measures, the results of the study appear UX-related problem areas anchored in the DeLone and McLean's ISSM (W. DeLone, 2003) had a consistently higher level of perceived persuasiveness than those anchored in the TAM (F.D. Davis, 1985).

According to the identified determinants for system success and continued intention, based on the updated ISSM of DeLone (W. H. DeLone & McLean, 2003) and ECM of Bhattacherjee (Anol Bhattacherjee, 2001), we propose an extension-model named Extension-ISSM (EISSM) in Figure 1 as our research model.

2.1 The information system success model (ISSM)

DeLone and McLean (W. H. DeLone & McLean, 2003) hypothesize that the greater the information quality, system quality, and service quality, get more individual net benefit, ISSM model is presented in the top parts of our research model as Figure 1. At a common level, there is considerable empirical research supporting the influence of system quality on IS Use (ARLS use in this study). The technology acceptance model (TAM) (F. D. Davis, Bagozzi, & Warshaw, 1989) predicts that perceived ease and usefulness, two key aspects of system quality (W. H. DeLone & McLean, 1992), have significant effects on attitude then cause information system (IS) use. Previous research has shown that information quality and system quality influences IS use suggested by (Igbaria, 1990). Moreover, Pitt et al.'s research (Pitt, Watson, & Kavan, 1995) as well as DeLone and McLean's model (W. H. DeLone & McLean, 2003) indicated that service quality and system quality influence IS use. These relationships may also be applicable within the ARLS context. Therefore, three hypotheses were established as below:

H1: Information quality is positively related to ARLS use.
H2: System quality is positively related to ARLS use.
H3: Service quality is positively related to ARLS use.

In DeLone and McLean updated model (W. H. DeLone & McLean, 2003) which assumes that system quality, information quality, and service quality, both individually and jointly, affect user satisfaction and use. The model also suggests user satisfaction and uses to be reciprocally interdependent, and presumes them to be direct antecedents of individual impact. These relationships may also be applicable within the ARLS context; thus, five hypotheses were established as below:

H4: Information quality is positively related to user satisfaction with ARLS.
H5: System quality is positively related to user satisfaction with ARLS.
H6: Service quality is positively related to user satisfaction with ARLS.
H7: ARLS use is positively related to User satisfaction
H8: User satisfaction is positively related to ARLS

Regarding individual net benefits, DeLone and McLean (W. H. DeLone & McLean, 2003) explained that net benefits (i.e., impacts) are measured in terms of job and decision-making performance. Individual net benefits measure the results of IS usage, according to DeLone and McLean (W. H. DeLone & McLean, 2003), certain net benefits will occur as a result of IS usage and IS user satisfaction. In general terms, it can be argued that if the user is satisfied with the IS, the IS will have an impact on the user's performance. In e-learning system, user satisfied with the IS will get greater

performance. Thus, individual net benefits which denote individual learning achievement in this study. This relationship may also be applicable within the ARLS context. Hence, we hypothesize:

H9: ARLS use is positively related to individual learning achievement.

2.2 Expectation–confirmation model (ECM)

Expectation–confirmation model (ECM) was proposed by Bhattacherjee (Anol Bhattacherjee, 2001), which for explaining IT continuance behavior based on the congruence between individuals' continued IT usage decisions and consumers' repeat purchase decisions. The model consists of four constructs: expectations, perceived usefulness, confirmation, and user satisfaction. The ECM anticipated that an individual's intention to continue IT usage is dependent on: the user's level of satisfaction with the IT; the extent of user's confirmation of expectations; and post-adoption expectations, in the form of perceived usefulness.

The bottom part of Figure 1 presents the ECM model. There are five main hypotheses in the ECM. First, users' satisfaction with IT has a positive effect on their intention to continue using the IT. Some marketing studies have explored that the primary reason explain why a consumer's decision to repurchase products or patronize services is their level of satisfaction, e.g. (Bearden & Teel, 1983; Oliver, 1993; Szymanski & Henard, 2001). For continued usage of IT products/services in a consumer context, there is some similarity between re-purchasing products or services. The ECM assumes an equivalent relationship in the latter context. In turn, user's satisfaction with IT is determined by the user's confirmation of expectations and their perceived usefulness of IT (which is one type of post-adoption expectation). The confirmation of expectations suggests that users obtained expected benefits through their usage experiences with the IT, and thus leads to a positive effect on users' satisfaction. On the other hand, based on the expectancy-confirmation paradigm, users' perceived usefulness of IT has a positive effect on their satisfaction with IT by working as a baseline for reference against confirmation judgments. This relationship is supported by the adaptation level theory, which proposes that users perceive stimuli only in relation to an adapted level. Prior marketing studies have found that the higher the users' expectations, the higher are their satisfaction (Oliver & DeSarbo, 1988). Moreover, previous IT adoption studies has consistently recognized that perceived usefulness is the most important determinant of users' adoption intentions (F. D. Davis, et al., 1989; S. Taylor & P. Todd, 1995; S. Taylor & P. A. Todd, 1995; Venkatesh, 2000). As a result, the ECM assumes users' perceived usefulness of IT has a positive effect on their intention to continue IT usage. Finally, the ECM assumes the confirmation construct will have a positive effect perceived usefulness of IT, causes perceived usefulness of IT be adjusted by confirmation contrast. (Anol Bhattacherjee, 2001; A. Bhattacherjee, 2001). Because e-learning is a kind of information technology on the Internet, we hypothesize:

H10: Perceived usefulness is positively related to User satisfaction.
H11: Confirmation is positively related to User satisfaction.
H12: Confirmation is positively related to Perceived usefulness.
H13: User satisfaction is positively related to individual learning achievement.
H14: User satisfaction is positively related to continued intention.

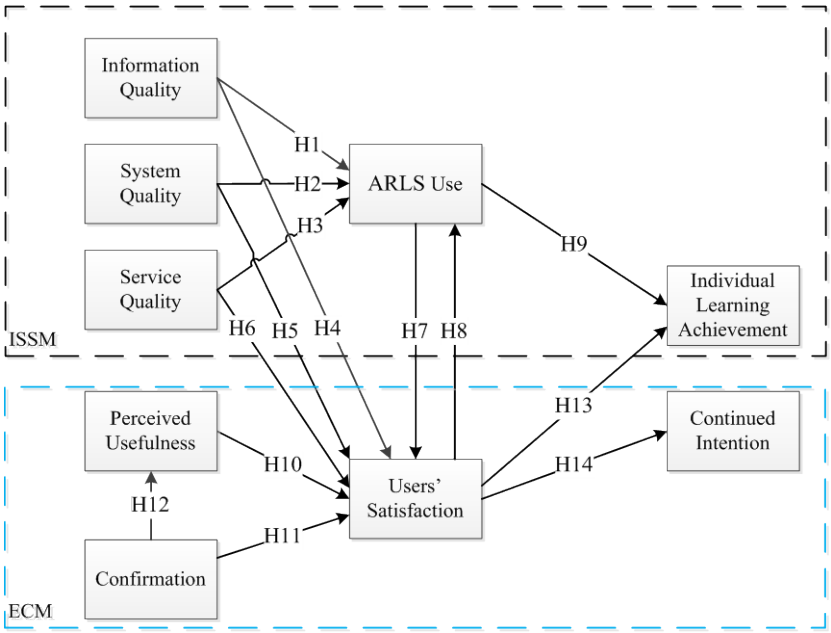

Figure 5 Research Model EISSM.

3. Methodology

3.1 Questionnaire: Instrument development and assessment of validity and reliability

In initial phrase of this study, we conducted pilot test on the 40 students who enrolled online courses about network equipment combination, for example learner can follow CISCO router operations and its modules combination with the courses that provided by our prototype ARLS. For measuring e-learning, the survey instrument is developed by adopting existing validated instruments wherever possible. Measurement items for ARLS use and Individual satisfaction were adopted from Cheung (Cheung, Chang, & Lai, 2000) and McKinney(McKinney, Yoon, & Zahedi, 2002). Measurement items for information quality were adopted from DeLone (W. H. DeLone & McLean, 2003). Questions were anchored on a seven-point Likert scale (1 strongly disagree, 7 strongly agree). To improve content reliability, the list of categorized measures was subsequently screened by an academic in charge of an augmented reality community group. We also judged construct validity by determining convergent and discriminant validity based on the level of consistency within the categorization of items (Moore & Benbasat, 1991).

4. Preliminary Results

Preliminary results in this work as shown in Table 1, the questionnaire was pilot-tested by convenient sampling. There were 40 responses, of which 37 were complete, giving a valid response rate of 92%, and the results of the pilot test were evaluated by using Cronbach's reliability and factor analysis. The reliability coefficient was first calculated for the items of each construct, and the standard lower bound for Cronbach's alpha set at 0.7 (Anderson & Gerbing, 1988), with items that did not significantly contribute to the reliability being eliminated. A factor analysis was then performed to examine whether the items produced the anticipated number of factors and whether the individual items were loaded on their appropriate factors. All items had high loadings on their related factors and low cross-loadings on other factors, which denote good convergent and discriminate validities in the questionnaire.

The next progresses about our work, an completed AR-learning system will be constructed for collecting entire user learning data in unsupervised learning environment; in turn conduct data analysis with PLS (partial least squares, PLS), which is suitable for our study for several reasons. First, PLS can test the psychometric properties of the indices and provide better evidence for the existence of relationships. Secondly, the investigation of this model is exploratory in nature. Thirdly, PLS has less

stringent standards regarding sample size, distribution parameters, and levels of correlation between variables. For this study, PLS-Graph version 3.00 Chin (Chin & Frye, 1996) and the bootstrap resampling method may be used to evaluate the measurement and structural models. We will perform data analysis in accordance with a two-stage methodology, Gerbing (Anderson & Gerbing, 1988) using PLS. The first step in the data analysis will establish the convergent and discriminant validity of constructs using the measurement model. The second step will test the structural model

Table 14 Results of reliability and validity tests.

Item	Factor loading	AVE	CR	Cronbach α
Information quality 1	0.852	0.76	0.891	0.83
Information quality 2	0.831			
Information quality 3	0.912			
System quality 1	0.725	0.683	0.840	0.903
System quality 2	0.728			
System quality 3	0.731			
System quality 4	0.828			
Service quality 1	0.767	0.689	0.913	0.917
Service quality 2	0.814			
Service quality 3	0.873			
Service quality 4	0.842			
Service quality 5	0.836			
Service quality 6	0.847			
ARLS use 1	0.697	0.684	0.954	0.926
ARLS use 2	0.737			
ARLS use 3	0.902			
ARLS use 4	0.913			
User Satisfaction 1	0.891	0.834	0.934	
User Satisfaction 2	0.913			
User Satisfaction 3	0.932			
User Satisfaction 4	0.941			
Learning Achievement 1	0.841	0.804	0.826	0.897
Learning Achievement 2	0.892			
Learning Achievement 3	0.873			
Learning Achievement 4	0.887			
Learning Achievement 5	0.932			
Learning Achievement 6	0.918			
Learning Achievement 7	0.924			
Perceived usefulness 1	0.931	0.867	0.871	0.871
Perceived usefulness 2	0.921			
Perceived usefulness 3	0.945			
Perceived usefulness 4	0.913			
Confirmation 1	0.797	0.783	0.896	0.897
Confirmation 2	0.837			
Confirmation 3	0.812			
Confirmation 4	0.883			
Continue intention 1	0.817	0.846	0.886	0.876
Continue intention 2	0.846			
Continue intention 3	0.855			

Continue intention 4	0.842

5. Conclusion and next progresses

Prior e-learning studies have found learner's learning achievement were inconsistent while they use e-learning through AR technology, and the acceptance-discontinuance anomaly phenomenon is a common occurrence. The questions are very interesting because it implies there are some critical factors positively or even negatively influence on users' learning achievement and acceptance behavior in the context. In order to explore the factors and answer the questions, this study proposed an extension model from ISSM, ECM and integrating the characteristics from user experience.

The preliminary pilot-test results of this study have shown our questionnaire reached good convergent and discriminate validities. We expect our research will present important theoretical and practical contributions. On the theoretical side, this study will develop and test the novel research model. Practically, this study will provide guidelines for practitioners to improve learning achievement in e-learning through AR technologies. Overall, this study is expected contribute toward the theoretical achievement of AR usage and provides insights into improving the e-learning through user experience. In our next steps, a complete AR e-learning system will be established to validate our research model. We expect the system well be a potential learning tool, since there were few empirical studies to measure user experience and utilize it to support e-learning with AR, this study is expected to attract interest in further research on e-learning areas.

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