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Smartphones as smart pedagogical tools: Implications for smartphones as u-learning devices

Dong-Hee Shin [a,*], Youn-Joo Shin [a], Hyunseung Choo [b], Khisu Beom [c]

[a] Department of Interaction Science, Sungkyunkwan University, 90327 International Hall, 53 Myeongnyun-dong 3-ga, Jongno-gu, Seoul 110-745, South Korea
[b] Department of Electrical and Computer Engineering, Sungkyunkwan University, 90327 International Hall, 53 Myeongnyun-dong 3-ga, Jongno-gu, Seoul 110-745, South Korea
[c] Department of Journalism and Mass Comm, Sungkyunkwan University, 90327 International Hall, 53 Myeongnyun-dong 3-ga, Jongno-gu, Seoul 110-745, South Korea

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ABSTRACT

This study aims at understanding the fundamental factors influencing users' intentions to continually use smartphones as a ubiquitous learning (u-learning) tool. This study examines consumers' experiences with smartphone learning in order to investigate the areas of its development as a u-learning application. In this paper, the modified unified theory of acceptance and usage technology (UTAUT) model is used with constructs from expectation-confirmation theory (ECT). While the findings confirm the significant roles of users' cognitive perceptions, the findings also shed light on the possibility of the smartphone serving as an enabler of u-learning. Users may want to use the smartphone as a telecommunication tool, as well as a u-learning application. The proposed model brings together extant research on smartphones and provides an important cluster of antecedents to eventual technology acceptance via constructs of continuance intention to use and actual usage of u-learning. The empirical findings demonstrate that employing perceived usability and perceived quality would be a worthwhile extension of the UTAUT/ECT in the smartphone learning context, as both were found to be influential in predicting smartphone users' attitudes and behavioral intentions. Practical implications for industry can be drawn from these findings in terms of strategies and new models for u-learning and beyond.

1. Introduction

Smartphones emerged around 2000, and sales have consistently increased with each succeeding year (Chen, Yen, & Chen, 2009). Growth in demand for advanced mobile devices boasting powerful processors, abundant memory, larger screens and open operating systems has outpaced the rest of the mobile phone market for several years. While smartphones have become very popular, they have not yet become ubiquitous in the educational sector; however, many experts predict that this technology will soon become an essential component of ubiquitous learning (u-learning) applications. Smartphones would presumably allow education professionals, such as professors, to input educational data into student records. Although smartphones would not be universally applicable for all campuses, they may prove particularly useful for ubiquitous learning applications, such as ubiquitous campus (u-campus) and mobile campus (m-campus).[1] Smartphones may prove to be quite useful in u-learning applications, but acceptance will depend on how well the user interface supports particular educational contexts.

While numerous recent studies have demonstrated increased use of PDAs and other mobile devices in educational settings (Campbell, 2005), the smartphone as a u-learning tool in the academic field has not been extensively researched. Some studies have focused on the adoption of smartphones in (1) a health care context (Park & Chen, 2007), (2) the delivery service industry (Chen et al., 2009), (3) the medical field (Trelease, 2008), and (4) individual adoption (Kim, 2008). Unanswered questions remain with respect to how users feel about the smartphone as a learning tool,

[1] The u-campus is defined as an information infrastructure equipped for ubiquitous wireless computing and communications that students, faculty, staff, and local communities can utilize easily via mobile devices, u-campus connects students to the people, information, content and offers that matter most to them while providing participating universities with real-time, interactive access to their campus through text messaging. Students can save money around town, connect with friends and even find links to concert tickets, travel giveaways and more. Ubiquitous learning (or u-learning) is equivalent to a form of simple mobile learning, i.e., learning environments that can be accessed in various contexts and situations.

* Corresponding author. Tel.: +82 02 740 1864; fax: +82 02 740 1856.
E-mail addresses: dshin@skku.edu (D.-H. Shin), cecilshin@hanmail.net (Y.-J. Shin), choo@ece.skku.ac.kr (H. Choo), kbeom@skku.edu (K. Beom).

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what users' experiences of smartphones in higher education are, and what will lead users to engage in u-learning.

It is important to investigate how users perceive usability, how their continuance intentions are formed and what cognitive perceptions are fulfilled in order to determine possible uses of smartphones in higher education. Those perceptions and experiences are essential to the learning process in education. In order to address these questions, this study applies the unified theory of acceptance and usage technology (UTAUT) to propose a smartphone acceptance model that incorporates perceived quality, satisfaction, confirmation, continuance and subjective norms as enhancing constructs to predict users' motivations for using u-learning services via smartphones.

With the integrated theoretical framework, this study conducts an empirical assessment of the research model in the u-learning context. It focuses on understanding the key factors influencing users' intentions to continually use smartphones as u-learning tools. It includes current use of smartphone learning as well as potential future uses. Eventually, it investigates the areas of smartphone development as a u-learning application. In light of this focus, this study offers a set of implications that can help academic professionals and smartphone developers to better understand how users develop perceived features, as well as an explanation of how these cognitive features contribute to users' intentions and continuance intentions for u-learning. The structural equation modeling approach was applied to assess the empirical strength of the relationships.

The findings should be of interest both to academics and practitioners. From a theoretical perspective, this study provides a model for identifying antecedents of user intentions as a contribution toward the larger effort to adopt a new form of digital pedagogy. From a practical standpoint, the findings should guide an industry that is promoting the smartphone as a u-learning tool to attract customers by enhancing usability and accessibility, as well as ensuring quality. The findings will offer insights into the implications of students' general perceptions of the smartphone as a learning tool in higher education. The smartphone industry is facing opportunities as well as challenges in developing new forms of educational applications, such as m-campus and u-campus. The results of this study demonstrate the advantages and challenges of advanced smartphone services by identifying possible uses and by prototyping feasible services and applications for u-campus.

2. Literature review

2.1. The smartphone as a ubiquitous learning tool

Due to their excellent adaptability, smartphones have been used as an application for m-campus (Clough, Jones, McAndrew, & Scanlon, 2008). SK Telecom, for example, has been providing m-campus service since 2008, with its coverage now reaching 73 universities in Korea. In the m-campus, a student can search for and borrow library books while riding on the morning subway. The student can also access the school's online system to check for any change in class schedules, register for classes and check grades. After arriving on campus, students can use their student ID card, stored as a barcode inside the handset's microchip, to mark class attendance and to reserve seats in the library.

In recent months, universities have rushed to create m-campus environments, distributing smartphones to students and faculty members so that they can check e-mail and process academic work. This has been done to cut costs and increase efficiency. The trend at university campuses in other countries, such as Stanford University, is to create digital environments where students use iPhone apps to navigate their way around campus and other high-tech tools. With IT-like smartphones, universities can be more flexible and efficient in structuring their academic affairs, including lectures. One university in Korea distributed Apple iPhones to 1500 professors, students and staff members. The devices have already facilitated communication on campus. Students can watch lectures, get their assignments and track their grades using the apps whenever and wherever they need them.

Utilizing the ubiquitous computing method, u-learning has been built into a learning context. U-learning is an advanced form of simple mobile learning in which learning environments can be accessed in various contexts and situations. A u-learning environment is any setting in which students can become totally immersed in the learning process (Liu & Hwang, 2009). A u-learning environment is a situation or setting of pervasive or omnipresent education or learning. It needs to be intelligently designed according to the strictest interpretation of the ubiquitous model so that it can predict changing contexts and user needs as they occur. The key tools of u-learning will be mobile phones, laptops and other portable wireless devices.

2.2. Theoretical background

Continuance theory is an extension of widely used system user acceptance models, such as the Technology Acceptance Model (TAM) (Davis, 1989), UTAUT (Venkatesh, Morris, Davis, & Davis, 2003), and ECT. Continuance theory focuses on experienced, continuing users rather than on those in the initial stages of technology adoption. Continuance intention is defined as an individual's intention to continue using a service in the post-acceptance stage (Bhattacherjee, 2001).

UTAUT implicitly deals with continuance by positing experience as a significant moderator of most of the relationships in the model (Venkatesh et al., 2003). Specifically, UTAUT posits two main determinants of usage behavior (usage intention and facilitating conditions), and three direct determinants of intention (performance expectancy, effort expectancy and social influence). Smartphones as a u-campus tool belong to a specific context that calls for unique constructs to be incorporated into the UTAUT in order to better explain variances. Such additional constructs fit nicely into the UTAUT domain. The modified UTAUT model enables a better explanation of smartphone acceptance and usage behavior.

Theoretical background also draws on ECT, a theory that focuses on the explanatory power of post-adoption behavior (Oliver, 1980). ECT suggests that both pre-behavior and post-behavior affect confirmation, which in turn influences satisfaction and continuance intention. According to ECT, continuance intention is defined as an individual's intention to continue using a service in the post-acceptance stage. Higher perceived performance leads to positive confirmation. The levels of confirmation then provide the basis for subsequent behaviors. Customers have a feeling of satisfaction or dissatisfaction based on their confirmation levels. Satisfied users form an intention to reuse the product in the future, while dissatisfied customers discontinue that behavior.

2.3. Combined model

UTAUT aims to explain user intentions to use an information system and subsequent usage behavior. The theory was chosen because it is comprised of four key constructs (performance expectancy, effort expectancy, social influence and facilitating conditions), which explain smartphone acceptance better than TAM. However, UTAUT has a weakness in that its coefficient of determination (R^2) is only achieved when moderating key relationships with up to four variables. Also, the grouping and labeling of items and constructs are problematic because a variety of disparate items were combined to reflect a single psychometric construct. In order to alleviate the weaknesses, the ECT model is incorporated because

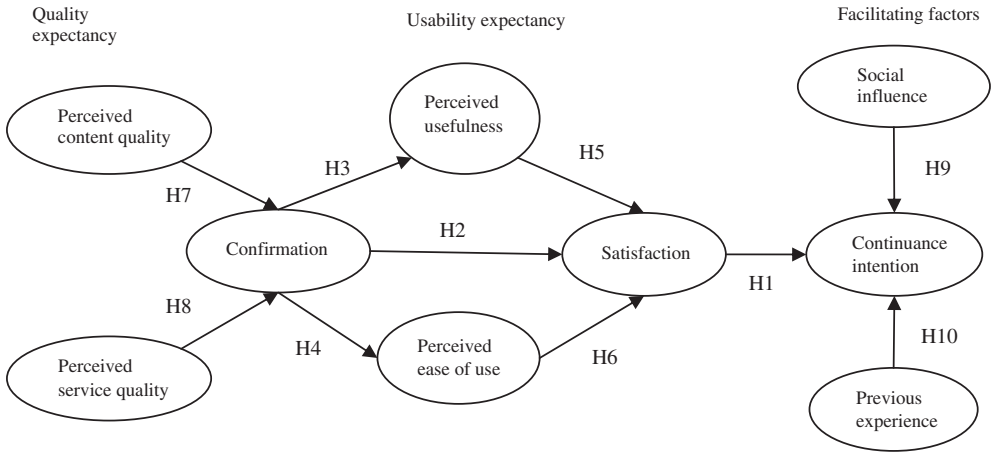

Fig. 1. Proposed research model for smartphone learning acceptance.

ECT posits that expectations, coupled with perceived performance, lead to post-purchase satisfaction. This effect is mediated through positive or negative disconfirmation between expectations and performance. Thus, by combining the two models, we can gain a better understanding as to what the expectations of smartphones are, how such expectations are confirmed/disconfirmed and by what performance factors, and how different constructs are mediated/moderated by other factors.

3. Hypotheses

The research model postulates four constructs that determine satisfaction, which then influences continuance intention (Fig. 1). Social influence is posited to affect continuance intention, while attitude is proposed to be affected by perceived usefulness (PU), perceived ease of use (PEoU) and expectation. The model is well-suited to reflect the nature of smartphones because it addresses the rapid progression of smartphones and usage dynamics toward a more fluid and agile mobile learning environment.

3.1. Satisfaction and continuance intention of smartphone learning

Extensive research on educational technology has shown that users' continuance intention is primarily determined by their satisfaction with prior IT use (Liu, Chen, Sun, Weble, & Kuo, 2010; Roca, Chiu, & Martinez, 2006). Satisfaction in this study is defined in an educational context as a psychological state related to and resulting from a cognitive appraisal of the expectation–performance discrepancy. In educational contexts, Hayashi, Chen, Ryan, and Wu (2004) empirically validated the fact that satisfaction is influenced by the level of user confirmation of online education services. Similarly, other studies, such as Shih, Muroz, and Sanchez (2006), have consistently shown the positive correlation between confirmation and satisfaction.

- H1. Users' satisfaction with the initial smartphone learning experience is positively associated with their continuance intention in u-campus services.
- H2. Confirmation of smartphone learning has a positive effect on satisfaction.

3.2. Perceived usability and confirmation of smartphone learning

Liu et al. (2010) empirically validated that PU is influenced by users' confirmation level in online services. The positive correlation between confirmation and PU has also been confirmed in virtual learning environments (Hayashi et al., 2004).

PEoU refers to the degree to which a person believes that using a particular system will be effortless (Davis, 1989). Legris, Ingham, and Collerette (2003) showed that PEoU has a strong positive correlation with intention to use an online learning system. It has been shown that PEoU is a strong belief in computer-assisted learning.

- H3. Confirmation has a positive effect on the PU of smartphone learning.
- H4. Confirmation has a positive effect on the PEoU of smartphone learning.

3.3. Perceived usability and smartphone learning satisfaction

The UTAUT studies have found that there is a positive correlation between perceived usability and satisfaction. Hayashi et al. (2004) indicated that PU was positively correlated with satisfaction in three different online education environments. Similarly, Rai, Lang, and Welker (2002) empirically showed that user satisfaction is significantly impacted by PU and PEoU. Bhattacherjee (2001) suggested that PU was a significant determinant of user satisfaction.

- H5. PU while using smartphones as a learning tool has a positive effect on satisfaction.
- H6. PEoU while using smartphones as a learning tool has a positive effect on satisfaction.

3.4. Confirmation and perceived quality of smartphone learning

According to ECT, service performance during and after the consumption experience has a positive effect on disconfirmation because higher performance is more likely to exceed expectations, resulting in positive confirmation and, ultimately customer satisfaction. Liu and Hwang (2009) extended ECT in the context of information systems by studying the relationship between perceived quality modeled in terms of information quality, service quality and system quality. Roca et al.'s study (2006) showed a significant relationship between quality and confirmation in e-learning service.

In this study, service quality and content quality are selected as antecedents of confirmation. Content is the most important in educational system to ensure a quality of education. At the same time, service quality is also essential to provide students with stable system. Thus, content and service can be fundamental qualities for smartphones as pedagogical tools.

- H7. Perceived service quality has a positive effect on smartphone learning confirmation.
- H8. Perceived content quality has a positive effect on smartphone learning confirmation.

3.5. Continuance intention and facilitating factors in smartphone learning

According to Liu et al. (2010), users' technology adoptions are influenced greatly by facilitating factors. In this study, previous experience and social influence were selected as the two factors closely related to u-campus services that facilitate intention. In the u-campus environment, users may feel uncomfortable with computer-assisted learning if they lack experience using a computer (Reed & Geissler, 1995). Research has shown that previous online learning experience can affect learners' perceptions of a new online curriculum (Cereijo, Young, & Wilhelm, 1999; Hartley & Bendixen, 2001; Liu et al., 2010).

Additionally, social norms may be an important factor in smartphone learning. Based on previous studies on social influence, the research model in this study hypothesizes a positive relationship between social influence and continuance intention in adopting smartphone learning. This is confirmed by recent empirical studies of smartphones (Verkasalo, Lopez-Nicholas, Castillo, & Bouwman, 2010).

- H9. Previous online learning experience has a positive effect on the continuance intention of smartphone learning usage.
- H10. Social influence has a positive effect on users' continuance intention to use smartphones in a u-learning context.

4. Study design

A survey was administered to a nationally representative university sample. The survey was distributed to ten universities (public and private in South Korea) where smartphones have been used in learning services. Each university was assigned 50 surveys, and each administered a survey either online or offline (class survey) to students, faculty and staff who had experienced smartphone learning. At the end of the survey period, each university returned the completed surveys. The surveys returned from the participating universities ranged in number from 20 to 50. The total number of collected surveys was 298, out of which 83 were excluded due to inconsistent responses or too many missing responses, leaving 215 valid surveys. Table 1 presents the sample demographics.

Table 1
Respondent characteristics ($N = 215$).

	Number	%
Age		
Under 20	39	18.13
21–30	151	70.23
31–40	20	9.30
Over 41	5	2.32
Smartphone experience		
1–3 months	49	22.79
3–6 months	95	44.18
6 months to 1 year	41	19.06
Over 1 year	30	13.95
Smartphone learning		
Yes	163	75.8
No	52	24.1
Education		
College	145	67.44
Master's	40	18.60
Ph.D.	25	11.62
Post-doctor	5	2.32
Gender		
Female	113	52.55
Male	102	47.44
Major		
Social Science	51	25.35
Humanities	43	20.00
Engineering	62	28.83
Physical Science	50	23.25
Others (mixed)	9	4.18
Occupation		
Students	134	62.32
Faculty	41	19.06
Staff	40	18.60

5. Results

5.1. Structural paths and hypotheses tests

The hypothesized causal paths were estimated in order to test structural relationships. Eight hypotheses were supported and two were abandoned. The results are summarized and depicted in Table 2 and in Fig. 2. The overall fit of the model was acceptable since the goodness-of-fit statistics were satisfactory. The results generally supported the proposed model, illustrating the new roles of the perceived quality of smartphones. The relationships among confirmation, satisfaction and intention were supported by the data, as indicated by a significant critical ratio (CR). Based on the significance, the relationship was identified as a key relational path because other relationships were derived from the path. PEoU of smartphones did not appear to be significantly influenced by confirmation (H4, $\beta = 0.21$, CR = 1.812), and it was more conducive to reaching a higher level of positive satisfaction (H6, $\beta = 0.30$, CR = 3.054). The influence of confirmation on PU was significant (H3, $\beta = 0.32$, CR = 2.153).

In contrast, satisfaction was the most important determinant of user continuance intention for smartphones (H1, $\beta = 0.54$, CR = 5.322). This reflects the significant effect of confirmation on user satisfaction (H2, $\beta = 0.49$, CR = 3.152). The effect of social influence (H9, $\beta = 0.42$, CR = 3.280) on continuance intention of usage was also supported by the results. There was a significant positive relationship between satisfaction and PU (H5, $\beta = 0.38$, CR = 3.413). These results imply that PU may influence satisfaction, which, in turn, affects customers' continuance intention of usage. Continuance intention was enhanced by social influence (H9, $\beta = 0.42$, CR = 3.280), but not by previous experience (H10, $\beta = 0.25$, CR = 1.910).

Fig. 2 indicates that the variance in smartphone learning intention explained by the model was 69%, which is fairly high, given that numerous factors may affect acceptance of, and intention to use, this service. The results show that 59% of the variance in individual satisfaction with the smartphone service could be explained by the large proportion of confirmation and PU, and the relatively small proportion of PEoU. Furthermore, perceived content and service quality explained 41% of the variance in individual confirmation toward the smartphone learning service.

5.2. An extended research model

The two rejected hypotheses have crucial implications for theoretical advancement. Previous studies using ECT have consistently shown that confirmation affects both PU and PEoU (Lin, Wu, & Tsai, 2005; Roca et al., 2006). In order to identify possible hidden effects, antecedent variables of confirmation were included in this study. This addition revealed an interesting baseline for revision of the

Table 2
Summary of hypothesis tests.

Hypothesis	Standardized coefficient (beta)	SE	CR	Support
H1: Satisfaction → Continuance	0.54	0.014	5.322**	Yes
H2: Confirmation → Satisfaction	0.49	0.103	3.152**	Yes
H3: Confirmation → PU	0.32	0.016	2.153*	Yes
H4: Confirmation → PoEU	0.21	0.091	1.812	No
H5: PU → Satisfaction	0.38	0.459	3.413**	Yes
H6: PoEU → Satisfaction	0.30	0.218	3.054**	Yes
H7: PCQ → Confirmation	0.38	0.154	3.392**	Yes
H8: PSQ → Confirmation	0.23	0.149	1.942*	Yes
H9: Social Infl. → Continuance	0.42	0.089	3.280**	Yes
H10: Previous exp. → Continuance	0.25	0.100	1.910	No

SE is an estimate of the standard error of the covariance.
CR is the critical ratio obtained by dividing the covariance estimate by its standard error.
* Values are critical ratios exceeding 1.96, at the 0.05 level of significance.
** Values are critical ratios exceeding 2.32, at the 0.01 level of significance.

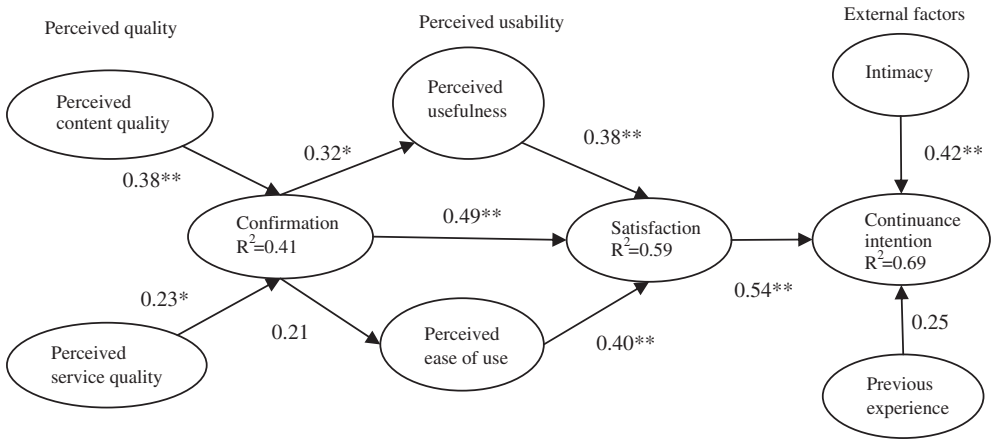

Fig. 2. Results of the initial research model.

initial model. It can be inferred that there were unexpected moderating relationships in the model; confirmation moderated the interaction between perceived service quality and PEoU and between perceived content quality and PU, and satisfaction moderated the interaction between PU and intention and between PEoU and intention.

Confirmation was found to have an unusually low effect on PU and PEoU separately. For example, the effect of confirmation on PU was shown to be highly significant (significance at $p < 0.01$) in the study by Lin et al. (2005). In many other studies, the significance levels and the magnitude of the influence of confirmation were higher than in this study (Chou & Chen, 2009; Korzaan & Morris, 2009; Roca et al., 2006). Given the minimal contribution of confirmation to the two classical TAM variables individually (PU and PEoU), the moderating effect of confirmation on the relationship between PU and PEoU should be considered. From a common sense perspective, if users are confirmed by quality, then they normally feel comfortable using the service. It can therefore be inferred that satisfaction moderates the relationship between PU and intention and also between PEoU and intention. As the effect of satisfaction on intention found in this study was somewhat higher than that seen in previous studies (Korzaan & Morris, 2009; Roca et al., 2006), and as it was also significantly higher than other effects in our model, it is reasonable to infer that satisfaction has a moderating effect. In other words, while users may have strong intention, it is unlikely their intention level is solely determined by how they feel about usefulness or ease of use.

It can be inferred that smartphone users may want to perceive more apparent usefulness than they would in other pedagogical devices. Additionally, users may want the ease of use to be more obvious for smartphones in a u-learning context than they would for other typical e-learning services. While users may be confirmed by the quality of smartphone services, the confirmation does not automatically lead users to believe in the usability of smartphones as u-campus tools. Instead, they may want to clearly conceptualize what is useful when using smartphones as u-campus or u-learning tools. Users also may want to experience the ease of receiving learning services from smartphones. Perceived content quality is a tool for users to gauge what is actually useful. In the same manner, perceived service quality is a tool for users to measure what ease of use really is when utilizing smartphone u-services.

Similarly, satisfaction may play a moderating role between PU and intention and between PEoU and intention. While users are satisfied with the usefulness of smartphones (H5: PU → Satisfaction), they may continue to use smartphones because of the usefulness they perceive. In other words, users' motivation to use smartphones can be directly influenced and strongly motivated by the PU, which is simultaneously enhanced by satisfaction. In the same manner, satisfaction can be seen as a moderator between PEoU and intention. While users are satisfied with the convenience of smartphone services (H6: PEoU → Satisfaction), they may want to use smartphones because of the PEoU alone. Thus, satisfaction can be inferred to play a moderating role between the PEoU and continuance intention.

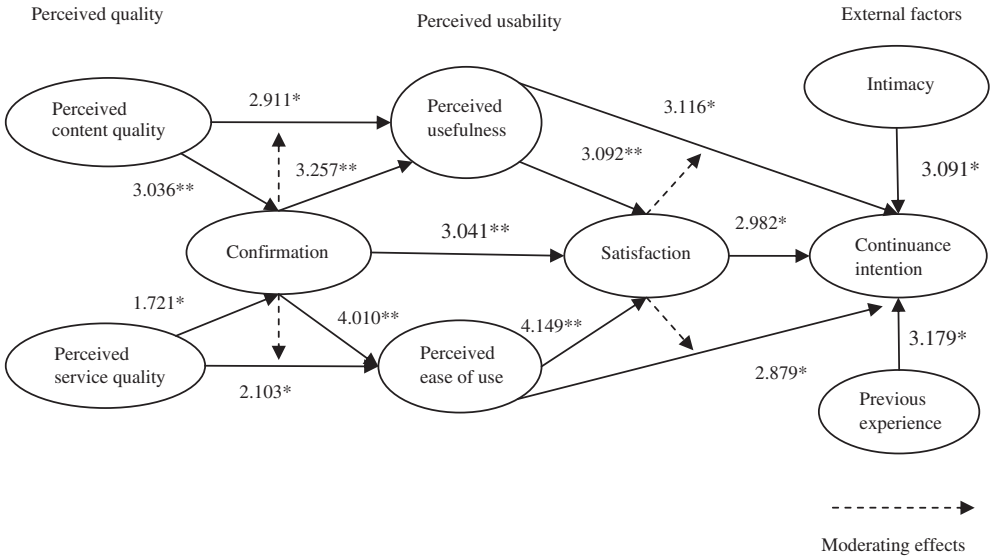

Fig. 3. Extended model with moderating effects.

Given the inferences above, testing these moderating effects and to adding new effects to the revised model is reasonable. The bootstrapping method was used for resampling in the extended model. The bootstrapping resampling procedure is a nonparametric approach for estimating the precision of paths and assessing whether or not the moderating effects are significant. In this study, bootstrapping involving 200 resamples was performed to derive *t*-statistics for the structural paths in order to obtain better statistical significance for the extended research model. This number of resamples was sufficient for obtaining adequate parameter estimates. Standard errors for calculating *t*-values are shown in parentheses next to the path coefficients. The structural model results from the extended model provide reasonable support for our theoretical model. The analysis explained a moderate-to-large amount of variance in the endogenous constructs.

The moderating effects of confirmation and satisfaction for the extended model are shown in Fig. 3. All indices were well above or below the cutoff points. The extended model had the same major links as those identified by the proposed research model. The normed chi-square for the extended model was 1.97. The adjusted goodness of fit index (AGFI), comparative fit index (CFI) and incremental fit index (IFI) were 0.94, 0.95 and 0.97, respectively. The normed fit index (NFI) and the non-normed fit index (NNFI) were 0.88 and 0.94, with RMSEA at 0.032. These results suggest that the measurement model adequately fit the data. The notable aspect of the extended model may be that the significances of confirmation of PU and PEoU were greatly increased compared to the initial model (3.257: Confirmation → PU; 4.010: Confirmation → PEoU). The direct effect of perceived content quality on PU was positive (2.911), as was the direct effect of perceived service quality on PEoU (2.103).

This finding is consistent with the significance of the moderating role of satisfaction on the paths from (1) PU to continuance intention and from (2) PEoU to continuance intention. Notably, the significance of satisfaction on continuance intention was reduced by the moderating effect (5.122 → 2.982). While the effect is reduced, the effects of both PU and PEoU on intention emerged as significant paths (3.116: PU → Intention; 2.879: PEoU → Intention). In other words, users' intentions will be greatly enhanced if they are confirmed by smartphone quality and intention. That is, using marketing terms, smartphone brand loyalty will increase with quality, and users will be more loyal to smartphones if they are satisfied with the usefulness and convenience of the smartphones.

This finding helps explicate interesting results with respect to the influences of confirmation and satisfaction on attitude and behavioral intention in technology adoption research. The results of this study indicate that smartphone users are cautious about the quality and the usability of u-learning. They want to confirm the quality of the smartphone and want to be satisfied by the usability, which then affect the continuance intention for u-campus services. The moderating roles of confirmation and satisfaction are notable, given that previous studies have not considered the antecedent effects of confirmation, nor have they investigated the antecedent influences of satisfaction. In fact, these relationships have rarely been empirically tested together. These relationships and the moderating effects are worthy of further development in future studies.

6. Discussion

Consistent with prior research, the results of this study show that satisfaction and confirmation are the two main predictors of intention. Previous studies have shown (Lin et al., 2005; Liu et al., 2010) and this study confirms the importance of usability. This study further clarifies that usability can be enhanced by service and content quality. These findings suggest the need for smartphones to provide educational content quality, as well as excellence of service to users, whether they are students or professionals. Focusing on user perceptions of smartphone quality is one key factor for achieving a market breakthrough. Although the quality issue has emerged as a major factor in smartphone acceptance, to date, the research on this issue is quite sparse, especially from the perspective of u-campus applications. This current study seeks to approach the issue from an empirical perspective so as to gain a better understanding of the concept of smartphone usability in the context of u-campus. In this study, the users' perception of quality showed a much stronger impact on intention than previous studies on IT use have indicated (Shin, 2008). In addition, the fact that perceived usability is closely and systematically interrelated with perceived quality was identified. The two sets of variables are mediated by confirmation and satisfaction, which eventually contribute to continuance intention. While usability and quality are important

factors, confirmation and satisfaction together play a mediating/facilitating role between quality and usability. This implication is important in the context of u-learning, in which various factors are intertwined in a complex fashion. Thus, clarification of the factor relationships can produce important implications for designing u-learning systems that utilize smartphones. Additionally, intriguing findings can be derived from the insignificant relationship between confirmation and PEoU. This weak link is consistent with the insignificant effect of previous experience on intention.

These two findings together imply that smartphones become increasingly easy to use and have few difficulties in their use. This inference is in line with recent studies that have shown PEoU replaced by other factors, such as enjoyment and utility (Shin, 2007; Verkasalo et al., 2010). Related to this point, the definition of ease of use may be redefined in the TAM literature. In response to the changing technological environment, the classical definition of ease of use may be changed in an educational context from "using technologies with little effort" to "utilizing technologies effectively." In this study, the respondents were educated students, and this purposive sampling may have led to low effects of PEoU and previous experience. Thus, while this finding may be useful, it should be clarified by future studies.

This finding constitutes a theoretical improvement for the UTAUT and ECT. As antecedent variables, the roles of PU/PEoU are important because one of the limitations of the current literature is that it does not help us explain acceptance in ways that guide development beyond suggesting that system characteristics have an impact on perceptions of ease of use and usefulness. Therefore, it is essential to understand the antecedents of the key acceptance variables to be able to explain individuals' acceptance and use. This study sought the answers by focusing on the end-user perspective in terms of how educational users perceive and interact with smartphones and how smartphone factors influence the development of users' attitudes toward u-learning. The findings not only support previous research on smartphone adoption (Chen et al., 2009; Kim, 2008; Park & Chen, 2007), but also provide a guide to designing smartphones that are useful for the u-campus.

7. Practical implications for education

Practical implications for the education sector can be drawn from these findings in terms of strategies and new models for u-learning and beyond. The findings of this study imply that the potential of smartphone user interfaces is not being fully realized in the context of u-learning. Based on the importance of customers' PEoU, educators should devise an easier way to use u-campus services. In particular, both students and educators should be able to utilize smartphones effectively and with little effort. The high level of PEoU found in this study is consistent with the findings of other studies, suggesting that users may regard convenience, accessibility and enhanced functionality as the primary benefits of the u-campus. Also, users may perceive traditional pedagogy as having an advantage in terms of ease and convenience of learning.

Thus, for smartphones to thrive as a u-campus tool, users should be provided with conveniently accessible enhanced functionality as well as ease of use and an enjoyable learning experience. Smartphones have the potential to stimulate new forms of learning opportunities and will require vendors to think differently about how to accommodate the needs of users as their preferences become more diverse. Viewing u-campus through the lens of traditional educational services might cause educators to miss important opportunities to enhance the user research experience.

Based on the finding that perceived quality impacts behavioral intention through attitude, educators should establish u-campus services by ensuring that their services provide users with quality of content and that those services are offered in accordance with users' expectations. Specifically, services should be reliable and promises and commitments should be kept. It has been argued that the most significant potential of smartphones lies in the areas of versatility and compatibility. As people turn increasingly to smartphones for many services they formerly obtained from other sources, their expectations for those services will change. Those changing expectations will undoubtedly have an impact on the development of future smartphones as ubiquitous tools. Specifically, the education industry may want to consider the following suggestions:

- Based on the finding of the importance of content quality, educational content providers must advocate for a standardized file format that is compatible with various platforms.
- In terms of usefulness and ease of use, service providers should consider developing better display technologies that are needed to enhance smartphone readability.
- Educational users want better service and new devices. Service quality in a smartphone format seems to be significant. Smartphone manufacturers should work with service providers to provide users with stable and secure services.

In conclusion, considering the ever-changing nature of smartphones, this study offers assistance in understanding behaviors associated with smartphone use, as well as implications for developing effective u-campus services. As user acceptance of smartphones as a new means of education and administration increases, and as firms begin to provide enabling platforms for users, the u-campus might become a superior application for the next generation of u-learning platform applications.

However, to become popular, smartphones have several challenges to overcome, and user acceptance is probably the most important of these. U-learning cannot replace the advantages of traditional education, in spite of the conveniences u-learning offers, such as easy storage and portability. It may be necessary to combine traditional pedagogy and u-learning formats to provide analog teaching and digital interaction to users. Service developers need to gain a better understanding of individual behaviors concerning u-learning, and should create effective linkages of analog pedagogy to digital interaction. This study provides a basis for an evaluative framework to determine behaviors of smartphone users and suggests an implicative way to develop smartphones as effective u-campus tools.

8. Limitations and future studies

Several limitations narrow the scope of the above conclusions. First, the findings reflect only limited aspects of user experiences with smartphones. This research is exploratory, and the inferences are tentative because u-campus is in the very early stage of development. These circumstances lead to a limited generalizability. In addition, because this study focuses on smartphones, generalizing the findings to other IT contexts, such as e-books, PDAs and tablet PCs, is difficult. Given that the population of smartphone users (and e-learning users) currently exceeds several million, the sample size of 215 may be inadequate. In addition, the research model is only valid for the Korean smartphone market, as the sample was drawn only from Korean users. Thus, the generalizability of this finding is limited.

With all of these limitations, the question that lingers is: To what extent do the findings of this study reflect the actual phenomena of the u-campus? Future studies should sample a larger number of users from different contexts; this may be achieved

using stratified sampling or a quota sampling method to ensure a certain distribution of demographic variables. A generalized application of the extended model would require a global data collection process for a more thorough validation. In addition, because perceived quality and usability are intrinsic motivations, it is not possible to generalize the findings to other applications. For example, because perceived quality is subjective, every smartphone user would rate u-learning quality differently, but there are differing expectations and levels of gratification when it comes to quality. The same logic applies to users' learning capabilities. All in all, this study took a first step toward exploring the user experience with u-learning and found a number of metrics to be reliable and nomologically valid.

Despite its several limitations, one modest contribution of this study is the exploration and testing of metrics for user behaviors in regards to increasingly popular smartphone services. In addition to the fact that all of the scales used in the study showed fairly high reliability, those of satisfaction, confirmation, and functionality demonstrated high nomological validity. Testing them against other factors will advance the understanding of smartphone user behaviors as a new paradigm of digital pedagogy.

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