A near field communication-enabled e-learning environment for context-aware mobile Japanese conversation learning

Chun-Chia Wang
Department of Information Management,
Taipei City University of Science and Technology,
Taipei, Taiwan
Email: toshhilotowang@gmail.com

Abstract: In this study, we utilised near field communication-enabled smartphones with context-aware technology to propose a context-aware mobile Japanese conversation learning system (CAMJAL) for Taiwanese students. Our proposed CAMJAL system was implemented to record students’ learning behaviours between peers in a context-aware computing environment. This system extend perceived convenience as external variable to technology acceptance model (TAM) to analyse its explanatory power and examine antecedent factors that affect acceptance of CAMJAL. Participants were 86 university students with advanced Japanese abilities from the northern part of Taiwan. After conducting CAMJAL with near field communication-enabled smartphones, data was collected by questionnaires. Our experimental results revealed that a) perceived convenience, perceived ease of use, and perceived usefulness were antecedent factors that affect acceptance of CAMJAL; b) perceived ease of use had a significantly positive effect on perceived convenience; c) perceived convenience had a significantly positive effect on perceived usefulness; d) perceived ease of use and perceived usefulness had a significantly positive effect on attitude towards use; and e) perceived ease of use, perceived usefulness, and attitude towards use had a significantly positive effect on behaviour intentions to learning. Overall, the extended TAM was effective in predicting and explaining the acceptance of CAMJAL.

Keywords: context-aware computing; mobile learning; near field communication; perceived convenience; technology acceptance model.


Biographical notes: Chun-Chia Wang received his MS and PhD in Computer Science from TamKang University, Taiwan, in 1994 and 1997, respectively. He is now an Associate Professor in Department of Information Management at Taipei City University of Science and Technology, Taipei, Taiwan. He was the Chairman of Department of Information Management and Director of Computer Center at Taipei City University of Science and Technology. His research interests include e-learning, e-commerce, multimedia computing and networking, and software engineering.
1 Introduction

In the past decade, the rapid improvement in broadband and wireless internet technologies has promoted the utilisation of wireless applications in our daily lives. Such an environment, a variety of embedded and invisible devices, as well as the corresponding software components, have been developed and connected to the internet wirelessly. This new internet-ready environment has established a ubiquitous computing environment which enables many people to seamlessly utilise huge amounts and various kinds of ‘functional objects’ through network connections anytime and anywhere (Minami et al., 2004). Ubiquitous computing is the latest trend in the information and communication world. It is normally associated with a large number of small electronic devices (small computers) which have computation and communication capabilities such as smart mobile phones, contactless smart cards, handheld terminals, sensor network nodes, radio frequency identification (RFIDs) etc., which are being used in our daily lives (Sakamura and Koshizuka, 2005). Lyytinen and Yoo (2002) stated that “the evolution of ubiquitous computing has been accelerated by the improvement of wireless telecommunications capabilities, open networks, continued increases in computing power, improved battery technology, and the emergence of flexible software architectures”. Therefore, another feature of ubiquitous computing is the use of wireless communication objects with sensors which can sense user information and environmental information in the real world and then provide personalised services accordingly. Such a feature is often called ‘context awareness’ (Khedr and Karmouch, 2004; Yang, 2006).

Based on ubiquitous computing technologies, electronic-learning (e-learning) researchers have noticed the progress of wireless communication and sensor technologies in recent years; therefore, the research issues have progressed from web-based learning to mobile learning (m-learning) (Chen et al., 2008), and from m-learning to context-aware ubiquitous learning (u-learning) or ubiquitous contextual learning, in which the learning system can detect students’ behaviours and guide them to learn in the real world with personalised support from the digital world (Hwang et al., 2008). U-learning can also be defined as “a new learning paradigm in which we learn about anything at anytime, anywhere utilising ubiquitous computing technology and infrastructure” (Sakamura and Koshizuka, 2005; Boyinbode and Akintola, 2008). It not only supports learners with an alternative way of dealing with problems in the real world, but also enables the learning system to more actively interact with the learners (Hwang et al., 2008; Hwang et al., 2010; Hwang et al., 2009; Yang et al., 2008). As the result, u-learning has attracted the attention of researchers to provide the right information at the right time and place for accommodating life and work style. Several significant characteristics of u-learning, which make it different from traditional e-learning, have been discussed, including seamless services, context-aware services, and adaptive services (Bomsdorf, 2005; Yang, 2006; Yang et al., 2007; Hwang et al., 2008). Researchers have also proposed the criteria for the establishment of u-learning, which include permanency, accessibility, immediacy, interactivity, and situating of instructional activities (Chen et al., 2002; Curtis et al., 2002).

Furthermore, computer supported collaborative learning (CSCL) (O’Malley, 1995) environments fulfil ubiquitous learning that focuses on the socio-cognitive process of social knowledge construction and sharing. In an information-rich world, we face the
A near field communication-enabled e-learning environment

challenge that is not only to make information available to people at any time, at any place, and in any form, but specifically to say the right thing, at the right time, and in the right way (Fischer, 2001). With the ubiquitous computing environment, it enables people to learn at any time and any place. Nowadays, ubiquitous learning has integrated high mobility with embedded computing environments and takes place in a variety of learning spaces (Chen et al., 2002; Ogata and Yano, 2004). In this study, we focused on learning conversation in Japanese as an application domain of u-learning, because Japanese conversation is strongly influenced by situations for native speakers of Japanese, e.g., the formality of conversation scenes. The proposed system, context-aware mobile Japanese conversation learning system (CAMJAL), was used to tackle the issues of right time and right place for learning Japanese in a ubiquitous computing environment. Learners used NFC-enabled smartphones, and CAMJAL provided them with the appropriate conversation for the context. Finally, this study aimed to predict and explain the acceptance of CAMJAL.

2 Literature review

2.1 NFC-based educational services

Research in NFC-based educational services has been growing in recent years due to a touch-based interaction paradigm. NFC technology allows electronic devices to interact with other devices simply by touch. Many studies have demonstrated the main advantages of NFC by using it simply and quickly and the speed of connection establishment. For example, Rukzio et al. (2006) found that touching with a mobile device is an intuitive, natural and non-ambiguous interaction way that does not incur much cognitive load for users. Välkkynen et al. (2006) stated that touching is an effortless way to select objects in the environment and easy to learn and use. Recently, a study of the interactive learning conducted by Garrido et al. (2011) introduced a NFC-based pervasive games with Moodle to encourage students’ learning motivation for a better understanding of the concepts by using NFC mobiles. Some other studies showed that the applications of NFC-base technology were effective when explored an attendance supervision system to integrate with children and teachers’ everyday school routines mainly due to the intuitiveness and effortlessness of the NFC touch-based interaction technique (Ervasti et al., 2010), and supported an examination systems by NFC technology in universities (Sodor et al., 2011). Although some diverse innovative NFC services in university and school settings were tested and implemented (e.g., Ayu and Ahmad, 2014; Ivanov, 2013; Miranda and Pastorelly, 2011; Miraz et al., 2009a, 2009b), NFC-based technology research must include studies examining how the implementations of NFC services and prototypes can create a mobile and ubiquitous digital learning environment to promote the diversity and fun of learning while facilitating students to learn more effectively at anytime and anywhere is necessary for consideration. These research findings discussed above have become the important bases of developing NFC-based educational teaching and learning methods. Thus, in this study, an attempt was made to explore a NFC-enabled learning environment via mobile phones to prove the usefulness of NFC-based technology for the process of language learning.
2.2 Technology acceptance model

Technology acceptance model (TAM) was proposed by Davis based on the theory of reasoned action (TRA) and aimed to construct a model for explaining and predicting users’ acceptance of a certain information system (Davis, 1989). From the perspective of TAM, both of perceived ease of use (PEOU) and perceived usefulness (PU) are assumed to be related to the acceptance of a computer or technology system. TAM suggests that perceived ease of use and perceived usefulness are beliefs about a new technology that influence an individual’s attitude toward and use of that technology (Davis et al., 1989). Recently, TAM has been employed by many experimental studies related to information technology and systems, including e-learning (Ong and Lai, 2006; Roca and Gagné, 2008), mobile learning (Chang et al., 2012; Park et al., 2011; Tai and Ting, 2011), blended learning (Tselios et al., 2011), online community (Liu et al., 2010), world wide web (Moon and Kim, 2001), mobile services (Hung et al., 2003; Lapczynski and Calloway, 2006; Liao et al., 2007; Wang et al., 2006; Yang, 2005), and wireless LAN (Yoon and Kim, 2007). These studies found that TAM efficiently predicted and explained users’ acceptance toward information technology (Legris et al., 2003).

Meanwhile, technology acceptance can be defined as a user’s willingness, agreement, acceptance, and continuous use of information technology. It can be categorised into attitude acceptance and behaviour acceptance (Arning and Ziefle, 2007). Attitude towards use, intentions to use, and actual use in TAM are indicators of technology acceptance. However, TAM can only be a relative indicator because data is self-assessed and not able to assess actual use (Legris et al., 2003) such that TAM-related studies (Roca and Gagné, 2008; Wang et al., 2006; Yoon and Kim, 2007) neglected actual use as an indicator of technology acceptance. Therefore, the TAM-related studies examined relationships among external variables, namely perceived ease of use, perceived usefulness, attitude towards use, and intentions to use.

Though perceived ease of use and perceived usefulness are two important determinants for an individual’s acceptance on information technology, even using mobile technology for e-learning (Chang et al., 2012), many studies predicted and explained users’ information technology acceptance based on TAM with external variables, and examined relationships between external variables and TAM variables, such as self-efficacy (Wang et al., 2006), perceived quality (Roca et al., 2006), perceived value (Turel et al., 2007), perceived playfulness (Moon and Kim, 2001; Roca and Gagné, 2008), and perceived convenience (Chang et al., 2012; Yoon and Kim, 2007). Originally, TAM assumed that external variables affect perceived usefulness and perceived ease of use directly, and perceived ease of use and perceived usefulness mediate the technology acceptance. However, many studies showed that external variables not only affected the technology acceptance indirectly by perceived ease of use and perceived usefulness, but also affected technology acceptance directly (Burton-Jones and Hubona, 2006; Chang et al., 2012; Moon and Kim, 2001; Ong and Lai, 2006; Yoon and Kim, 2007). Finally, attitude towards use also positively influenced behaviour intentions to use on technology adoption (Hung et al., 2003; Liao et al., 2007).

2.3 Perceived convenience

Product and service are two kinds of convenience for consumers. Berry et al. (2002) explained that a way to determine whether a product or service is convenient depends on
time and effort. A product or service is considered to be convenient when it is available to save time for a user. On the other hand, a product or service is considered to be convenient when it reduces the cognitive, emotional, and physical burdens for a user. In early marketing usage, convenience denoted the time and effort consumers used in purchasing a product rather than a characteristic or attribute of a product (Brown, 1990). Brown (1990) examined five dimensions of the convenience of a product or service, namely time, place, acquisition, use, and execution. Cheolho and Sanghoon (2007) adopted variables of perceived usefulness, perceived ease of use, behaviour intentions, and perceived convenience to analyse a ubiquitous wireless LAN environment. The analytical results indicated that perceived ease of use has significantly positive effects on perceived convenience. But, perceived convenience has no significant impact on behaviour intentions to use wireless LAN. Yoon and Kim (2007) examined the convenience of wireless LAN based on the perspective of the convenience suggested by Brown (1990), but only using three dimensions: time, place and execution. To et al. (2007) revealed that convenience value affects shopping motivation, which was a determinant of consumers’ intentions to shop on the internet. Hossain and Prybutok (2008) studied on RFID and Gupta and Kim (2007) studied on online shopping showed that perceived convenience is an antecedent factor that affects intentions to use a mobile technology or system.

However, Yoon and Kim (2007) studied ubiquitous computing by extending TAM with perceived convenience and found that perceived convenience doesn’t affect intentions to use directly. Besides, Yoon and Kim (2007) also found that perceived ease of use positively affects perceived convenience, and perceived convenience positively affects perceived usefulness. Their findings were contradictory to Hossain and Prybutok (2008), who proposed that convenience includes ease of use and usefulness. Consequently, there is a need to further examine the relationships between perceived convenience and TAM variables in certain circumstances.

Figure 1  The theoretical model and hypotheses (see online version for colours)
3 Research model and hypothesis development

Perceived convenience is one of the features of mobile learning, and it was employed in this study to extend TAM as proposed by Davis. Attitude towards use (ATU) and behaviour intentions to learning (BIL) were indicators of technology acceptance in the extended TAM. Relationships among perceived convenience, perceived ease of use, perceived usefulness, attitude towards use, and behaviour intentions to learning were examined in CAMJAL system. The theoretical model and hypotheses of this study were proposed based on theories and related studies from literature review as shown in Figure 1.

3.1 Hypotheses on relationships between perceived convenience and TAM variables

Yoon and Kim (2007) found that perceived ease of use positively affects perceived convenience in a wireless LAN acceptance model. Chang et al. (2012) also found that perceived ease of use has a positive influence on users’ perception of convenience in their study. Thus, Hypothesis 1 is perceived ease of use positively affects perceived convenience in using mobile technology for Japanese learning in the present study.

H1 Perceived ease of use positively affects perceived convenience in using mobile technology for Japanese learning.

Yoon and Kim (2007) and Chang et al. (2012) found that perceived convenience positively affects perceived usefulness. Therefore, hypothesis 2 was established as perceived convenience positively affects perceived usefulness in using mobile technology for Japanese learning in the present study.

H2 Perceived convenience positively affects perceived usefulness in using mobile technology for Japanese learning.

Although Yoon and Kim (2007) found that perceived convenience doesn’t directly affect intention to use a wireless LAN, they did not examine relationships between perceived convenience and attitude towards use of a wireless LAN. According to the literature review, perceived ease of use is an antecedent factor that affects perceived convenience; perceived ease of use positively affects attitude towards use of technology (Chang et al., 2012; Davis et al., 1989; Kuo and Yen, 2009) and attitude towards use of technology mediated the effect of perceived ease of use on intentions to use technology (Castañeda et al., 2007; Davis et al., 1989). These results implied that perceived convenience might positively affect attitude towards use of technology; thus, Hypothesis 3 was established as perceived convenience positively affects attitude towards use mobile technology for Japanese learning.

H3 Perceived convenience positively affects attitude towards use mobile technology for Japanese learning.

3.2 Hypotheses on relationships between TAM variables

According to the TAM model, relationships between perceived ease of use, perceived usefulness, attitude towards use, and behaviour intentions to learning were as follows:
perceived ease of use positively affects perceived usefulness;

b. perceived usefulness and perceived ease of use positively affect attitude towards use; and

c. perceived usefulness and attitude towards use positively affect intention to learn.

These relationships have been examined by various technology acceptance studies on websites (Chang et al., 2012; Moon and Kim, 2001) and mobile services (Kuo and Yen, 2009). A study of ubiquitous computing by Yoon and Kim (2007) and a study of e-learning technology acceptance model by Ong et al. (2004) found that perceived ease of use positively affects intention to use e-learning. Therefore, with a Japanese mobile learning environment, relationships between perceived ease of use, perceived usefulness, attitude towards use, and behaviour intentions to use mobile technology for Japanese learning were derived as follows:

H1 Perceived ease of use positively affects perceived usefulness.

H2 Perceived ease of use positively affects attitude towards use of mobile technology for Japanese learning.

H3 Perceived usefulness positively affects attitude towards use of mobile technology for Japanese learning.

H4 Perceived usefulness positively affects behaviour intentions to use mobile technology for Japanese learning.

H5 Attitude towards use positively affects behaviour intentions to use mobile technology for Japanese learning.

H6 Perceived ease of use positively affects behaviour intentions to use mobile technology for Japanese learning.

4 Research method

4.1 Samples

The university students were suited to attempting CAMJAL activities. With wi-fi available on campus, these students took part in learning situations allocated in different classrooms, and got more self-study time and spare time. The participants were 86 university students taught by the same instructor randomly assigned to 43 groups (i.e., each group consisted of two students). A total of 86 responses (100%) were received due to no missing data. The sample consisted of 24 males (27.9%) and 62 females (72.1%) and ranged from 19–23 years of age. Respondents had over four years of network and online learning experience (45.3%), and half a year of mobile learning experience (64%).

4.2 Measures

Data for latent variables was collected by a questionnaire with a 5-point Likert-type scale. The response options were from 1 (strongly disagree) to 5 (strongly agree). The five latent variables from the previous studies were modified to measure variables in this study. Each measurable variable was reviewed by two Japanese instructors, four
university students and two information technology experts to confirm that questions for each variable were clear enough and were described properly. The measurement of perceived convenience drawn from Yoon and Kim (2007) and Chang et al. (2012) was modified with four items, and the measurement of perceived ease of use, perceived usefulness, attitude towards use, and behaviour intentions to learning drawn from Davis (1989) and Moon and Kim (2001) were also modified with 4, 5, 4, and 4 items, respectively. Operational definitions for the latent variables and the measured items are shown in Table 1.

Table 1  Operational definitions for latent variables and measured items

<table>
<thead>
<tr>
<th>Latent variables</th>
<th>Operational definitions</th>
<th>Measured items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived convenience</td>
<td>Perceived convenience is defined as a level of convenience towards time, place, and execution that one feels when pursuing a task during the CAMJAL</td>
<td>PC1 I can learn Japanese at any time through the CAMJAL</td>
</tr>
<tr>
<td>(PC)</td>
<td></td>
<td>PC2 I can learn Japanese at any place through the CAMJAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PC3 The CAMJAL is convenient for me to engage in Japanese learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PC4 I feel that CAMJAL is convenient for me to learn Japanese</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>Perceived ease of use refers to a level of easiness that one feels when using CAMJAL</td>
<td>PEOU1 Learning to operate CAMJAL would be easy for me</td>
</tr>
<tr>
<td>(PEOU)</td>
<td></td>
<td>PEOU2 My interaction with CAMJAL would be clear and understandable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEOU3 It would be easy for me to become skillful at using CAMJAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PEOU4 I would find CAMJAL easy to use.</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>Perceived usefulness is a feeling that one holds towards the improvement in CAMJAL</td>
<td>PU1 Using CAMJAL would enable me to accomplish my learning Japanese more quickly</td>
</tr>
<tr>
<td>(PU)</td>
<td></td>
<td>PU2 Using CAMJAL would improve my learning Japanese performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PU3 Using CAMJAL would increase my learning Japanese productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PU4 Using CAMJAL would enhance my learning Japanese effectiveness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PU5 I would find CAMJAL useful in my learning Japanese</td>
</tr>
<tr>
<td>Attitude towards use</td>
<td>Attitude towards use is an attitude that one feels positively towards the CAMJAL</td>
<td>ATU1 Learning Japanese through CAMJAL is a good idea</td>
</tr>
<tr>
<td>(ATU)</td>
<td></td>
<td>ATU2 Learning Japanese through CAMJAL is a wise idea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ATU3 Learning Japanese through CAMJAL is a pleasant idea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ATU4 Learning Japanese through CAMJAL is a positive idea</td>
</tr>
</tbody>
</table>
Table 1  Operational definitions for latent variables and measured items (continued)

<table>
<thead>
<tr>
<th>Latent variables</th>
<th>Operational definitions</th>
<th>Measured items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour intentions to learning (BIL)</td>
<td>Behaviour intentions to learning refer to one’s willingness to learn Japanese through context-aware mobile learning after the CAMJAL</td>
<td>BIL1 I would like to continuously use CAMJAL to learn Japanese if I can use it</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIL2 I predict that I will continuously learn Japanese through CAMJAL if I can use it</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIL3 I would like to recommend the other users to continuously use CAMJAL to learn Japanese</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIL4 In next weeks, I would like to learn Japanese through CAMJAL</td>
</tr>
</tbody>
</table>

Figure 2  Logging in to CAMJAL system (see online version for colours)

Figure 3  Touch an NFC tag on the wall (see online version for colours)
Figure 4  Download of learning material (see online version for colours)

Figure 5  Two learning practice modes (see online version for colours)

Figure 6  A snapshot of practice alone (see online version for colours)
A near field communication-enabled e-learning environment

Figure 7  Forwarding learning material with NFC (see online version for colours)

Figure 8  Choosing a role from the scenario at the beginning of the dialogue with peers (see online version for colours)

Figure 9  Practicing conversation alternatively (sn: 0) (see online version for colours)
Figure 10  Practicing conversation alternatively (sn: 1) (see online version for colours)

Figure 11  Practicing conversation alternatively (sn: 2) (see online version for colours)

Figure 12  Uploading the recorded files (see online version for colours)
4.3 Procedure

This study firstly developed a CAMJAL system on an NFC-enabled smartphone (Xperia Sony Z1), Mifare cards, and wireless LAN (IEEE 802.11n). The programme was implemented with Java-based APIs. The logging system of CAMJAL is shown in Figure 2 and the learner’s ID is required. Once successfully logged into the system, the learner touches an NFC tag on the wall with an NFC-enabled smartphone to download the learning material (a part of the conversation video) as shown in Figure 3 and Figure 4. CAMJAL provides two scenario learning modes: practice alone and dialogue with peers as shown in Figure 5. If the learner chooses practice alone mode, he or she can play one sentence and then immediately repeat it to record his or her pronunciation. A snapshot of the scenario learning is shown in Figure 6. If the learner chooses dialogue with peers mode, two learners have to use the P2P function of the NFC in order to complete and pass the learning material. The P2P mechanism runs an NFC device to exchange data with the other peer holding an NFC device. After that, the other learner gathers the learning material from the learner who previously logged into CAMJAL as shown in Figure 7. In Figure 8, according to the selection of roles, these two learners can play two different roles, respectively. In the dialogue with peers situation, these two learners alternate practicing the Japanese conversation according to a sequence number displayed on the screen. The dialogue scenarios of the practice are shown in Figure 9–11. The system also provides a recording function which allows learners to store their learning materials in a database so that instructors can trace the learning profiles to monitor learners’ information through the recorded data. The uploaded file is shown in Figure 12. According to the students’ uploaded files, the instructor logged in the system to check out
the students’ learning portfolios and realised personalised learning statue for each student at anytime. A representation was shown in Figure 13 while the instructor logging in the CAMJAL system. After participants engaged in the CAMJAL learning activities for two weeks, data was collected by a questionnaire that examined relationships among variables proposed in the model.

4.4 Data analysis

Structural equation modeling (SEM) is a statistical method that combines factor analysis and path analysis and provides theory construction and analyses relationships among variables. In this study, SEM was employed to examine the research model and hypothesizes. SEM analysis consists of covariance analyzing software (Chin, 1988), such as LISREL and AMOS, and component analyzing software, such as PLS-Graph and SmartPLS. The component analysis analyses relationships among latent variables through path modeling based on the partial least squares (PLS). Sørebø et al. (2009) pointed out that PLS is a second version of the regression method that combines confirmatory factor analysis and linear regression. PLS allows researchers to run measurement model and structural model analysis simultaneously (Bollen, 1989). The measurement model examines hypothesised links between indicators and latent variables, whereas the structural model estimates hypothesized paths between exogenous (independent) and endogenous (dependent) latent variables. Especially, PLS is suitable for analyses with small or medium sample sizes (Lee et al., 2007), whereas LISREL is suitable for analyses with large sample sizes (Hulland, 1999). In recent years, researchers in fields related to information management (Burton-Jones and Hubona, 2006; Turel et al., 2007) and education (Annear and Yates, 2010; Sørebø et al., 2009; Tselios et al., 2011) have tended to perform the model analysis for latent variables with PLS.

The sample size in this study was 86 participants, which implied a small sample size, so the statistical analyzing software, SmartPLS 2.0 (Ringle et al., 2005) was employed. PLS examines the significance of path coefficients in the model analysis by conducting different resampling methods. SmartPLS 2.0 performed significance of path coefficient tests by conducting bootstrapping sampling (Annear and Yates, 2010) in order to provide t-test values for path coefficients in the model analysis. The samples of bootstrapping in this study were used to generate 5,000 samples of 86 cases.

5 Results

5.1 Assessment of measurement model

To assess reliability and validity using PLS, researchers typically calculate a block of indicators’ composite reliabilities (CR) and average variance extracted (AVE) (Barclay et al., 1995; Chin, 1998). Interpreted like Cronbach’s alpha internal consistency reliability estimate, a composite reliability of 0.70 or greater is considered acceptable for research (Fornell and Larcker, 1981). The AVE measures the variance captured by the indicators relative to measurement error (Fornell and Larcker, 1981), and it should be greater than 0.50 to justify a latent variable (Barclay et al., 1995). Results indicated adequate composite reliabilities and AVEs as shown in Table 2.
A near field communication-enabled e-learning environment

To evaluate discriminant validity, we examined the correlations of latent variables. When the square root of each latent variable’s AVE is greater than the correlation of the latent variable to other latent variables, the correlation of latent variables demonstrated discriminant validity. The proposed model’s correlations of latent variables demonstrated adequate discriminant validity as shown in Table 2.

Table 2  Reliabilities and correlations of latent variables

<table>
<thead>
<tr>
<th>Latent Variable</th>
<th>Composite reliability</th>
<th>Average variance extracted</th>
<th>Correlations of latent variables and average variance extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Perceived convenience</td>
<td>0.968</td>
<td>0.885</td>
<td>0.941</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>0.959</td>
<td>0.824</td>
<td>0.792</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>0.968</td>
<td>0.908</td>
<td>0.807</td>
</tr>
<tr>
<td>Attitude towards use</td>
<td>0.951</td>
<td>0.828</td>
<td>0.792</td>
</tr>
<tr>
<td>Behaviour intentions to learning</td>
<td>0.970</td>
<td>0.889</td>
<td>0.838</td>
</tr>
</tbody>
</table>

Notes: *Diagonal elements in the correlation of latent variables matrix are the square root of the average variance extracted. For adequate discriminant validity, diagonal elements should be greater than corresponding off-diagonal elements.

5.2 Assessment of structural model

A bootstrapping procedure was used to generate t-statistics and standard errors (Chin, 1998). Interpreted using multiple regression, the $R^2$ indicates the amount of variance explained by the model (Barclay et al., 1995). To evaluate the full model, $R^2$ values were calculated for perceived convenience, perceived usefulness, attitude towards use, and behaviour intentions to learning. Structural model results are presented in Figure 14.

Figure 14  The structural model (see online version for colours)
According to Table 3, perceived ease of use demonstrated direct, statistically significant, positive relationships with perceived convenience (H1 \( p < 0.001 \)), perceived usefulness (H4 \( p < 0.001 \)), attitude towards use (H5 \( p < 0.001 \)), and behaviour intentions to learning (H9 \( p < 0.01 \)). Individuals who perceived more perceived ease of use were likely to realise high degrees of perceived convenience, proceed high approaches of attitude towards use, and perform high attempts of behaviour intentions to learning, thus supporting hypotheses 1, 4, 5, and 9.

Perceived convenience demonstrated a direct, statistically significant, positive relationship with perceived usefulness (H2 \( p < 0.001 \)). Individuals who realised higher degrees of perceived convenience were more likely to perceive high levels of perceived usefulness, thus supporting hypothesis 2. However, perceived convenience did not demonstrate a direct positive relationship with attitude towards use, thus hypothesis 3 was not supported. In this sample, individuals with high perceived convenience were no more likely to influence attitude towards use than were other variables.

Perceived usefulness demonstrated direct, statistically significant, positive relationships with attitude towards use (H6 \( p < 0.001 \)) and behaviour intentions to learning (H7 \( p < 0.01 \)). Individuals who perceived more perceived usefulness were likely to progress high approaches of attitude towards use and perform high attempts of behaviour intentions to learning, thus supporting hypothesis 6 and 7.

Attitude towards use demonstrated a direct statistically significant relationship to behaviour intentions to learning (H8 \( p < 0.001 \)), supporting hypothesis 8.

Table 3  Path coefficients and results of the hypothesis test

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path</th>
<th>Path coefficient</th>
<th>t value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Perceived ease of use ( \rightarrow ) Perceived convenience</td>
<td>0.807</td>
<td>24.766***</td>
<td>Accept</td>
</tr>
<tr>
<td>2</td>
<td>Perceived convenience ( \rightarrow ) Perceived usefulness</td>
<td>0.351</td>
<td>4.269***</td>
<td>Accept</td>
</tr>
<tr>
<td>3</td>
<td>Perceived convenience ( \rightarrow ) Attitude towards use</td>
<td>0.109</td>
<td>1.595 n.s.</td>
<td>Reject</td>
</tr>
<tr>
<td>4</td>
<td>Perceived ease of use ( \rightarrow ) Perceived usefulness</td>
<td>0.547</td>
<td>6.548***</td>
<td>Accept</td>
</tr>
<tr>
<td>5</td>
<td>Perceived ease of use ( \rightarrow ) Attitude towards use</td>
<td>0.376</td>
<td>4.501***</td>
<td>Accept</td>
</tr>
<tr>
<td>6</td>
<td>Perceived usefulness ( \rightarrow ) Attitude towards use</td>
<td>0.408</td>
<td>6.485***</td>
<td>Accept</td>
</tr>
<tr>
<td>7</td>
<td>Perceived usefulness ( \rightarrow ) Behaviour intentions to learning</td>
<td>0.201</td>
<td>3.087**</td>
<td>Accept</td>
</tr>
<tr>
<td>8</td>
<td>Attitude towards use ( \rightarrow ) Behaviour intentions to learning</td>
<td>0.499</td>
<td>4.814***</td>
<td>Accept</td>
</tr>
<tr>
<td>9</td>
<td>Perceived ease of use ( \rightarrow ) Behaviour intentions to learning</td>
<td>0.243</td>
<td>2.803**</td>
<td>Accept</td>
</tr>
</tbody>
</table>

Note: ** \( p < 0.01 \), *** \( p < 0.001 \)

In this model, R\(^2\) is the percentage of response variable variation that is explained by its relationship with one or more predictor variables, because PLS focuses mainly on minimisation of error or maximisation of variance explained in all endogenous variables.
As shown in Figure 14, R² for the four endogenous variables in the structural model, including behaviour intentions to learning, attitude towards use, perceived usefulness, and perceived convenience, were 0.816, 0.832, 0.732, and 0.651, respectively. In other words, perceived usefulness, perceived ease of use, and attitude towards use explained about 82% of the total variance in behaviour intentions to learning; perceived usefulness and perceived ease of use explained about 83% of the total variance in attitude towards use; perceived convenience and perceived ease of use explained about 73% of the total variance in perceived usefulness; and perceived ease of use explained about 65% of the total variance in perceived convenience. Since the research model explained more than 50% of the total variance in attitude towards use and behaviour intentions to learning, the research model held a good predictability and explanatory power for the acceptance of the CAMJAL system.

6 Discussions

6.1 Research hypotheses

According to the results of assessment of structural model, from the viewpoint of perceived convenience, the results revealed that perceived ease of use positively affected perceived convenience, which was consistent with the findings by Yoon and Kim (2007) and Chang et al. (2012), meaning that the easier the use of the CAMJAL system, the more convenient it will be perceived by a user. Perceived convenience positively affected perceived usefulness, which was also consistent with Yoon and Kim (2007) and Chang et al. (2012), meaning that the more convenient the CAMJAL system, the more useful one perceived it to be. Even though Chang et al. (2012) has shown that perceived convenience positively affected attitude towards use, revealing that the more convenient the English mobile learning system, the more positive attitude towards use the English mobile learning system, this study showed that perceived convenience did not affect attitude towards use directly, which was opposite to Chang et al. (2012). Whether or not users' experiences of using NFC functionality mediate the effects of external variables on attitude towards use should be further examined. For the TAM relative hypotheses, the results showed that:

a  perceived ease of use positively affected perceived usefulness;

b  perceived ease of use and perceived usefulness positively affected attitude towards use; and

c  perceived usefulness, perceived ease of use, and attitude towards use positively affected behaviour intentions to learning.

These results were consistent with the findings on TAM proposed by Davis (1989).

6.2 Effects

Effects among latent variables consist of direct effects and indirect effects, so the overall effects from latent variables were the summation of direct effects and indirect effects. Effects among latent variables in this study were shown in Table 4. As shown in Table 4, perceived ease of use was the antecedent factor that affected perceived convenience;
perceived ease of use and perceived convenience were the antecedent factors that affected perceived usefulness; perceived ease of use had a greater overall effect on perceived usefulness than that on perceived convenience; and the order (from greatest to smallest) for the direct effects of the latent variables on attitude towards use was perceived usefulness, perceived ease of use, and perceived convenience. Since perceived ease of use had a direct effect on attitude towards use and had an indirect effect on attitude towards use through perceived convenience and perceived usefulness, the order (from great to small) for the overall effects of the latent variables that affected attitude towards use was perceived ease of use, perceived usefulness and perceived convenience.

Though perceived convenience did not affect behaviour intentions to learning directly, the factor affected behaviour intentions to learning indirectly through perceived usefulness and perceived ease of use. So, the order (from greatest to smallest) for the overall effects of the latent variables that affected behaviour intentions to learning was perceived ease of use, attitude towards use, perceived usefulness, and perceived convenience. As a result, perceived convenience, perceived ease of use, and perceived usefulness were the antecedent factors that affected attitude towards use and behaviour intentions to learning of the CAMJAL system.

Table 4  Effects among each latent variable

<table>
<thead>
<tr>
<th>Perceived convenience</th>
<th>Perceived usefulness</th>
<th>Attitude towards use</th>
<th>Behaviour intentions to learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>D I O</td>
<td>D I O</td>
<td>D I O</td>
<td>D I O</td>
</tr>
<tr>
<td>Perceived convenience</td>
<td>- - -</td>
<td>0.35 - 0.35</td>
<td>0.11 0.17 0.28 - 0.21 0.21</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>0.81 - 0.81</td>
<td>0.55 0.28 0.83</td>
<td>0.38 0.49 0.87 0.24 0.41 0.65</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>- - -</td>
<td>- - -</td>
<td>0.48 - 0.48 0.20 0.24 0.44</td>
</tr>
<tr>
<td>Attitude towards use</td>
<td>- - -</td>
<td>- - -</td>
<td>- - -</td>
</tr>
<tr>
<td>Note: D = direct; I = indirect; O = overall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7 Conclusions

This study has presented a CAMJAL system, which uses the interaction with dynamic NFC-enabled smartphones to let learners practice Japanese conversation. A preliminary experiment yielded promising results regarding the acceptance of this novel interaction technology and the usability of the system prototype. Learners could interact with them by touching attached NFC-tags with their mobile devices to download learning materials that the instructor assigned in advance. In addition, the interaction between the dynamic NFC-enabled smartphone, the learning materials could be delivered between peers with the P2P functionality.

In this study, we also evaluated the learning intentions and efficiencies of the learners based on the proposed system. We used perceived convenience in an extended technology acceptance model (TAM) to investigate the learners’ behavioural intention
towards adopting an NFC-based CAMJAL. One important research finding revealed that perceived convenience positively affects perceived usefulness; however, it didn’t affect behaviour intentions to learning directly but only affected behaviour intentions to learning indirectly through perceived usefulness. Therefore, excepting perceived usefulness and perceived ease of use, perceived convenience was one of the antecedent factors that affected behaviour intentions to learning. The acceptance model of the CAMJAL proposed by this study explains about 83% of the total variance in attitude towards use and about 82% of the total variance in behaviour intentions to learning. Overall, the proposed CAMJAL was good in predicting and explaining learners’ acceptance of NFC-enabled empirical development. A feedback system that reflects the instructor’s evaluation results on the students’ CAMJAL system is recommended to carry out in the future work.

References


A near field communication-enabled e-learning environment


