edam

ISSN 1303-0485 • **eISSN** 2148-7561
DOI 10.12738/estp.2015.2.2139
Copyright © 2015 EDAM • http://www.estp.com.tr
Educational Sciences: Theory & Practice • 2015 April • 15(2) • 539-551

Received | 21 August 2013
Accepted | 27 March 2014
OnlineFirst | 20 March 2015

A Learning Environment for English Vocabulary Using Quick Response Codes*

Yuksel Deniz Arikan[a]
Ege University

Sevil Orhan Ozen[b]
Usak University

Abstract

This study focuses on the process of developing a learning environment that uses tablets and Quick Response (QR) codes to enhance participants' English language vocabulary knowledge. The author employed the concurrent triangulation strategy, a mixed research design. The study was conducted at a private school in Izmir, Turkey during the 2012-2013 academic year. The study sample was determined using the criterion sampling method. The criterion for selection was participants' possession of a mobile device. There were a total of 22 participants including one English teacher in the study, of which 12 were female and 10 male. The students' knowledge of English vocabulary was pretested using the Vocabulary Check List (VCL). During eight classes, participants completed English vocabulary activities using QR codes and tablet PCs. This learning environment integrated digital learning materials and real learning objects using QR codes. After the activities, students' knowledge of English vocabulary was again tested using the VCL, and the participants' opinions about the learning environment were solicited using semi-structured interviews. The research's qualitative data were analyzed using a descriptive analysis. The quantitative data were analyzed using the Wilcoxon signed-rank test and web analysis programs. The study found that the participants' overall rate of completing learning activities was low. The results of the VCL post-test indicated that participants' English language vocabulary knowledge had increases significantly. Participants' opinions regarding the learning environment were analyzed, and it was determined that although they had faced a few problems with the equipment, they experienced a general feeling of curiosity and excitement while using the environment. They found the environment entertaining and reinforcing, stating that learning environments of this kind should be used in other courses, too. The participant teacher stated that although the environment was effective there were a number of time management issues and caused difficulties in classroom management.

Keywords: QR Codes • U-Learning • Ubiquitous learning • Learning English • Learning vocabulary

* This study is based on a master's thesis by Sevil Orhan Ozen with the consultancy of Assist. Prof. Dr. Deniz Arikan. Its title s is: "A New Perspective on Learning: Developing A Ubiquitous Learning Environment."

a Corresponding author
Assist. Prof. Yuksel Deniz Arikan (PhD), Computer and Instructional Technologies Teaching Department, Faculty of Education, Ege University, Bornova Campus, Izmir, Turkey
Research areas: Social learning environments, mobile technologies, cyber worlds, ethics in informatics, special methods in education, project development and management
Email: y.deniz.arikan@gmail.com

b Sevil Orhan Ozen, Computer and Instructional Technologies Teaching Department, Faculty of Education, Usak University, Usak 64000 Turkey
Email: sevil.orhan@usak.edu.tr

In the present day, English is one of the most important languages spoken, often finding itself as the second language in many countries whose native language is not English. In English language education, a variety of methods, techniques, and technologies are used to develop reading, listening, and speaking skills. As the popularity of using these new technologies increases, it has become increasingly important to provide learners with opportunities to learn English without restrictions of time or location.

Language learning is based on vocabulary acquisition. Since students need to know the right words to express their thoughts without difficulty (Huang et al., 2012), considerable research on vocabulary learning has been done. With the development of computers and multimedia environments, a wide range of studies have used multimedia technologies, audio texts, and graphics to support vocabulary learning (Kim & Gilman, 2008; Sun & Dong, 2004). Mobile, wireless, and sensor technologies have been gradually integrated into educational activities, which has led to the establishment of learning environments that include high mobility and context awareness. Researchers have noticed that mobile and wireless technologies, such as multimedia technologies, are popular in language education. Chen and Chung (2008) developed an individualized mobile vocabulary learning system using palmtop computers. Huang et al. (2012) developed a u-learning system for English vocabulary, called UEVL (Ubiquitous English Vocabulary Learning). Laroussi (2004) developed a cyber-classroom called "Ubi-Learn" based on U-Learning in which he conducted a language course allowing students not only to attend in person or via a distance learning environment, but also to use computers or any mobile device in the class. In a study entitled TANGO (Tag Added Learning Objects), researchers created a system on computer-aided language learning in a U-informatics environment (Ogata, Akamatsu, & Yano, 2005). Ogata, Yin, and Yano (2006) developed a U-Learning system, used to support the learning of reflexive and mimetic words in Japanese, called JAMIOLAS (Japanese Mimicry and Onomatopoeia Learning Assistant System) using wireless sensors. Ogata, Li, Hou, Uosaki, Moushir, and Yano (2011) developed a U-Learning system called SCROLL (System for Capturing and Reminding Of Learning Log). This system used U-technologies in daily life and digitally recorded the information learned. Liu and Chu (2010) researched the influence of the games on HELLO, a U-Learning environment, on English learning achievement and motivation. Leone and Leo (2011) created three different scenarios for three different English courses in a U-Learning environment. They used QR codes for these scenarios. This study revealed that QR codes have the potential to increase the mobile devices' effectiveness level due to their being flexible tools for obtaining knowledge and promoting individual learning.

In recent years, researchers (Chen, Chang, & Wang 2008; Hsieh, Jang, & Chen, 2011; Jones & Jo 2004) have used the RFID (Radio-Frequency Identification) tags on ubiquitous objects. In these applications, the sensors perceive the objects when learners approach them, and the learners' mobile devices transfer information about these objects. In their studies, Tseng, Hsu, and Hwang (2009), Liu (2009), as well as Law and So (2010) used QR tags on ubiquitous objects. In these studies, after learners make observations about an object and show the QR tag to the barcode reader on their mobile device, knowledge about this object is transferred. RFID readers are usually placed on PDAs. For this reason, each student in such U-Learning environments is supposed to have a PDA that can make use of RFID. Although this situation creates a financial burden, the QR reader programs are easy to download onto mobile devices without any additional expenditure. Researchers prefer to use QR tags in their studies since they are low-cost and easy to access.

It is obvious that with the rapid developments in communication technologies and increases in bandwidth, people now have more opportunities to benefit from wireless applications in their daily lives. Thus, many studies have been conducted that focus on the use of mobile devices, RFID, and QR tags in English language teaching. With the popularization of these technologies, there has been a reorientation from M-Learning (mobile learning) toward U-Learning (ubiquitous learning) in education (Hwang, Tsai, & Yang, 2008). U-Learning, as a new topic of research in education, aims to create a new learning environment where students can learn anytime and anywhere (Sakamura & Koshizuka, 2005). According to Cheng, Sun, Kansen, Huang, and He (2005), U-Learning is currently at the cutting edge of E-Learning. Arkun and Askar (2010) tackled the concept of "U-Learning" as "Ubiquitous Learning," while Ozarslan (2010) defined it as, "learning independent of device, place, and time." Sensor technologies make it possible to conduct more active studies of learning in learning environments (Chiou, Tseng, Hwang, & Heller, 2010). U-Learning environments are based on learners' behaviors in the real world and their perception of environmental parameters. Certain environmental parameters can be use in recognizing the position of the learner (Chin & Chen, 2013).

The main characteristics of U-Learning are sustainability, accessibility, spontaneity, interaction, the status of teaching activities, mobility, position awareness, capability of collaboration, context awareness, and instant adaptation (Hsieh, Chen, & Hong, 2007). Hwang et al. (2008) states that five status parameters should be defined so as to be able to conduct a U-Learning activity: *a*) personal context sensed by the system, *b*) environmental context sensed by the system, *c*) feedback taken from the learner via the mobile learning device, *d*) personal data retrieved from the databases, and *e*) environmental data retrieved from the databases.

In general, U-Learning applications make use of wireless technologies and mobile device platforms to perform learning activities. The mobile devices used in U-Learning activities are PDAs, tablet PCs, and mobile phones. Moreover, U-Learning environments make use of embedded devices such as GPS, RFID tags, QR tags, and sensors along with wireless technologies (Marinagi, Skourlas, & Belsis, 2013). QR codes cost less than RFID. Costly devices such as PDAs or RFID are not that practical for users and are rarely used. The use of cheaper mobile devices capable of reading QR codes makes it possible to access more users (Hwang, Wu, Tseng, & Huang, 2010).

QR Codes

QR codes were developed in 1994 by Denso Wave, a Japanese company, as a kind of symbol that can easily be read by a scanner. The term QR is an abbreviation of "Quick Response." It is capable of storing a variety of content such as texts, URLs, automatic messages and communication information. The QR code (Figure 1) stores knowledge both vertically and horizontally, and is thus more useful than a regular barcode, which can only store information horizontally. The information in a QR code can be decoded by a mobile device with an interior camera and QR code reading software (Savarani & Clayton, 2009). There are various websites on the internet to generate QR codes, including: qrcode.kaywa.com, qrkodolusturma.com, qrstuff.com, and the-qrcode-generator.com. The codes generated by these sites can be saved and printed.

Figure 1: Sample QR Code (Savarani & Clayton, 2009).

The use of QR codes in education brings many benefits, including low cost, easy use, portability/mobility, instant accessibility, and momentary pleasure. On the other hand, problems related to QR code use include slow internet speeds, the cost of mobile internet, the visual similarity of QR codes, software problems, and the brightness settings of devices (Leone & Leo, 2011). As an example of QR codes being used in education, Ogen (2012) suggested "connecting to an audio file that provides the pronunciation of the object in a foreign language or to a link that that shows the meaning of the word in a foreign language by placing a QR code on the object."

This study aimed to develop a learning environment conducive for participants to learn English vocabulary using QR codes and to receive feedback from them. As such, the research question is: "Does the newly-created learning environment enhance English vocabulary learning, and what do the participants think about it?" The sub-problems are: (*i*) "Is there a significant difference in the English vocabulary knowledge of the learners who participated in activities in the learning environment?" (*ii*) "What are the opinions of the participants and the participant teacher about the learning environment?" The most important reasons for using QR codes in the study were their low cost and appropriateness for use with mobile technologies. The mobile devices used in the study were tablet PCs. Tablet PCs were selected because of their widespread use both in daily life and in the Turkish educational system through the FATIH Project and since they are portable and compatible with QR codes. Real learning objects and digital learning materials were integrated using QR codes in the new learning environment. Although outcomes related to the environmental factors brought about by the U-Learning technologies used in studies in the literature could not be used in this study due to the technologies applied, user feedback and records were obtained. There are a large number of studies on both high school and university students in the relevant literature. This study was conducted in collaboration with middle school students and contributes not only to the

integration of mobile devices—very popular in Turkey—with educational activities, but also to the design of learning environments. It will assist content developers, learners, and educators with these issues. Moreover, this study is also significant because it is the first to use mobile devices and QR codes in English vocabulary teaching.

Method

This study used the concurrent triangulation design, one of the mixed research designs identified by Creswell (2009). The researcher brought the qualitative and quantitative data into a single study and both analyzed and interpreted them.

Study Population

The criterion used to select participants was ownership of a mobile device. The activities were conducted at a private school in Izmir, Turkey during the second term of the 2012-2013 academic year with the approval of the school principal. The population consisted of 21 fourth grade students (11 female and 10 male) and a female teacher. All except two students in the group stated that they had used tablet PCs at home. Fourteen students said that they had never seen QR codes before. Four said they had seen them on the products at the market, on the school's signboard, or while playing games on the internet. Only two students said that they knew how and why these codes were used.

Data Collection Tools

Tracking programs that follow the movements of the participants in the system and the Vocabulary Check List (VCL) were used to answer the first sub-problem of the research. The comment page on the internet and the semi-structured participant and teacher interviews were used to answer the second sub-problem of the research. The authors administered the VCL tests, conducted the interviews, and analyzed the data from all sources.

Vocabulary Check List: The four-category VCL was applied to determine whether there was any difference in participants' knowledge of English vocabulary before and after the activities. The test was designed by Unal (2006) based on the four-phase knowledge scale used by Zimmerman (1997) and the Vocabulary Knowledge Scale (VKS) created by Wesche (1993). The test responses are: A: I do not know this word; B: I have encountered this word before, but I am not sure about its meaning; C: I can make sense of this word when it is used in a sentence, but I cannot use it myself, and D: I can use this word in a sentence.

The VCL Validity and Reliability Analysis: Since Unal (2006) used the VCL test in English, it was first translated into Turkish by two academic specialists in English. Then, three English teachers and four academic specialists in English were consulted to ensure that the test would be understandable for fourth grade students. Four English experts, two of who specialized in evaluation and assessment and the other two being English teachers, were consulted for the appearance and content validity of the VCL test. The authors also asked for the opinions of 10 fourth grade students to determine the comprehensibility of the categories on the VCL. The researchers administered the VCL test in Turkish to 120 sixth grade students at a public school in Izmir, Turkey as a reliability analysis. The analysis determined that the Cronbach's Alpha reliability coefficient of the test was 0.949.

The VCL Scoring System: The authors used the scoring system used by Paribakht and Wesche (1993). Two English teachers scored each word according to the categories. The participants' responses to the words were scored one by one. The frequencies and percentages were calculated to determine learners' knowledge levels before and after the activities. Then, the self-report categories were divided into two groups: known and unknown. The A and B self-report categories were marked as unknown, and the C and D self-report categories as known.

Semi-structured Participant and Teacher Interviews: The researchers prepared semi-structured interview sheets to obtain the opinions of participants about the new learning environment. Four experts also provided their opinions about the interview sheets. Then, the pilot study was implemented in collaboration with three students and an English teacher. Revisions were made based on the feedback. After the pilot study and having consulted expert opinions, sub-questions and alternative questions were added to both sheets. The final semi-structured participant interview sheet prepared by the researchers consists of nine questions, and the teacher interview sheet consists of seven questions.

Process

The VCL test was administered as a pretest before the activities to determine the participants' knowledge of English vocabulary. Then the

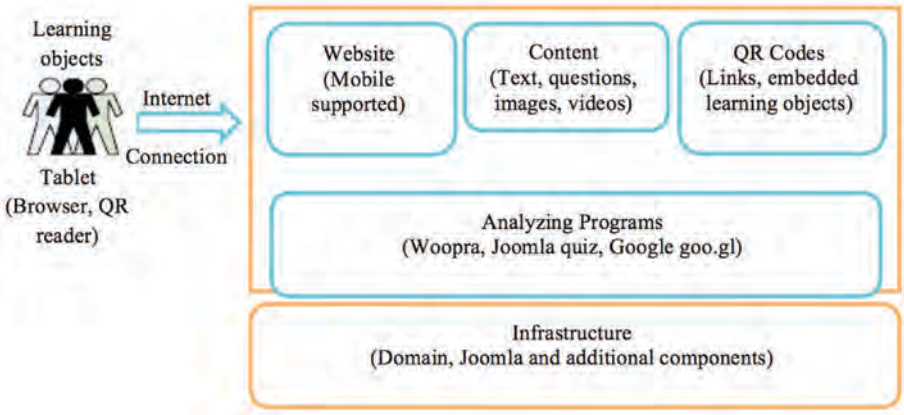

Figure 2: Learning environment architecture.

system was introduced to the participants. The study was conducted in eight lessons (two lessons a day on four different days of the week). In the experimental phase of the study, the participants observed learning objects, connected the object-related link on the system prepared using QR codes, watched the linked video and answered a question in the later part of the video. The participants were asked to comment on an open-ended question on the system. The students were able to see the comments made by the others on the system. The VCL was administered as a post-test after the activities to determine any differences in participants' knowledge of English vocabulary. At the end of the activities, the researchers performed semi-structured interviews to obtain both the participants' and the teacher's opinions about the environment. The outcomes of these interviews were analyzed with the other qualitative data. Figure 2 shows the architecture of the learning environment.

The texts describing the grammar rules for each of the 35 words in the learning environment, the sentences in English, and the questions were prepared by two lecturers in a university's foreign languages department and an English teacher. Twenty-two learning objects were prepared for 35 target words. Thirteen words were given with grammatical knowledge of the learning object. Thus, each learning object comprised multiple words. Of the 22 learning objects, one group included real objects, another flashcards, and yet another words related to grammar rules. The texts were visualized and 22 flash-based videos were produced by the researchers. A question related to the content of each video was asked following all videos. The final forms of the materials were reanalyzed by the experts who prepared the textual content. Then QR tags were prepared for and attached to the 22 learning objects. Finally, the QR tag reading program and a scanner appropriate for the flash-based video display were installed on the tablets to be used in the learning environment. Figure 3 shows the participants swiping the tag on a learning object to the barcode reader.

a

b

Figure 3: a) Learning object and b) participant swiping a learning object on the barcode reader.

Data Collection

The researchers conducted their research during the second semester (Spring) of the 2012-2013 school year, collecting the data themselves. The participants completed the approximately 40-minute VCL before and after using the learning environment. The authors interviewed 20 participants and the teacher who used the U-Learning environment. The interviews were recorded by an audio recording device and notes were taken to avoid data loss. The organization and analysis of the data were performed by the researchers.

Analysis and Interpretation of the Quantitative Data: To determine if there were any changes in the participants' knowledge of English vocabulary, the researchers used the Wilcoxon signed-rank test, a non-parametric test, on the total scores on the VCL. The participants were unable to reach the content of four learning objects due to the QR codes for these objects being incorrectly printed. Therefore, the words in these learning objects were excluded from participants' total scores.

Analysis and Interpretation of the Qualitative Data: The authors performed a descriptive analysis to assess the qualitative data collected through the study. The interview data attained from the participants and the comments written on the system were arranged under the following four themes: (1) ease of use, (2) emotions, (3) the influence on learning, and (4) usefulness, and the interview data attained from the teacher were arranged under the following three themes: (1) advantages and disadvantages, (2) material-method, and (3) usefulness. In this phase, the data were read five times (twice with no interval and three times at intervals). They were grouped according to the codes, and the quotations related to the codes were arranged. These codes were then grouped according into themes, and the direct quotations were selected. The encoding of the data, the arrangement of quotations, the delineation of themes, and the selection of direct quotations were performed twice in a signle month.

Findings

The Participants' Completion of the Learning Activities and English Vocabulary Knowledge

In order to determine how many participants completed the learning activities, the researchers analyzed the number of participants who clicked on the links, the number of times participants viewed a page, the number of QR tag readings, and the number times the videos were displayed. Based on the number of QR tag readings, 58.97% of participants completed the learning activities. Regarding their responses to the questions, 2 of the 21 participants did not answer any of the questions. The values calculated for the remaining 19 participants showed that 49.70% of participants responded to the questions in the learning activities. Fourteen participants reached the final page of the activities, and the rate at which they completed the activities was 30.95%, which is lower than expected. The records indicate that the participants showed the QR codes to the reader multiple times before answering the related question. It is also estimated that some participants preferred simply to read the QR codes instead of also answering the questions and completing the learning activities. Moreover, some students might have failed to complete the activities due to difficulties stemming from the learning environment. Although the studies in the relevant literature were assessed to make comparisons with the current study, the authors could not find an appropriate source. Table 1 indicates the results of the Wilcoxon Signed-Rank Test that was applied to determine any changes in students' vocabulary before and after the activities.

Table 1
The Wilcoxon Signed-Rank Test Results

	n		sd	*z*	*p*
VCL pretest	21	104.3	26.65	-3.304	0.001
VCL post-test	21	116	26.72		

$p < .01$

Table 1 shows that participants' mean score on the VCL pretest was 104.3, and that on the post-test it was 116. This difference between the VCL pretest and post-test results of the participants is statistically significant (z = -3,304, $p < .01$). To conclude, although participants' rate of completing the learning activities in the new U-Learning environment was low, this environment did improve their English vocabulary knowledge.

Participants' Opinions about the Learning Environment

The Learning Environment's Ease of Use: Based on the findings from the interview data and on participants' comments made regarding the system, the participants were divided into two groups: "Having experienced difficulty during the

activities" and "Not having experienced difficulty during the activities." Five participants said that they had experienced difficulty using the QR codes with the reader. Five had problems using the keyboard to type, 4 had trouble logging into the system with their user name and password, and 1 had problems with the earphones. One participant reported having difficulty due to a malfunction of the tablet PC. The entire data show that 10 students had difficulties during the activities.

On the other hand, 5 participants said they had no difficulty using the system. They even found it easy to use. Furthermore, 3 participants said they had experienced problems trying to connect to the internet, and 1 participant stated that although it had experienced difficulties in the QR code reading process, it did not prevent easy use of the system. One participant said that although he had expected the system to be very difficult to use, he found that was, in fact, very easy. The data show that 10 students used the system with ease.

Here are some interview statements related to the above-mentioned difficulties:

P1-int; about the tablet's failure to read the codes despite showing them correctly:

> "I had a little difficulty. Sometimes the tablets did not read the tags. I was holding it straight, but sometimes it did not read the tag" [P1-int].

This expresses the difficulties students experienced using the QR codes. On the other hand, the number of QR codes read during the activities indicate that the codes on the learning objects were shown to the reader by at least 21 participants. Therefore, 7 of the 18 learning activities (38.8%) were seen via barcode reader by less than 21 participants. This finding reveals that participants had difficulty using the QR codes with the reader.

P5-int said that it was difficult to type on the keyboard since it was hard to push the tablet's keys, and that the letters of the word that they wanted to write kept changing automatically:

> "You know the keyboard on the tablet PC. I had a little difficulty in using it. It is hard to write on that keyboard. I said this before. It is also sometimes difficult to push the keys on it because writing appears on the keyboard" [P5-int].

Moreover, it was observed that participants made spelling mistakes in their responses to the questions following the videos. For example, P6's response to the question following Video 3 activity was recorded as:

> "1st half past 12." [P6-response].

This can be interpreted in one of three ways. Either participants were unaware of their spelling mistakes, they did not know the correct spelling of the word, or they had difficulties using the keyboard on the tablet PC. P9 had difficulty using the earphones since they fell out while trying to listen to the videos:

> "I had a little difficulty wearing the earphones. They kept on falling out." [P9-int].

P1-int reported experiencing difficulty because of a tablet PC malfunction:

> "The tablet I had was already broken anyway, and I was comfortable with the new tablet. I don't think that the activity was very difficult." [P1-int].

P4-int and P17-int had no difficulty doing the activities except for the slowness of the internet connection and being unable to read the codes:

> "As a matter of fact, it was not too difficult for me. The only difficulty I had was being unable to watch some parts due to the internet being so slow. That's all." [P4-int].

> "No. I only disconnected from the internet one time during the activities. And then I asked you for help. Apart from that, it was easy to connect." [P17-int].

Participants said that the activities were easy to complete. These findings indicate that students should be provided with training on these technologies to make them more user-friendly for the students.

Feelings Experienced in the Learning Environment: Findings acquired by the interview data and the comments on the system revealed that 14 participants stated to have found the U-Learning environment entertaining or enjoyable, 12 stated to have liked it, and 1 stated not to have liked it. Eight participants said that they had felt happy while using the U-Learning environment, 6 stated that they had felt a sense of excitement, 5 said they were bored by it, 4 said they were curious, 1 felt nervous, and 1 felt fear. Here are some of the participants' statements about their feelings while using the U-Learning environment:

P16-int found pleasure using tablet PC technology:

> "I had so much fun. Everyone was in a hurry, and it was nice. It was really entertaining. We both had fun and felt free during this activity. To me, it was enjoyable. I would like to do it again.

I really would. I didn't know that tablet PCs were so entertaining." [P16-int].

P5-int liked the U-Learning environment due to the clarity of the figures in the activity, saying:

"Yes, I even tried to download it to my ... brand tablet PC. The figures in it are very clear. That's what I liked about it." [P5-int].

P2-int was being happy to learn more about QR codes than he had previously known:

"I knew about the tags. But I didn't know how to read them. I hadn't seen the QR Droid before and I was very curious about it. I'm so happy that I learned about it here." [P2-int].

P3 expressed feelings of excitement and curiosity about the activities:

"I felt a little excited while using the activities. Because it was the first time I had ever seen such a program. I was a little bit curious. I wondered what it was going to be like." [P3-int].

P10-int said that the videos were boring:

"The videos and the other stuff were a little bit boring. But it was kind of fun. It was still a little boring." [P10-int].

P11-int expressed displeasure with the model of the tablet used:

"I was happy, but I didn't enjoy it so much. And I don't know the reason why. Maybe I didn't like the ... brand tablet PC." [P11-int].

They also reported feeling bored during the activities. P9-int did not enjoy the activities:

"It was not nice at all." [P9-interpretation].

P6-int expressed irritation with the difficulty of controlling the activities:

"I got a little angry in the Start section because I couldn't make it work." [P6-int].

P15-int expressed fear about harming the tablet:

"I only played a game on my friend's tablet PC once. It was the only tablet PC I had ever seen. So I was a little bit scared. I thought that I might drop it or make something go wrong with it. These were my feelings." [P15-int].

The Influence of the Learning Environment on Learning: Based on the interview data and comments on the system, it was determined that 7 participants found the U-Learning environment instructive, 7 found it both instructive and a good way to review vocabulary, 5 found it educational on how to use tablets, and 1 said that it had no influence on learning. Here are some of the participants' statements regarding the influence of the U-Learning environment on their learning:

P7-int said that the activities in the U-Learning environment aided him in acquiring new vocabulary, saying:

"It made it easy to learn. Naturally, we get bored while listening to lessons. We review the new words that we learn. We do the activities. But we have fun while doing these activities here. Because using tablets makes it more entertaining. We only listen and usually get bored during the regular lessons. But when we used the tablets, we learned by doing, and it was even more easy to learn." [P7-int].

This participant also said that the U-Learning environment was very instructive in teaching English vocabulary. P4-int said the activities in the U-Learning environment were helpful for her both in learning new words and in reviewing previously acquired vocabulary.

"Yes. I knew about these last year. But I don't remember them now. For example, I learned how to tell time even better. I had known about the other ones, so it was more of a review for me. It really contributed to my knowledge." [P4-int].

This participant also stated that the U-Learning environment was both instructive and a good way to review new words in English. P3-int agreed with P4; adding however, that the activities did not include enough content in English:

"Yes, it did contribute to my learning. I really think that I learned new things. At least it helped reinforce our English vocabulary. However, it might have been better if it were enriched a little bit more. Maybe it should be richer in terms of content. It should be increased. You can fill in the gaps and add more text to it. This will give it more content." [P3-int].

This statement reveals that the English content of the U-Learning environment should be more text-based. P11-int reported that the activities in the U-Learning environment were not so helpful:

"It did not make a big contribution to my learning. It was more like a review." [P11-int].

Nevertheless, this participant still noted the vocabulary strengthening aspect of the activities. P6-int said the activities in the U-Learning environment improved their knowledge about how to use tablet PCs:

> "It helped me learn how to use tablet PCs. I mean, I had difficulty writing my comments because I was unable to push the buttons, for example. But then I managed to do it. And I learned how to do it. You know, things like that." [P6-int].

Participants felt that the U-Learning environment helped them learn how to use tablet PCs. Since none of the words in the U-Learning environment were new to P16-int, this participant said the activities did not help him acquire of English vocabulary:

> "Actually, I didn't think much about it. We just showed the tags to the barcode reader. Some problems occurred. I knew all the subjects beforehand. So, to be honest, I didn't learn many new things." [P16-int].

These statements of the participant reveal thoughts that the activities in the U-Learning environment did not make big contributions to their learning. The Joomla quiz reports showed that only two participants (P14 and P16) gave no response to the questions in the learning activities. This outcome supports P16's ideas about the influence of the U-Learning environment on their learning.

On the other hand, the findings about the study's second sub-problem indicate that the U-Learning environment enhanced participants' English vocabulary knowledge. Moreover, an analysis of participants' responses to the questions following the videos showed that 73.52% of their responses were correct, and 34.11% were incorrect. These outcomes are in accord with participants' opinions about the influence of the U-Learning environment on their learning.

Practicality of the Learning Environment: The interview data and the comments on the system revealed that 17 participants were willing to continue doing the activities in the U-Learning environment in their English lesson since they thought it would make the lesson more entertaining and free. Three participants however were unwilling to continue with this new environment, thinking that it would be a distraction and cause them to lag behind. Here are some statements by the participants about continuing similar activities in their English lessons:

P16-int said that it would be better if activities similar to those in the U-Learning environment were continued to be done in English lessons since students learned better doing them and since learning was more comfortable, more enjoyable, and more free in this environment.

> "I want to continue doing them because they are entertaining and because we have fun and feel free while doing the activities." [P16-int].

P15 expressed unwillingness to continue doing activities in the U-Learning environment because of the distraction it would cause in the English lesson or because of students' low success in English:

> "I don't want to continue doing these activities since we will have a regular written exam and because I'm not so good at English." [P15-int].

While only 1 participant expressed unwillingness to continue activities similar to those in the U-Learning environment in any lesson except English, 7 participants wanted to do them in all of their courses. In response to the question, "In what classes would you like to do similar activities?" Five students mentioned their Turkish course, 4 mentioned Mathematics, and 3 mentioned Social Sciences. One student suggested Visual Arts. German, French, Laboratory, and Physical Education each received a single vote. Moreover, 2 students stated that the activities could be done when there was no teacher for the class and during breaks. One student said they could be done as the final lesson of the day. In response to the question, "Which lesson would be unfavorable for similar activities?" Four students stated that Physical Education, and three that Music would be unfavorable. Turkish and Laboratory, on the other hand, each were indicated by a single student. P8-int expressed a better learning experience thanks to the whole activity done through the computer and tablet PC, stating that it would be a good idea to do similar activities in classes other than English:

> "On Mondays, we have only two courses related to a specific field. And we have one or two lessons for each of them; that's all. Because now all tasks are performed on computers or tablet PCs. So in one sense, it is a good way to learn. And it is even better to feel it with your bare hands. That's why." [P8-res].

P20-res stated that although continuous homework caused boredom, tablet-based activities were more entertaining. Thus, it would be better if such activities were done in more courses than simply in English:

> "The Turkish lesson might be a good choice for these activities. As a matter of fact, I would like to do them in all courses. I would only exclude it in Physical Education because it would prevent us from doing sports. When we go home, we immediately start doing our homework, and we hardly ever watch TV or play computer games. So, I would like them to be done at school so we

could at least play these games here. It was so much fun, I would like to do it in all lessons. I would really like to do it again." [P20-res].

The Teacher's Opinions about the Learning Environment

The Pros and Cons of the Learning Environment: P-Teac said that the U-Learning environment was not beneficial for classes since its implementation took a long time and included a number of delays. She also stated that it was also difficult to control the class during the activities and that it distracted students:

"We began to read the QR codes at the Start point. We read the learning objects one by one. Then we finished at the Finish point. We saw that there were short and relevant PowerPoint presentations after each object. But this process took too long for us." [P-Teac].

"Children need to have their tablets and show the tags to the reader. Then they show the tags to the barcode reader, print the tags, and they see the slides again. You see, it takes 15 minutes even just to say it. When are we supposed to teach? For us, your system is a total waste of time. We already have started a long race, and this barcode-reading system is not appropriate for our goals." [P-Teac].

"It causes children to lose concentration, and it is not possible for them to regain it during the activities. For this reason, it is not very advantageous. I cannot see the whole system. We more or less lose control over the children." [P-Teac].

"Children get busy with other things as soon as they have their tablet PCs. They have very little concentration. They do not follow instructions and get caught up with other things after they finish reading the tags." [P-Teac].

Methods and Materials Used in the Learning Environment: P-Teac said that the materials and methods were effective since the QR codes were attention-grabbing and were large enough to be read without difficulty. The researcher was also well-prepared for the activities, and the instructions were given understandably and correctly:

"If we consider the QR codes as the basis for the activities, the materials and the form of activities were quite successful. There are no problems with it. The objects were chosen to grab children's attention." [P-Teac].

"The codes were also suitable for getting students' attention, and they were large enough for them to read. At least, it was not very difficult for the children." [P-Teac].

"Our teacher was really well-prepared and confident about what to do." [P-Teac].

"Our teacher was very successful at giving instructions to the students. We did not have any problems during the class. The children were also very happy with this experience." [P-Teac].

The Practicality of the Learning Environment: P-Teac expressed thoughts about the continuity of the learning environment under three headings: "our own classes," "other classes," and "the future of the U-Learning environment in education." P-Teac said that they used smart boards and computers to convey course content to students, which allows for more permanent learning acquisitions than the U-Learning environment:

"We already use the smart board system in our classes. Each book has its own system. We do not read the barcodes, but we put the whole content of our textbook on the board using the computer. So, children are able to learn about an object, but how permanent is the learning in that process? Not at all. Learning is more permanent when we teach an object using PowerPoint and bring the real objects to the class. This also enables us to do more exercises related to them." [P-Teac].

P-Teac also expressed thoughts about the use of this learning environment in classes other than English:

"Perhaps it can be used in the Mathematics class to show figures. Or maybe in Science. It depends on the method of the planned activities as well as on the content and the objects to be used." [P-Teac].

P-Teac claimed that the classes in which the U-Learning environment could be used would depend on to the activities, the method, content, and the objects of the lesson to be taught. P-Teac expressed her thoughts about continuing to use the learning environment employing QR codes:

"It is not possible for this method to become widespread in educational activities. I cannot say anything about the barcodes. But it might be possible to arrange for each book to have its own barcode system, and the codes for each unit could be placed in the book. The exercises are shown automatically when these codes are read by the system. It might be possible that way, but it can never be used in an individualized education system." [P-Teac].

P-Teac also emphasized that it would be difficult for these activities to be used widely in the educational system. However, the teacher gave an example about the possible use of QR codes in the U-Learning environment, stated that it would be difficult for these codes to be used in individualized education.

To conclude, the participant teacher holds that the school's system of smart boards and computers used in English lessons are more effective and does not want to apply the U-Learning environment because it has too many disadvantages that would prevent it from being used widely in educational activities. However, the teacher believes that this system could be used in classes other than English depending on the methods, content, and objects used.

Discussion

This study analyzes the influence of the new learning environment benefiting from the use of QR codes and tablet PCs on enhancing English vocabulary. It furthermore discusses participants' opinions about this environment. Regarding the participants' completion rate of the learning activities in the environment, it was determined that: (*i*) 58.97% of participants completed the associated learning activities based on the QR codes of 18 learning objects; (*ii*) 2 of the 21 participants did not answer any of the questions, leading the researchers to calculate values for 19 participants; (*iii*) of these 19 participants, only 49.70% responded to the questions in the learning activities, and (*iv*) 14 participants were able to reach the final page of the activities. Thus, the actual rate of completing the learning activities was 30.95%, which was lower than expected. Although it was found that participants had only partially completed the learning activities, the authors were unable to find any studies in the relevant literature to compare with this research.

Although the majority of them did not finish the activities, the activities in the U-learning environment did improve participant students' English vocabulary. Considering that students only partially completed the activities, it is possible to say that they only experienced a partial increase in their English vocabulary. However, it should also be clearly stated that the activities in the U-Learning environment functioned as a review for some students since they already knew the vocabulary used in the activities. The findings of this research are supported by those of the study by Ogata et al. (2006).

Ten participants reported experiencing difficulties with the learning environment for a variety of reasons, including reading the QR codes, logging into the system, typing on the tablet PC, using the earphones, and tablet malfunction. Meanwhile, 10 participants stated that they had found the environment very easy to use and had experienced no difficulties. Uemukai, Hara, and Nishio (2004) found that the information embedded in a U-Learning environment can be used anytime and by anyone thanks to mobile devices and wireless communication technologies. On the other hand, the findings of this research reveal that middle school students need more practical education regarding how to use these technologies effectively in an educational setting.

The participants stated that the U-Learning environment was entertaining and that they were happy while using it. They were curious and excited about the activities behind the objects, and they enjoyed the environment in general. It was determined that participants' positive thoughts about the environment resulted from their use of tablet PCs, listening and typing on the keyboard instead of writing by hand, and having fun while learning with real learning objects and visuals. However, a small number of the participants said that the environment was boring, that they had felt nervous and angry because they were unable to complete the exercises, or that they were afraid of damaging the tablet PC. Other participants did not like the activities in the U-Learning environment because they felt that they had to rush in order to finish them, use other applications on the tablet PC, or connect to the internet.

A significant number of participants reported that the U-Learning environment was instructive and an effective review. This result is in accord with the high number of correct responses in the system and the improvement in participants' English vocabulary. This research outcome is supported by the results of the studies by Ogata et al. (2011) and Leone and Leo (2011).

It was observed that participants were willing to continue similar activities not only in their English course, but in their other subjects as well. They stated that doing similar activities in classes like Turkish and Social Sciences would also be appropriate since they include many writing tasks. However, they would not like to do such activities in their Physical Education, Music, or other similar lessons since they require different skills, such as physical activity. A review of the relevant literature

indicates other studies similar to this one; namely, Ogata et al. (2005), who conducted a study of foreign language learning, Hsieh et al. (2011), who conducted a study of butterflies in a natural sciences course, and Hwang et al. (2012), who conducted a study of plants in Science class.

Although the participant teacher found the materials and method effective, she emphasized the disadvantages of the U-learning environment, which include the duration of the activities, distractions experienced by the participants, and difficulty in maintaining control over the class. There is a difference between the participant teacher's statements and the point made by Hwang (2006), who stated that the interaction between the learner and the U-Learning system is individualized, and that the system functions as a guide for the students. The authors anticipate that problems related to class management will decrease as the use of these technologies in educational activities by students and teachers increases.

According to the participant teacher, presenting real objects in class to convey learning content is more effective than the U-Learning environment. Moreover, the teacher stated that U-Learning could be used in the Mathematics class to introduce figures and that similar activities could be done in other courses depending on the content, materials, and methods used. The teacher stressed that the U-Learning environment in question could not be used for individualized education, and that it would be difficult for it to become widely used in educational activities. On the other hand, Bomsdorf (2005) emphasized that U-Learning environment could be beneficial for individualized learning since it enables individuals to complete learning activities embedded throughout daily life. His interpretation differs from the other results mentioned above. The research results suggest that in order to contribute further to this field of research, researchers should:

1) conduct further studies on the contribution of U-Learning environments and QR codes to learning and then research these issues at different levels and fields of study,
2) minimize technical difficulties and implement U-Learning for longer periods of time, and
3) conduct studies that compare U-Learning environments using RFIDs and GPS by analyzing participants' perceptions.

References

Arkün, S., & Aşkar, P. (2010, May). Ubiquitous learning: Conceptual framework. Paper presented at the International Symposium on Teacher Education Policies and Problems II, Ankara, Turkey.

Bomsdorf, B. (2005, December). *Adaptation of learning spaces: Supporting ubiquitous learning in higher distance education.* Paper presented at meeting of Mobile Computing and Ambient Intelligence: The Challenge of Multimedia, Daghtul Seminar Proceedings 05181, Schloss Daghtul, Germany. Retrieved on January 12, 2013 from http://drops.dagstuhl.de/opus/volltexte/2005/371/pdf/05181.BomsdorfBirgit.Paper.371.pdf

Chen, C.-M., & Chung, C.-J. (2008). Personalized mobile English vocabulary learning system based on item response theory and learning memory cycle. *Computers & Education*, *51*(2), 624–645. doi:10.1016/j.compedu.2007.06.011

Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Computers & Education*, *50*(1), 77–90. doi:10.1016/j.compedu.2006.03.004

Cheng, Z., Sun, S., Kansen, M., Huang, T., & He, A. (2005). A personalized ubiquitous education support environment by comparing learning instructional requirement with learner's behaivor In *19th International Conference on Advanced Information Networking and Applications* (Vol. 2, pp. 567–573). IEEE. doi:10.1109/AINA.2005.46

Chin, K.-Y., & Chen, Y.-L. (2013). A mobile learning support system for ubiquitous learning environments. *Procedia - Social and Behavioral Sciences*, *73*, 14–21. doi:10.1016/j.sbspro.2013.02.013

Chiou, C.-K., Tseng, J. C. R., Hwang, G.-J., & Heller, S. (2010). An adaptive navigation support system for conducting context-aware ubiquitous learning in museums. *Computers & Education*, *55*(2), 834–845. doi:10.1016/j.compedu.2010.03.015

Creswell, J. W. (2009). *Research design: qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, Calif: Sage Publications.

Hsieh, H.-C., Chen, C.-M., & Hong, C.-M. (2007, August). Context-aware ubiquitous English learning in a campus environment. In *Advanced Learning Technologies, ICALT 2007, Seventh IEEE International Conference* (pp. 351–353). IEEE. doi:10.1109/ICALT.2007.106

Hsieh, S.-W., Jang, Y.-R., Hwang, G.-J., & Chen, N.-S. (2011). Effects of teaching and learning styles on students' reflection levels for ubiquitous learning. *Computers & Education*, *57*(1), 1194–1201. doi:10.1016/j.compedu.2011.01.004

Huang, Y.-M., Huang, Y.-M., Huang, S.-H., & Lin, Y.-T. (2012). A ubiquitous English vocabulary learning system: Evidence of active/passive attitudes vs. usefulness/ease-of-use. *Computers & Education*, *58*(1), 273–282. doi:10.1016/j.compedu.2011.08.008

Hwang, G. J., Wu, C. H., Tseng, J. C. R., & Huang, I. (2010). Development of a ubiquitous learning platform based on a real-time help-seeking mechanism. *British Journal of Educational Technology*, *42*(6), 992-1002. doi:10.1111/j.1467-8535.2010.01123.x.

Hwang, G. H., Chen, B., Chu, H. C., & Cheng, Z. S. (2012, March). Development of a Web 2.0-based ubiquitous learning platform for schoolyard plant identification. In *Wireless, Mobile and Ubiquitous Technology in Education (WMUTE), 2012 IEEE Seventh International Conference on* (pp. 259-263). IEEE. doi:10.1109/WMUTE.2012.63

Hwang, G.-J., Tsai, C.-C., & Yang, S. J. H. (2008). Criteria, strategies and research issues of context-aware ubiquitous learning. *Educational Technology & Society*, *11*(2), 81-91.

InTec InSights: Technology Integration Ideas for the Classroom: QR Codes and Ideas for Using them in the Classroom. (n.d.). Retrieved April 11, 2013 from http://karenogen.blogspot.com/2012/01/qr-codes-and-ideas-for-using-them-in.html

Jones, V., & Jo, J.H. (2004). Ubiquitous learning environment: An adaptive teaching system using ubiquitous technology. In R. Atkinson, C. McBeath, D. Jonas-Dwyer & R. Phillips (Eds.), *Beyond the comfort zone: Proceedings of the 21st ASCILITE Conference* (pp. 468-474). Perth. Retrieved from http://www.ascilite.org.au/conferences/perth04/procs/jones.html

Kim, D., & Gilman, D. A. (2008). Effects of text, audio, and graphic aids in multimedia instruction for vocabulary learning. *Educational Technology & Society*, *11*(3), 114-126.

Laroussi, M., & Derycke, A. (2004). New e-learning services based on mobile and ubiquitous computing: Ubi-learn project. In *CALIE04, International Conference on Computer Aided Learning in Engineering education, 16-18 février 2004* (pp. 6-pages).

Law, C. Y., & So, S. (2010). QR codes in education, *Journal of Educational Technology Development and Exchange*, *3*(1), 85-100.

Leone, S., & Leo, T. (2011). The synergy of paper-based and digital material for ubiquitous foreign language learners. *Knowledge Management and E-Learning: An International Journal*, *3*(3), 319-341.

Liu, T.-Y. (2009). A context-aware ubiquitous learning environment for language listening and speaking: A context-aware ubiquitous learning environment. *Journal of Computer Assisted Learning*, *25*(6), 515–527. doi:10.1111/j.1365-2729.2009.00329.x

Liu, T.-Y., & Chu, Y.-L. (2010). Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation. *Computers & Education*, *55*(2), 630–643. doi:10.1016/j.compedu.2010.02.023

Marinagi, C., Skourlas, C., & Belsis, P. (2013). Employing ubiquitous computing devices and technologies in the higher education classroom of the future. *Procedia - Social and Behavioral Sciences*, *73*, 487–494. doi:10.1016/j.sbspro.2013.02.081

Ogata, H., Akamatsu, R., & Yano, Y. (2005). Computer supported ubiquitous learning environment for vocabulary learning using RFID tags. In J.-P. Courtiat, C. Davarakis, & T. Villemur (Eds.), *Technology enhanced learning* (Vol. 171, pp. 121–130). Springer US. Retrieved from http://dx.doi.org/10.1007/0-387-24047-0_10

Ogata, H., Li, M., Hou, B., Uosaki, N., El-Bishouty, M. M., & Yano, Y. (2011). SCROLL: Supporting to share and reuse ubiquitous learning log in the context of language learning. *Research and Practice in Technology Enhanced Learning*, *6*(2), 69-82.

Ogata, H., Yin, C., & Yano, Y. (2006, November). JAMIOLAS: Supporting Japanese mimicry and onomatopoeia learning with sensors. In *Wireless, Mobile and Ubiquitous Technology in Education, 2006. WMUTE'06. Fourth IEEE International Workshop on* (pp. 111-115). IEEE. doi:10.1109/WMTE.2006.261356

Paribakht, T. S., & Wesche, M. B. (1993). Reading comprehension and second language development in an comprehension-based ESL program. *TESL Canada Journal, 11*(1), 9-29.

Sakamura, K., & Koshizuka, N. (2005, November). Ubiquitous computing technologies for ubiquitous learning. In *Wireless and Mobile Technologies in Education, 2005. WMTE 2005. IEEE International Workshop on* (pp. 11-20). IEEE. doi:10.1109/WMTE.2005.67

Saravani, S. A., & Clayton, J. F. (2009). A conceptual model for the educational deployment of QR codes. In *Same Places, Different Spaces. Proceedings Ascilite Auckland 2009*. Retrieved from http://www.ascilite.org.au/conferences/auckland09/procs/saravani.pdf

Sun, Y., & Dong, Q. (2004). An experiment on supporting children's English vocabulary learning in multimedia context. *Computer Assisted Language Learning*, *17*(2), 131–147. doi:10.1080/0958822042000334217

Tseng, J. C., Hsu, S. Y., & Hwang, G. J. (2009, July). A collaborative ubiquitous learning platform for computer science education. In *ACM SIGCSE Bulletin* (Vol. 41, No. 3, pp. 368-368). ACM. doi:10.1145/1562877.1563010

Uemukai, T., Hara, T., & Nishio, S. (2004, March). A method for selecting output data from ubiquitous terminals in a ubiquitous computing environment. In *Distributed Computing Systems Workshops, 2004. Proceedings. 24th International Conference on* (pp. 562-567). IEEE. doi:10.1109/ICDCSW.2004.1284088

Ünal, E. N. (2006). *An investigation into the role of interactive vocabulary instruction on learners' vocabulary knowledge* (Master's thesis, Çukurova University, Institute of Social Sciences, Adana, Turkey). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi

Zimmerman, C. B. (n.d.). Historical trends in second language vocabulary instruction. In J. Coady, T. Huckin, J. Coady, & T. Huckin (Eds.), *Second language vocabulary acquisition* (pp. 5–19). Cambridge: Cambridge University Press. Retrieved from http://ebooks.cambridge.org/ref/id/CBO9781139524643A010