Ubiquitous English Learning System with Dynamic Personalized Guidance of Learning Portfolio

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ABSTRACT

Situated learning has been recognized as an effective approach in enhancing learning impressions and experiences for students. Can we take advantage of situated learning in helping students who are not English native speakers to read English articles more effective? Can the effectiveness of situated learning be further promoted by individual portfolio? This paper proposes a situated and reading-based English learning system that integrates a reading guidance mechanism into the development of an English learning environment. To facilitate reading, the system offers not only translation of the vocabulary but also the powerful functions such as translation, pronunciation and explanations of sentences, paragraphs and articles. More importantly, the guidance mechanism provides personalized reading suggestions for increasing learning performance according to the assessment of defined dynamic parameters. The assessment refers to a detailed record of the learner behavior, kept as a Learning Portfolio by the system, for improving the accuracy of reading guidance. The experiments show that learners who adopted a situated and reading-based English learning system exhibited higher quality performance than those who adopted conventional learning systems. And, the performance of learners who utilized the learning support system with a reading guidance mechanism was of higher quality than that of learners who merely utilized a simple situated learning system.

Keywords

English reading, Situated learning, Reading guidance, Learning portfolio, Ubiquitous learning

Introduction

Languages are an important means of interpersonal communications. The English language is, in particular, an important one in the international community (Spolsky & Shohamy, 1999). In non-English-speaking countries, the improvement of English proficiencies of nationals has become an important policy to enhance national competitiveness. In the meantime, the rapid advances of information technologies have significantly changed the way people acquire, apply and disseminate information. The advances have also brought magnificent changes and progress to teaching methods in the application of education. The teaching environments that combined computer-aided learning systems with teaching strategies have become an integral part of diversified teaching techniques (Lin & Hsieh, 2001). Furthermore, the growing popularity of wireless technologies and mobile devices have contributed to the development of mobile learning (Chinnery, 2006; Jeng et al., 2010; Klopfer, Squire, & Jenkins, 2002; Soloway et al., 2001). Accordingly, the teaching support system that combined with information and networking technologies to assist the learning of foreign languages has become an important research and development issue (Collins, 2005; Shih, 2005; Sun, Huang & Liu, 2011).

Ubiquitous learning as an educational concept has gradually gaining momentum (Huang et al., in press; Huang, Hwang & Hsieh, 2008; Hwang, Tsai & Yang, 2008;). It is being applied to the development of learning support in English-language learning. For example, Ogata and Yano (2004a) proposed the TANGO learning system that allows students to move actual objects in the learning environment according to instructions to enhance the learners’ understanding of English vocabulary related to the objects they moved. Follow-up studies combined cooperative learning pedagogy with knowledge maps in a wireless learning environment to help students build English vocabulary (El-Bishouty, Ogata & Yano, 2007; Ogata and Yano, 2004b). Petersen & Markiewicz (2008, 2009) developed PALLAS, a personalized mobile English learning system. The system offers study materials based on the needs and preferences of students to facilitate a personalized learning experience. Chen & Li (2009) established a...
ubiquitous learning system that provides suitable vocabulary to the learners based on their vocabulary capacities and wireless base station positioning to enhance their vocabulary levels. Many of these studies focused on the learning and familiarization of English vocabulary as the main goal of the English learning support system. However, pure memorization of English words provides limited help to the improvement of English proficiencies. Students are not all that familiar with when to use what English words or the composition of English sentences. Sometimes, even if students know all the superficial meanings of individual words, they get lost to the implication of the whole sentences. Problems of this kind indirectly prohibit the reading, writing and speaking abilities of students.

To resolve the problems mentioned above, the training in reading comprehension of English-language articles can be applied. Reading is a process where the reader and the reading material establish a meaningful connection in an active and smooth manner (Neil, 1991). Reading ability contains a highly complex cognitive process. The stronger the reading ability, the more able a person is to gather, understand and determine information in order to achieve personal goals and develop potentials (Nunan, 1999). Learning to read in English is the acquisition of an English vocabulary and the establishment of a linguistic capability to understand sentence patterns and syntaxes from reading materials (Hirvela, 2004). It is an important secret of learning any second foreign that one should not only be able to recognize words in articles, but also able to construct the applications and implications of words from the contexts (Day & Bamford, 1998; Gehard, 1996). Fasting and Lyster (2005) found that in the process of teaching experiments, computer-aided reading helps to develop linguistic skills. Some studies indicated that the appropriate use of computer-aided reading can effectively assist teachers to improve the reading proficiency of students in primary and secondary schools (Lynch, Fawcett & Nicolson, 2000; Nicolson, Fawcett & Nicolson, 2000). Some researches indicated that the combination of technological environments and good guidance and reading instructions enhance the linguistic capabilities and enhance reading comprehension of students (Dreyer & Nel, 2003; Stepp-Greany, 2002).

Besides, situated learning involves learners actively participating in a virtual environment and acquiring knowledge through interaction with people, events, and objects in the environment (Brown et al., 1989). Situated learning (Lave & Wenger, 1991) theory emphasizes a learning situation which stimulates the intrinsic and extrinsic learner motivations, encouraging learners to introduce abstract ideas into concrete thinking, perception, knowledge, and cognition; the learners interact with their environment (Clancey, 1995) and, in doing so, obtain knowledge through context. Palmer & Hornby and other language scholars have proposed situational language teaching theories, stressing that language learning is natural to learners. For practical vocabulary, language should be taught in a context and applied to a particular situation (Hornby, 1950).

Based on the abovementioned advantages of English learning upon reading and situated learning, this paper first outlines the reading-oriented situated learning model. Moreover, because that most previous English learning support tools or systems focus on learning vocabulary, students relatively lack for the ability to infer, analyze, judge, organize, or apply their vocabulary. Even if learners may be proficient in memorization, they may not be able to connect words or interpret sentences. Therefore, the learning system proposed in this paper provides students with the learning support in vocabulary, phrases, sentences, paragraphs and articles. With the situated teaching as the foundation, this paper constructs a ubiquitous English-reading learning system that combines RFID location-aware technologies, uses learners’ positions as the situational information, and provides situational English articles that are highly relevant to the specific location and surroundings as learning materials.

Furthermore, when a learning system provides a non-linear and highly autonomous learning model, although students can select contents based on their own decisions and preferences (Duffy, Lowyck & Jonassen, 1993), beginners or passive learners may experience learning disorientation and cognitive overloads (Lin & Gayle, 1996). This affects the thinking and organization of the learning contents, the internalization of knowledge and the effectiveness of learning (Nelson, 1992; Stanton, Correia, & Dias, 2000). The addition of a guidance and support system can mitigate the negative effects (Brusilovsky, 1999; Chen & Hsu, 2008; Hartley & Sleeman, 1973; Maes, 1994). Therefore, the second focus of this paper is to provide appropriate and personalized guidance mechanism for English reading. The guidance mechanism fully utilizes the data of learning portfolio to assess the dynamic parameters defined in the system for suggesting more appropriate reading materials to students in the appropriate sequence.
Ubiquitous English-Reading Learning System

Before doing this experiment, this learning system has been conducted the acceptance and satisfaction evaluation (Wu, Sung, Huang, & Yang, 2010). Based on the result of evaluation data, the learning system has done a minor modification to make it more user-friendly.

Campus Situations for English Learning

This study designs eight campus situations by referring to a university in southern Taiwan. The reading materials offered by the system for students to read and learn are all highly relevant to the student locations and surroundings. The situations and the corresponding materials are as follows:

1. Restaurants and shops: dining, food, order, mall, shopping, etc.
2. Dormitory: daily life, indoor entertainment, etc.
3. Softball field: baseball, softball, Major League, Chinese Professional Baseball League, etc.
4. Library: query and checkout services, book and magazine publications, guided reading, etc.
5. Computer classroom: information, Internet, digital technology, etc.
6. Gym: sports and exercise, indoor competitive ball sports, workout, etc.
7. Teaching complex: teaching activities, tests, class affairs, teachers and students, etc.
8. Parking lot: cars, motorcycles, transportation, etc.

System Architecture

Figure 1 shows the system architecture of this learning system. It is constructed in an IEEE 802.11 WiFi network in a campus. Active RFID tags are installed in the eight situational locations throughout the campus. Students carry with them the mobile learning devices, such as PDAs or smartphones, installed with RFID readers and a built-in WiFi adaptor. Data can be transmitted via wireless networks and RFID technology provides location awareness. Once a mobile learning device senses the location of the student via RFID, the location information will be sent to the U-Reading System which includes Dictionary Server, Learning Material Database, and Portfolio Database. According to the reading guidance mechanism, from the Learning Material Database, the system selects the reading materials highly relevant to the situation and suitable for the students. The student can learn the materials with the supporting functions, e.g. Chinese translation of the vocabulary, phrases, sentences, paragraphs and articles. The audio function allows the students to listen to the pronunciation or recitation. All these features aim to assist learning of the reading
materials. The translation and pronunciation of words and phrases is accessed from Dictionary Server; whilst the translation and pronunciation of sentences, paragraphs and articles are accessed from Learning Material Database. The reading materials are sourced from digital versions of English-learning magazines, audio books, Chinese-English news websites and in-house compilations. Since the system provides functions more than just a directory of English words, it is able to assist the student to understand better the meanings and structures of sentences and the application of words. The learning behavior of each student is collected and recorded in Portfolio Database. Relevant statistics of learning portfolio are calculated and fed back to the Reading Guidance Mechanism as decision-making parameters. Teachers can also access the statistics from the Web-based teachers’ interface in order to adjust their teaching strategies and materials accordingly.

Learning Functions and Interface

RFID tags are installed at the appropriate locations throughout the campus and an RFID reader is equipped into the mobile learning device. RFID SDKs support relevant APIs so that the system programs can write, detect and access situational codes with RFID tag memories.

![Learning function interface](image)

The English-reading learning interface and the support functions are shown in Figure 2. Once the RFID reader is activated, it can detect and display the location of the user. The system can immediately select suitable reading articles and displayed on the mobile device from the database according to the Reading Guidance Mechanism. Users can inquire for the translation of words, phrases, sentences, paragraphs or whole articles. The inquired results are shown in the lower part of the screen. Users can select the pronunciation or recitation function to improve their speaking and listening. The notebook function logs the inquiries and results to facilitate off-line reviews afterwards. The figure below demonstrates the situation of “restaurant”, as one of the eight campus situations.

Back-end Functions for Teachers

The back-end system provides basic features such as the establishment and maintenance of students’ data and teaching materials (Figure 3). The learning behavior is also logged into the back-end database. Therefore, the system also provides Web-based inquiry functions to teachers for all the statistics of the learning portfolio. The statistics
include the number of times and rankings of the usage rates of situations, reading materials, the inquiries of words, sentences, paragraphs and articles for translation and pronunciation. Such information helps teachers to better understand the activities of students so that they can adjust teaching materials or strategies accordingly.

Reading Guidance Mechanism

The RFID technology senses the locations and corresponding situations of students to provide situational reading materials. Meanwhile, the system also offers personalized guidance to students to enhance learning effectiveness.
The reading guidance mechanism takes into account the reading relation degree, reading difficulty, and learner ability with regards to the learning portfolio. Learning portfolio can serve as a reference material for the calculation of reading article suggestion (Drachsler et al., 2009). The guidance mechanism dynamically calculated guidance parameters to improve the accuracy of the suggested reading materials and sequence. Figure 4 shows the flow of guidance parameter calculation and decision making. The guidance parameters and decision making are described in detail in the following sections.

Assessment of Reading Relation Degree

The system proposed by Chen (2008) uses the linguistic terms in course description to compute the Concept Relation Degrees for the sequential arrangement of learning courses. This paper defined a different item, Reading Relation Degree, to enhance the relation and proper sequence between suggested reading articles. The system refers to the vocabulary inquired by the student for the previous article in the specific situation to calculate Reading Relation Degree of each unread article in the situation, in order to recommend an article that contains the same vocabulary as much as possible as the previous one. The re-appearance of the same words further familiarizes the students and enhances their understanding of the meanings and usages for these words in different contexts. The Reading Relation Degree for articles $a_x$ and $a_y$ is defined as $R(a_x, a_y)$ and expressed in Eq. (1). The article $a_x$ is the previous article that the student read. The collection of the vocabulary words inquired by the student for that article is $U_x = \{ u_i | i \in [1, m_x] \}$, whilst $V_y = \{ v_i | i \in [1, n_y] \}$ is the collection of the vocabulary words appear in the article $a_y$. $W_y = \langle w_1, w_2, w_3, \ldots, w_{n_y} \rangle$ is the composition of words in the article $a_y$. The first part after the equality sign is the percentage of $U_x$ appears in the article $a_y$. $\omega$ denotes the weighting. The second part takes into consideration the reappearance of the same words in order to calculate the percentage of $W_y$ belongs to $U_x$. 

$$R(a_x, a_y) = \omega \sum_{i=1}^{m_x} \frac{f(u_i)}{m_x} + (1 - \omega) \sum_{i=1}^{n_y} \frac{g(w_i)}{h_y}$$

where

\[
f(u_i) = \begin{cases} 1 & , u_i \in V_y \\ 0 & , \text{otherwise} \end{cases}
\]

\[
g(w_i) = \begin{cases} 1 & , w_i \in U_x \\ 0 & , \text{otherwise} \end{cases}
\]

$R(a_x, a_y)$ is between 0 and 1. The higher the value, the higher the reading relation degree is.

Assessment of Reading Difficulty

To assess the level of difficulty of reading materials, Chen & Hsu (2008) referred to Flesch Reading Ease Readability Formula (Flesch, 1948) and the vocabulary classification of the GEPT. The assessment considers the differing judgment of English native speakers and non-English native speakers concerning the level of difficulty of reading materials. The benchmark is based on the average standard of the general public. As the target users of this system are university students in Taiwan in the contexts of campus life, this paper refers to the average English proficiencies of students as one of the major criteria in the assessment of the difficulty for reading materials. In Taiwan, all colleges and universities accept enrollments based on the results of joint-entrance examinations. On average, the quality of students is different from one school to another. Therefore, in addition to Flesch’s Formula and GEPT, this paper further takes into account the learning portfolio of words and sentences inquired by all the students in order to make real-time dynamic calculations and adjustments for reading difficulty of articles. The Reading Difficulty of the article $a_x$ is defined as Eq. (4). $D_{INIT}(a_x)$ is calculated based on Flesch Reading Ease Readability Formula and the vocabulary classification of the GEPT. This value (between 0 and 1) is used as the
initial value for the predetermined reading difficulty of \( a_x \). \( D_{PF}(a_x) \) is the reading difficulty dynamically calculated on the basis of the statistics in the learning portfolio, with \( \alpha \) as the weighting.

\[
D(a_x) = \alpha \cdot D_{INIT}(a_x) + (1 - \alpha) \cdot D_{PF}(a_x)
\]

The Flesch’s formula is as follows:

\[
RE = 206.835 - (1.015 \times ASL) - (84.6 \times ASW)
\]

where

\( ASL = \text{Average Sentence Length} \)
\( ASW = \text{Average number of Syllables per Word} \)

The value of \( RE \) is between 0 and 100. The higher the value is, the lower the level of difficulty. This paper converts this value into a value between 0 and 1 by Eq. (4), and the higher the value, the more difficult the material is.

\[
D_{REF}(a_x) = 1 - \frac{RE(a_x)}{100}
\]

\[
= 0.01015 \times ASL(a_x) + 0.846 \times ASW(a_x) - 1.06835
\]

The GEPT collects more than 8,000 English words and classified these words into Elementary, Intermediate and High-Intermediate. This paper calculates \( D_{GEPT}(a_x) \), the difficulty indicator based on the GEPT, and the value is between 0 and 1. A high value means a high difficulty.

\[
D_{GEPT}(a_x) = \frac{\frac{1}{6} C_E(a_x) + \frac{1}{2} C_I(a_x) + \frac{1}{3} C_H(a_x)}{C_E(a_x) + C_I(a_x) + C_H(a_x)}
\]

\[
D_{INIT}(a_x) = \frac{D_{PF}(a_x) + D_{GEPT}(a_x)}{2}
\]

where, \( C_E(a_x), C_I(a_x) \) and \( C_H(a_x) \) denote the number of words of Elementary, Intermediate and High-Intermediate in article \( a_x \), respectively.

\( D_{PF}(a_x) \) is the indicator to the difficulty of reading materials calculated on the basis of learning portfolio consists of the assessment of the vocabulary and sentences. The criteria contain the frequency of the translation inquiries and the capabilities of the inquirer. The calculations are as follows:

\[
F_v(a_x) = \sum_{v \in V_x} \frac{q(v)}{p(v) \cdot |V_x|}
\]

\[
L_v(a_x) = \sum_{v \in V_x} \sum_{i=1}^{q(v)} \frac{c_i(v)}{q(v) \cdot |V_x|}
\]

where, \( F_v(a_x) \) and \( L_v(a_x) \) denote the average frequency of the translation inquiries and average capability of inquirers for the vocabulary appears in the article \( a_x \); \( q(v) \) denotes the total number of times for the inquiries made by all the students on word \( v \); \( p(v) \) denotes the total number of times the word \( v \) appears throughout the articles read by all the students; \( c_i(v) \) indicates the capability of the learner when the word \( v \) is inquired for the \( i \)-th time. \( V_x \) is the collection of the vocabulary words that appear in the article \( a_x \). Therefore, the indicator to the difficulty for the vocabulary in the article \( a_x \) based on the learning portfolio is as follows:
\[ D_{pp}^v (a_s) = \frac{F_v (a_s) + L_v (a_s)}{2} \]
\[ = \frac{1}{2} \left( \sum_{v \in V} q(v) \cdot p(v) \cdot |V_x| + \sum_{i=1} q(v) \cdot c_i(v) \cdot |V_x| \right) \]

Similarly, \( q(s) \) is the total number of times that sentence \( s \) is inquired by all the students; \( p(s) \) denotes the total number of times for sentence \( s \) to appear in all the articles read by all the students; \( c_i(s) \) is the capability of the learner when the sentence \( s \) is inquired for the \( i \)-th time; \( S_x \) is the collection of the sentences that appear in the article \( a_x \).

Therefore, the indicator to the difficulty for the sentences in the article \( a_x \) based on the average frequency of the sentence inquiries \( F_S (a_x) \), the average capability of the inquirers \( L_S (a_x) \) and the learning portfolio is as follows:

\[ F_S (a_s) = \sum_{s \in S_x} \frac{q(s)}{s(s) \cdot |S_x|} \]

\[ L_S (a_x) = \sum_{s \in S_x} \sum_{i=1} \frac{c_i(s)}{q(s) \cdot |S_x|} \]

\[ D_{pp}^s (a_s) = \frac{F_s (a_s) + L_s (a_s)}{2} \]
\[ = \frac{1}{2} \left( \sum_{s \in S_x} \frac{q(s)}{s(s) \cdot |S_x|} + \sum_{s \in S_x} \sum_{i=1} \frac{c_i(s)}{q(s) \cdot |S_x|} \right) \]

\( D_{pp} (a_s) \) represents the average responses of a specific group of students to the difficulty of reading materials. The incorporation of this value can enhance the calculation accuracy of the reading difficulty for the reading materials.

\[ D_{pp} (a_s) = \frac{D_{pp}^v (a_s) + D_{pp}^s (a_s)}{2} \]

**Assessment of Learner Ability**

The reading guidance mechanism takes into account the learner ability for offering reading materials. The assessment of learner ability in this paper consists of two parts. The first part is \( A_{INIT} (l_y) \), the test score of the student \( l_y \) in the subject of English in the joint university entrance examination. This is the initial value for the ability of the student. The second part is the indication value \( A_{PF} (l_y) \) calculated real-time and dynamically according to the records in the learning portfolio. Below is the equation for the Learner Ability, i.e. \( A (l_y) \), of the student \( l_y \). The value is between 0 and 1. A high value means a strong ability. \( \beta \) denotes the weighting.

\[ A (l_y) = \beta \cdot A_{INIT} (l_y) + (1 - \beta) \cdot A_{PF} (l_y) \]

The calculation of \( A_{PF} (l_y) \) includes the past performance of the student when facing vocabulary and sentences.

\[ A_{PF} (l_y) = \frac{A_{PF}^v (l_y) + A_{PF}^s (l_y)}{2} \]
The following Eq. (18) expresses the past performance of the student when facing vocabulary. One of the indicators is \( P_V(l_y) \), which is the percentage of the absence of vocabulary inquiries by student \( l_y \), among all the words that appear in the reading materials previously read by that student, which indicates the performance history of the student \( l_y \). Another indicator is \( Q_V(l_y) \), which is the percentage of the inquiries made by all the other students, among all the words inquired by the student \( l_y \), which is a comparison of the ability of the student \( l_y \) against the ability of all the other students.

\[
A'_p(l_y) = \frac{P_V(l_y) + Q_V(l_y)}{2} \tag{18}
\]

\[
P_V(l_y) = \sum_{a_x \in E'} \left( 1 - \frac{h_V(a_x)}{|V'| \cdot |E'|} \right) \tag{19}
\]

\[
Q_V(l_y) = \sum_{a_x \in E} \sum_{v \in U_x} \frac{r_V(v)}{|U_x| \cdot |E'|} \tag{20}
\]

where, \( E' \) denotes the collection of all the articles read by the student \( l_y \); \( h_V(a_x) \) is the number of words inquired by the student for the article \( a_x \); \( V' \) is the collection of the vocabulary words that appear in the article \( a_x \); \( U_x \) is the collection of the vocabulary words inquired by the student \( l_y \) for the article \( a_x \); \( r_V(v) \) is the percentage of the inquiries made by all the other students for the word \( v \) in the articles that contain the word \( v \) (the number of inquirers divided by the number of readers).

\[
A'_p(l_y) = \frac{1}{2} \left( \sum_{a_x \in E'} \left( 1 - \frac{h_V(a_x)}{|V'| \cdot |E'|} \right) + \sum_{a_x \in E \cup U_x} \sum_{v \in U_x} \frac{r_V(v)}{|U_x| \cdot |E'|} \right) \tag{21}
\]

Similarly, the ability concerning the comprehension of the sentences is expressed as following Eq. (22) and Eq. (23). The percentage of the absence of the inquiries by the student \( l_y \) is defined as \( P_S(l_y) \). \( Q_S(l_y) \) is the percentage of the inquiries made by other students for the sentences also inquired by the student \( l_y \).

\[
A'_p(l_y) = \frac{P_S(l_y) + Q_S(l_y)}{2} \tag{22}
\]

\[
A'_p(l_y) = \frac{1}{2} \left( \sum_{a_x \in E} \left( 1 - \frac{h_S(a_x)}{|S_x| \cdot |E''|} \right) + \sum_{a_x \in E} \sum_{s \in T_x} \frac{r_S(s)}{|T_x| \cdot |E''|} \right) \tag{23}
\]

where, \( h_S(a_x) \) is the number of sentences inquired by the student \( l_y \) for the article \( a_x \); \( S_x \) is the collection of the sentences that appear in the article \( a_x \); \( T_x \) is the collection of the sentences inquired by the student \( l_y \) for the article \( a_x \); \( r_S(s) \) is the percentage of the inquiries made by all the other students for the sentence \( s \) in the articles that contain the sentences (the number of inquirers divided by the number of readers).

**Recommended Reading Materials**

The guidance is about providing the next best option for learners based on their needs (Eklund & Sinclair, 2000). As shown in Eq. (24), this paper selects the article with the highest assessment value, i.e. \( a_{fix} \) for the learner \( l_z \) based on the evaluation of the Reading Relation Degree, Reading Difficulty, Learner Ability.
\[
a_{fit} = \arg \max_{a_y \in E-E'} K_{\text{fitness}}(a_y) \\
= \arg \max_{a_y \in E-E'} \left( \lambda \cdot R(a_y,a_y) + (1-\lambda)\left(A(l_x) - D(a_y)\right) \right)
\]

where, \( E \) is the collection of articles; \( E' \) is the collection of the articles read completely; \( K_{\text{fitness}}( ) \) is the evaluation function of the suitability of the reading materials, \( \lambda \) is the weighting of the evaluation parameter.

**Experiment**

**Design**

This study evaluates the students of three classes in the freshman year of a university. Each class is defined as one group for the evaluation. Three groups, which are group \( P \) (Paper), group \( R \) (Reading), and group \( G \) (Guidance), are established. The students of group \( P \) learn from paper-based materials and do not access any support of the learning system. The teaching is in the form of traditional lectures in the classroom. Both group \( R \) and group \( G \) use the Ubiquitous English-Reading Learning System, with the only difference that group \( G \) has additional assistance from the personalized reading guidance mechanism. The experiment was designed to compare the learning effectiveness of these three groups and to evaluate whether the system can enhance learning motives, interests, and a sense of participation. The benchmark was the reading materials centering on the situation of restaurants and shops. The goal was to assess the differences in learning effectiveness of the traditional classroom approach, the u-learning system, and the u-learning system combined with the reading guidance mechanism. We attempted to understand if the learning performance of learners with the reading guidance mechanism (group \( G \)) proposed by this study was higher than that of other two groups (group \( R \) & group \( P \)). Did learners who adopted the English learning system (group \( R \) & group \( G \)) exhibit higher learning performance than those who adopted conventional learning methods (Group \( P \))? All learning content was identical and came from the same Learning Material Database.

**Participants**

The research participants are the freshman students learning English in a university in Taiwan. There are a total of 113 students from the selected three classes. One class consists of 36 students (22 males and 14 females), another class 39 students (23 males and 16 females), the third class 38 students (22 males and 16 females). The teacher is very interested in the application of technologies into English-language teaching and grasping the learning status of students, thus is cooperative in this experiment.

**Procedure**

In this experiment, there are 18 weeks each semester for the English-language curriculum, with two classes per week. The 9th and 18th weeks are dedicated to the mid-term and final exams, respectively. From the 1st to the 8th week, traditional lecturers are given with teachers explaining the basis of contexts and grammar. A pre-test is performed in the 9th week, to assess the level of familiarity of each student. From the 10th to the 17th week, the experimental teaching is given. To ensure that both the teacher and students are familiar with the learning flows and the operations of the system devices, an orientation on the learning flows and the device instructions is held in the 10th week. From the 11th week onward, group \( P \) studies the reading materials in the conventional manner; whereas group \( R \) and group \( G \) begin to use the mobile devices equipped with WiFi and RFID components and the proposed Ubiquitous English-Reading Learning System for English reading (Figure 5). In the seven weeks of experimental learning, the teacher arranges a feedback session in the 14th week. Based on the records and statistics shown on the back-end system and the responses from the students, the teacher corrects the behavior bias and cognitive mistakes of students to facilitate further learning. The experimental learning finishes at the end of 17th week. The Learning Material Database at the backend contained roughly 40 articles for each campus situation. Each student was required to read at least 20 articles for the situation of restaurants and shops during the experiment. In the last week, i.e. the 18th week, students take the final written examination (post-test) and fill in the questionnaire concerning the system acceptance.
Limitations

This experiment adopted the learning method that required high autonomy, which means participants were required to exhibit high autonomy and self-discipline during the experiment. Moreover, during the experiment the charge capacity of mobile devices was limited, and learners who were not familiar with the operation of the devices might suffer from crashing the system and difficulty of operation.

In the article recommending guidance mechanism, this paper combined data of individual and group learning portfolios on the decision-making calculation of recommended guidance. The higher the frequency of recorded reading behaviors in the learning portfolios database, the more accurate the results are.

Data Collection

Pre-test and Post-test Scores

Both the pre-test and the post-test are based on the questions designed by the teacher. The questions are about the location and surroundings of the situation of restaurants and shops. The teacher designs the questions also by referring to the teaching materials in the Learning Material Database. The questions are in the form of vocabulary explanations, blank fillings, sentence translation and reading comprehension. The test results indicate whether the proposed Ubiquitous English-Reading Learning System can help students to improve their English proficiency and understanding. Assessments are also made to gauge whether the reading guidance mechanism is beneficial to English learning.

Survey on Suitability of Recommended Reading Materials

After a student finishes reading each English-language article, the system automatically presents a questionnaire for the student to fill in replies concerning the level of difficulty and relevance of the article. The analysis aims to evaluate the suitability of the recommended reading materials to the students with and without access to the reading guidance mechanism.

Questionnaire on System Acceptance

The ease of use and practicality of the system will influence the intention of learners in using the system and hence their learning effectiveness (Davis, 1989). This study performs a questionnaire survey on the system acceptance to gather feedbacks for further designs and improvements. The questionnaire is designed based on the questionnaire developed by Davis (1989) and Harwick & Barki (1994). The measurement is based on the Likert 5-point scale. The criterion-related validity and construct validity are ensured with the assistance and correction from two experts.
Cronbach $\alpha$ coefficient is above 0.7, indicating good consistency and stability. A total of 75 questionnaires are issued. After the elimination of 10 ineffective questionnaires, there are 65 effective questionnaires. The effective recovery rate is 87%.

**Results**

**Assessments of Learning Effectiveness**

**Within-Group Assessment**

This analysis is based on the t-tests of dependent samples of group $P$, group $R$ and group $G$. Table 1 summarizes the statistical analysis of the variances in the pre-test and post-test results.

<table>
<thead>
<tr>
<th>Group</th>
<th>Test</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>group P</td>
<td>Pre-test</td>
<td>38</td>
<td>65.16</td>
<td>5.726</td>
<td>-1.471</td>
<td>.150</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>38</td>
<td>66.21</td>
<td>4.592</td>
<td></td>
<td></td>
</tr>
<tr>
<td>group R</td>
<td>Pre-test</td>
<td>39</td>
<td>64.74</td>
<td>5.571</td>
<td>-11.398</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>39</td>
<td>80.97</td>
<td>6.714</td>
<td></td>
<td></td>
</tr>
<tr>
<td>group G</td>
<td>Pre-test</td>
<td>36</td>
<td>64.97</td>
<td>5.882</td>
<td>-18.817</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>36</td>
<td>84.53</td>
<td>5.853</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\alpha = .05$ ; *p < .05

The analysis indicates that the students in group $P$ make very limited progress from the traditional learning approach in classroom. However, the overall learning effectiveness is far inferior to the students in the other groups who use the learning system. The reason should be a lack of effective support, learning fun and motives. In contrast, the students in both group $R$ and group $G$ show significant improvements in learning effectiveness after they use the learning system. This shows a convenient reading support and the situated learning (of reading what you see) enhances an understanding of the English language and betters the learning outcomes. The students in group $G$ with additional access to the reading guidance mechanism report an average of progress scores 3.33 higher than that of group $R$. This indicates that the reading guidance mechanism with multi-facet consideration can provide more appropriate reading materials and sequence dynamically to the students. The reading relevance can enhance the connection of learning content and memory, and the students’ ability is matched with the recommended articles, thus can reduce learning obstacles and enhance learning effect.

**Between-Group Assessment**

Between-Group Assessment included a pre-test and a post-test. In the pre-test, we adopted a one-way ANOVA to discuss the English performance of group $P$, group $R$, and group $G$ before the experiment. The results of statistical analysis are shown in Table 2 below.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>group P</td>
<td>65.16</td>
<td>38</td>
<td>5.726</td>
<td></td>
<td></td>
</tr>
<tr>
<td>group R</td>
<td>64.74</td>
<td>39</td>
<td>5.571</td>
<td>.051</td>
<td>.951</td>
</tr>
<tr>
<td>group G</td>
<td>64.74</td>
<td>39</td>
<td>5.571</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

The average pre-test scores of group $P$, group $R$ and group $G$ are 65.16, 64.97 and 64.74, respectively. These scores are similar. The $p$ value is greater than 0.05, indicating a lack of significant variances in the learning effectiveness of these three groups. There are no obvious differences in the levels of English-language test results since the university ensures that the levels of students in each class are in a normal distribution.
Table 3 shows the analysis of the post-test results of group P, group R and group G by using ANOVA of independent samples. The purpose is to understand that the learning effectiveness of the group of students in group P and group R that use the learning system. The analysis also aims to evaluate the learning outcomes of group R and group G who use the reading guidance mechanism of the system.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>group P</td>
<td>66.21</td>
<td>38</td>
<td>4.592</td>
<td></td>
<td></td>
</tr>
<tr>
<td>group R</td>
<td>80.97</td>
<td>39</td>
<td>6.714</td>
<td>105.426</td>
<td>.000*</td>
</tr>
<tr>
<td>group G</td>
<td>80.97</td>
<td>39</td>
<td>6.714</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

As shown in Table 3, the value p of statistical analysis is less than .05. The result shows that the scores of the post-test in group P, group R, and group G had significant differences. We further observed that the scores of the post-test in group P were 14.76 lower than the scores in group R. The scores of the post-test in group R were significantly higher than the scores in group P. This shows that the learning effectiveness of group R, who uses the system, is significantly better than the students who resort to traditional learning approaches. It confirms that the learning support of the proposed system can effectively enhance learning results, and furthermore, the system can effectively connect the reading materials with situations, thus reducing abstraction. It can effectively help students to internalize the contents and improve their understanding of the English language so that they can use the language better. Additionally, the average score of group G is higher than that of group R. These analysis results demonstrate that although both groups use the learning system, the group that has access to the reading guidance mechanism benefits more give the personalized guidance based on the reading relevance and level of difficulty of learning materials, and ability of learners. In addition, the standard deviation of group G is smaller than that of group R, indicating that the system is conducive to closing the gap between the students.

**Suitability of Recommended Reading Materials**

Table 4 shows the suitability of the recommended reading materials. A questionnaire survey is performed on group R and group G. The questionnaire is based on Likert 5-point point scale and the scores are calculated with percentages. Regarding the level of difficulties suitable to the capabilities of learners, the survey shows that the average score of group G is 4.04, higher than that of group R at 3.43, a clear indication of the results of the learning guidance mechanism. About 30% of the group R respondents disagree that the level of difficulties is appropriate to their capabilities because there is a lack of reading guidance and a sequence of recommended articles.

<table>
<thead>
<tr>
<th>Questions</th>
<th>strongly disagree</th>
<th>strongly agree</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of difficulties suitable to my own capabilities</td>
<td>group R</td>
<td>2% 28% 10% 45% 15%</td>
<td>3.43</td>
</tr>
<tr>
<td>group G</td>
<td>0% 5% 16% 49% 30%</td>
<td>4.04</td>
<td></td>
</tr>
<tr>
<td>Sufficient relevance of the reading materials</td>
<td>group R</td>
<td>11% 19% 27% 25% 18%</td>
<td>3.20</td>
</tr>
<tr>
<td>group G</td>
<td>4% 10% 23% 38% 25%</td>
<td>3.70</td>
<td></td>
</tr>
</tbody>
</table>

As for the relevance of reading materials, although group R does not use the reading guidance mechanism, 43% of the respondents think it is sufficient. The percentage is greater than 30% of the respondents who do not think it is sufficient. The average of the 5-point scale measurement is 3.20, not too poor a number. This is because the reading materials for the same situation are high relevant already. The users in group G use the reading guidance mechanism and achieve an average of 0.5 higher than group R.

There is an additional remark concerning the suitability of recommended reading materials. The results of both the difficulty and relevance of the recommended reading materials could still be improved if the backend database significantly expands its collection of reading materials.
Assessment of System Acceptance

The questionnaire survey on the system acceptance is performed on group \( R \) and group \( G \), in order to understand the learners’ satisfaction and acceptance regarding the learning system. The survey results are summarized in Table 5.

Table 5 shows that the average values of most questionnaire replies are greater than 3.0. This indicates that most learners are positive about this system in their study of the English-language materials. About 77% of the learners believe that the contents are appropriate and can meet their English-learning requirements. As many as 85% of the learners think that such a learning system is beneficial to the overall English-language learning. Meanwhile, the fact that the contents are highly relevant to the surroundings helps to reinforce memorization and learning effectiveness. About 80% of the learners are willing to continue with the system and more than happy to recommend the system to others. The system is generally well-received as its learning mechanism and supporting functions can allow learners to achieve different results. The average values for the responses concerning the appropriate size of the display screen and the appropriate size of fonts were lower than those of other responses. As this learning system is installed on PDAs, inherent limitations to font and screen sizes persist. Meanwhile, it is the first time that the surveyed learners use this new learning method and learning tool, few of them need time to adjust to it. Most of the surveyed learners find this novel way of learning acceptable and believe that this system can be a great option to improve their English learning.

Table 5. The results of learners’ system acceptance

<table>
<thead>
<tr>
<th>Questions</th>
<th>strongly disagree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The fonts in the system were of appropriate size.</td>
<td>14% 36% 28% 13% 9%</td>
<td>2.67</td>
</tr>
<tr>
<td>The buttons in the system were clear and easy to use.</td>
<td>0% 8% 23% 48% 21%</td>
<td>3.82</td>
</tr>
<tr>
<td>The operation guidelines of the system were clear and easy to use.</td>
<td>7% 13% 25% 35% 20%</td>
<td>3.48</td>
</tr>
<tr>
<td>The colors in the system were clear and easy to differentiate.</td>
<td>2% 9% 19% 47% 23%</td>
<td>3.80</td>
</tr>
<tr>
<td>The browsers in the system were of appropriate size.</td>
<td>18% 40% 26% 11% 5%</td>
<td>2.45</td>
</tr>
<tr>
<td>The system messages were easy to understand.</td>
<td>1% 8% 19% 37% 35%</td>
<td>3.97</td>
</tr>
<tr>
<td>The learning contents provided in the system were appropriate to the learners’ needs.</td>
<td>0% 10% 13% 45% 32%</td>
<td>3.99</td>
</tr>
<tr>
<td>I have a stronger impression of the English content I learned through this kind of learning method.</td>
<td>0% 7% 15% 45% 32%</td>
<td>4.07</td>
</tr>
<tr>
<td>I like the design of the learning system interface.</td>
<td>0% 10% 20% 48% 22%</td>
<td>3.82</td>
</tr>
<tr>
<td>It’s easier for me to learn through this learning method than when learning from a teacher</td>
<td>1% 6% 12% 46% 35%</td>
<td>4.08</td>
</tr>
<tr>
<td>This kind of learning method helps me to learn anytime I want.</td>
<td>0% 10% 20% 40% 30%</td>
<td>3.90</td>
</tr>
<tr>
<td>I am very interested in this kind of English learning system.</td>
<td>6% 12% 18% 42% 22%</td>
<td>3.62</td>
</tr>
<tr>
<td>The contents introduced in the system are related to my life.</td>
<td>0% 10% 12% 45% 33%</td>
<td>4.01</td>
</tr>
<tr>
<td>This system helps me to learn English.</td>
<td>2% 6% 10% 46% 36%</td>
<td>4.08</td>
</tr>
<tr>
<td>I enjoy learning through this system.</td>
<td>1% 9% 10% 48% 32%</td>
<td>4.01</td>
</tr>
<tr>
<td>I would be happy to recommend this system to other learners.</td>
<td>0% 10% 12% 42% 36%</td>
<td>4.04</td>
</tr>
<tr>
<td>This system helps me improve my English reading abilities.</td>
<td>1% 8% 12% 45% 34%</td>
<td>4.03</td>
</tr>
</tbody>
</table>

Discussion and Conclusion

This paper designs a learning system that can effectively enhance the English-proficiency of students in non-English speaking countries by combining wireless technologies, RFID equipment and mobile devices. The system provides comprehensive supporting features to assist the learning of reading materials by making up the inefficiency of vocabulary-centric memorization-oriented learning model. It can truly improve the ability of students in learning from the reading materials (from words, phrases, sentences, paragraphs to whole articles) in terms of organization of sentences, application of words and understanding of meanings and implications. The system is designed based on the theory of reading-based and situated learning to recommend reading materials that highly relevant to the surroundings at the location of the learners in order for learners to enhance their learning effectiveness. To further
enhance learning outcomes, it importantly utilizes the records of learning portfolio to offer reading guidance by taking into account the reading relation degree, difficulty degree and learner ability. All data are dynamically computed in real-time to guide the decision-making indicators and provide progressive reading suggestions to learners in the situated environment. This approach is beneficial to the digestion and internalization of reading contents. A series of evaluations on freshman students in universities show that the results of this system are positive. According to the results of evaluation, learners who had adopted situated English learning system improved significantly in their English performance and increased their interests in learning English. This English learning environment combines the theory of situated learning can enlighten students converting abstract perception into concrete thinking. Moreover, this learning strategy can let students practice applications of words, phrases and sentences reflective to the situations which they are in. Those results further confirmed related theories of situated language teaching. Learners who were provided with reading guidance mechanism in learning system scored significantly higher in the post-test after English lessons than the other two groups did. We could learn from this phenomenon that including learning guidance support mechanism in the learning system and providing adequate reading articles to learners could efficiently reduce learning obstacles and increase learning efficiency. Besides, according to the analysis of questionnaire, most learners believed that articles recommended by the system were appropriate to the proficiency of learners, and they also believed this kind of learning system benefited English learning and satisfied the need of English learning. Currently, the system operates in a campus environment. However, it can surely extend to daily life situations to assist the general public in learning English. Future studies can add Intelligent Agents to the system to provide features such as automatic searches, screening, classification and filing of reading materials to effectively expand the Learning Material Database in order to enhance the richness and diversity of the reading contents. Moreover, we can focus on analyzing more detailed learning portfolio arguments during learning process. Those may include the relevance of the time spent on article reading, the influence on proficiency of learners and difficulty of articles, the possibility of auxiliary voice to improve reading pronunciation and the influence of weight coefficient differences on the formula of guidance mechanism. We expect that this study can provide perspectives and directions worthy of studying for academic research in related fields by subsequent detailed analysis and induction.

Acknowledgments
This work was supported in part by the National Science Council (NSC), Taiwan, ROC, under Grant NSC 97-2511-S-006-001-MY3, NSC 97-2511-S-218-002-MY3, and NSC 99-2631-S-011 -002.

References


