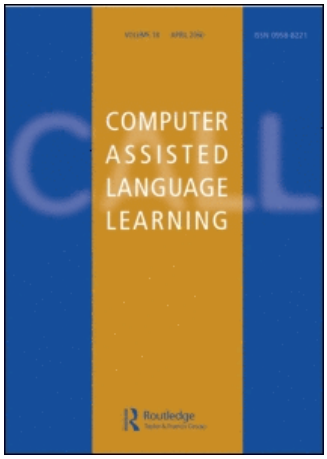

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Vocabulary on the move: Investigating an intelligent mobile phone-based vocabulary tutor

Glenn Stockwell [a]
[a] Waseda University, Tokyo, Japan

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Vocabulary on the Move: Investigating an intelligent mobile phone-based vocabulary tutor

Glenn Stockwell*
Waseda University, Tokyo, Japan

Mobile learning has long been identified as one of the natural directions in which CALL is expected to move, and as smaller portable technologies become less expensive, lighter and more powerful, they have the potential to become a more integral part of language learning courses as opposed to the more supplemental role often assigned to computer labs. Mobile phones have been the topic of a number of recent studies, including for learning pragmatic phrases via mobile email, and as electronic flash cards. With the development of mobile systems that can access the Internet, more sophisticated applications which allow the use of databases and interactive web content have been made possible. The current study describes one such application, investigating the use of a prototype mobile-based intelligent vocabulary tutor system by learners in an advanced EFL class. Learners used the tutor to complete vocabulary activities in a variety of task formats through either their mobile phone or through a computer, and the system kept logs of all access to the system. A profile of each learner was created in terms of the vocabulary that they had difficulty with, and presented these items to the learners more frequently than items that were less likely to cause learners problems. Learner access logs to the vocabulary activities and the learner profiles were analysed, and a survey was administered to learners at the completion of the project. The results are discussed in terms of learner usage patterns and learner perspectives regarding each platform.

Introduction

The prospect of the evolution of computer-assisted language learning from a predominantly classroom-based entity into one that is free from time and space boundaries has been viewed as a future direction for CALL since technologies that allowed people to send, receive and/or carry data with them started to emerge. CALL itself has gone through several phases of development as a field; the terms

*Waseda University, 1-6-1 Nishi-waseda Shinjuku-ku, Tokyo, Japan. Email: gstock@waseda.jp

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behaviouristic/structural CALL, communicative CALL and integrative CALL popularized by Warschauer (1996, 2000), although chronological in part, are largely linked to developments in the theories underlying our practice in CALL, as well as to the evolution of the technologies themselves. As Warschauer and Healey (1998) describe, this last stage, integrative CALL, sees students using a wider variety of technological tools where language learning becomes ongoing rather than something that occurs in isolated bursts in the computer lab. The nature of this definition suggests that in order for learning to be continuous, learners need access to technologies that they can access freely, consistent with Bax's description of an ''integrated'' approach to CALL that sees the physical location of the computer as being ''in every classroom, on every desk, in every bag'' (2003, p. 21).

Arguments such as these posed here suggest that mobile technologies will hold a central role in the future of computer-based language learning activities. There is no doubt that the technologies themselves are becoming more pervasive, and the number of students who own mobile technologies such as mobile phones or MP3 players is increasing at an impressive rate. This fact has excited teachers and researchers alike with the prospect of being able to provide learners with language learning resources that are no longer dependent upon institutional resources, or that put time and place constrictions on them. Despite the enthusiasm and the widening use of mobile phones for language learning purposes, research into sophisticated systems is still very much in its infancy. Furthermore, there is still very little research that looks at how learners themselves use and perceive mobile language learning activities, and the degree to which learners actually engage in activities when non-mobile alternatives are available to them.

The purpose of the current study was to obtain preliminary data regarding the use of a mobile-based learning system to determine the initial viability of such a system, both in terms of whether an intelligent system could be provided to learners via a mobile system, and how the learners would react to the use of such a system. The study was intended to form the basis of continual development of the system with increased functionality and to identify learner needs and requests. Learners were provided with language learning activities that were available through both mobile and non-mobile means, to investigate whether learners showed a preference for one platform or the other, whether there were differences in the ways in which learners used each of the platforms, and whether the platform had any other effects on the language learning process. One underlying goal of the study was to ensure that the tasks that learners were asked to undertake were not trivial or underutilized the capacity of the platforms being used. Vocabulary was identified by the learners as an area that they wanted to develop, particularly as many of the learners had planned to take the Test of English for International Communication (TOEIC) test at the end of the semester. An intelligent system was thus developed that attempted to identify the lexical items the learners were less familiar with, and to provide them with more targeted practice with these items.

The paper begins with a brief discussion of how mobile technologies have been used in language learning, followed by a description of the development of intelligent

systems and an overview of vocabulary instruction through CALL. Data were collected through detailed logs and a survey, the results of which are presented along with a discussion of the implications for further design and usage of the system.

Mobile Learning

As the brief discussion above alludes to, mobile technologies have the potential to enable a transition from the occasional supplemental use associated with computer labs to frequent and integral use (Roschelle, 2003). Studies that investigate the use of various forms of mobile technologies for learning—language and otherwise—have started to appear in the literature over the past few years, and have included technologies such as mobile phones (e.g. Motiwalla, 2007; Thornton & Houser, 2002), MP3 players (e.g. McCarty, 2005), and PDAs (e.g., Patten, Sánchez & Tangney, 2006). The term ''mobile'' in itself is encompassing, and as such could also include wireless laptop computers, portable DVD players and even handheld electronic games.

At this stage, perhaps the most widespread technology is the mobile phone, where the overwhelming majority of students in Japanese universities, at the very least, own and carry a mobile phone with them most of the time. It is not surprising, then, to see that language teachers have started to capitalize on this technology, and the types of activities that learners undertake are diverse, in many ways mirroring the types of activities that are seen in computer-based environments. Thornton and Houser (2001, 2005), for example, provided their learners with a series of mini-lessons over their phones. Kiernan and Aizawa (2004), in contrast, used mobile phones to facilitate interaction between learners to teach targeted structures, while Taylor and Gitsaki (2003) used the browser function of their students' phones to perform Internet searches. Other activities that have been suggested are mobile flash cards (Houser & Thornton, 2006) for studying vocabulary, and learning reminders (Levy, 2006) where learners were provided with SMS-based notifications about, for example, what they had learnt during the class, or upcoming programs on television that were thought to be of benefit to learners.

The small but illustrative range of activities provided here does suggest a great deal of diversity in the ways that a seemingly simple tool such as the mobile phone can be used in language learning. Sophistication of activities will depend to a large degree on the availability of services in different regions, but as technologies such as mobile-based web-browsers become more pervasive, the options available to teachers and learners increase. Both learner reactions to mobile technologies and the possible effects on language acquisition have been very promising (Thornton & Houser, 2005), who showed that, according to pre- and post-tests, learners demonstrated linguistic gains by receiving mini lessons via mobile email, and that more than 70% of learners preferred to receive these over mobiles compared with desktop computers.

It is important to bear in mind, though, that not all feedback regarding mobile technologies, particularly mobile phones, has been positive. Many learners have bemoaned the small screen and the inconvenient keypad for language input

(e.g. Thornton & Houser, 2002), which continues to plague their use. Learners are also often liable for costs of sending emails or accessing the Internet when using their mobile phone, which has an effect on how frequently they are willing to use them. In Japan, however, there are packages by which people may pay a fixed rate per month which gives them unlimited access to the Internet as well as the number of emails that they send and receive, and many students take advantages of these packages.

Intelligent Language Tutoring Systems

Intelligent systems have had a history of being largely misunderstood and over-estimated, and early expectations of what they could achieve were very unrealistic (Duquette & Barrière, 2001). When these expectations failed to come to pass, the field underwent subdivision and reconsideration, and more realistic goals were established. Two major fields that have emerged are natural language processing and intelligent tutoring systems. Natural language processing (NLP) involves parsing of natural language input, either written or spoken, and includes error correction, machine translation, and chat bots (programs that you can converse with). Of these, error correction has featured most commonly in the CALL literature, with studies being carried out in Thai (Danuswan, Nishina, Akahori, & Shimizu, 2001), Japanese (Nagata, 2002), and English (Tokuda & Chen, 2004), often as a part of a tutoring system.

Intelligent tutoring systems (ITS) are computer-based instructional systems designed to reproduce the behaviour of a human tutor in its ability to adapt to the learning needs of individual students (Moundridou & Virvou, 2003), and store knowledge that a human teacher would have on the content to be taught, the student, and the pedagogical strategies (Curilema, Barbosab, & de Azevedo, 2007). According to Kang and Maciejewski (2000), intelligent tutoring systems consist of four components. They have an *Expert Knowledge Module*, which provides the information to be taught, a *Student Model Module*, which is a dynamic representation of the student's competence, a *Tutoring Module*, which designs and regulates instructional interactions with the learner, and a *User Interface Module*, which controls the interactions between the system and the learner.

Intelligent tutoring systems that are specifically designed for language learning are referred to as intelligent language tutoring systems (ILTS) and may include error-specific feedback to learners based on the language they input into the computer, and have shown to be effective as tools in language learning environments (see Heift 2001, 2002, 2003; Heift & Nicholson, 2001). A discussion of intelligent CALL systems has been provided by Gamper and Knapp (2002).

Vocabulary Learning

There is no need to go over the importance of vocabulary in language learning (see Hulstijn, 2000), which has been the focus of a large number of studies both in CALL and non-CALL environments. Vocabulary has been one of the most commonly taught language areas through technology in recent years (e.g. Dodigovic, 2005;

Yoshii, 2003; Yoshii & Flaitz, 2002), and the range of technologies used is broad, including courseware (both commercial and self-developed), online activities (such as *Hot Potatoes*), dictionaries, corpora & concordancing, and CMC technologies (see Stockwell, 2007, for a discussion).

Ma and Kelly (2006) identify three types of CALL-based vocabulary learning applications: multimedia packages with vocabulary, written texts with electronic glosses, and dedicated vocabulary programs. While each of these has its own specific advantages, it also has the potential for limitations. Multimedia packages tend to include a smaller amount of vocabulary because attention is given to all skills. Written texts allow for a wide range of vocabulary, but it is necessary to read a large amount in order to cover all needed vocabulary. At the same time, it is possible to skip vocabulary items if they are not necessary for understanding meaning (i.e. low salience). Dedicated programs for vocabulary allow for more concentrated work on specified items generally following a specified theory of language learning.

The idea in the current study was to design and develop a prototype mobile-based intelligent vocabulary learning system with a view to expanding the system to be used across classes and year levels depending on the logistical difficulties and the learners' reactions. The system was designed to adapt to the learners' needs to give them more targeted activities, and could be used on both PC and mobile platforms. The system also kept logs of the learners' progress in order to get a picture of areas of difficulty as well as an indication of the range of vocabulary known by the learners in the class.

While Thornton and Houser's (2005) study indicated that learners preferred the mobile platform over PCs, it was not clear whether they had a choice between the two, and if they did, what proportions each of the platforms was used. Furthermore, the two activity types described in their study were email, which meant that learners received messages without the need to actively access the system, and in-class web-based activities, where learners were required to evaluate the resources as a part of their class activities. In contrast, the current study sought to firstly obtain preliminary data to determine if learners would use the mobile activities when they needed to actively access materials of their own volition, and secondly, to examine the capabilities of the system and identify any logistical problems to assist in the next stage of development.

The specific research questions were formulated to address the first of these two issues, and are listed below.

1. Do learners exhibit a preference for the computer-based or mobile platform for learning vocabulary?
2. Are there differences in the ways in which vocabulary tasks are performed on computers or on mobile phones?
3. How do learners perceive the use of the mobile phone for learning vocabulary?

In addition, log data were obtained in conjunction with observation of the system in order to investigate the second issue. The methodology that was adopted to address these issues is explained forthwith.

Method

Participants

As this was a preliminary study of the viability of the technology, the study was conducted in a small advanced English class at Waseda University. There were only 11 participants in the study, which made dealing with potential problems with the prototype technology easier. The course was an elective course for third- and fourth-year students, and was generally taken by higher proficiency learners, many of whom had some experience living in an English-speaking country. The course covered a wide range of topics, including human communication, cultural imperialism, academic dishonesty, medical ethics and marketing techniques. The study itself was conducted over the course of the 13-week semester, with participants working through the vocabulary activities from the second week onwards. An orientation was held in the first week where the system was explained to the learners, and they logged in and attempted to use the system to ensure that they understood what was required of them and how to configure any preferences.

Vocabulary Selection

Vocabulary items were selected from the text materials, which was an advanced level commercially available textbook. A total of nine lessons were completed from the textbook over the course of the semester, and 65–70 items per lesson were selected, totalling 612 items. In order to determine the frequency or ''difficulty'' of the vocabulary items selected, the completed list was compared with the JACET 8000 list, a frequency list compiled by the Japan Association of College English Teachers of the 8000 most commonly used words in English.[1] Nearly half were from the higher range (Levels 6–8) of JACET 8000, or were not in the list. A breakdown of the words may be seen in Table 1.

Because the items were selected subjectively from the textbook on the grounds of what the researcher thought the learners were either unlikely to know or what it was

Table 1. Frequency ratings of vocabulary according to JACET 8000 list ($n = 612$).

Level	No. of vocabulary
1	41
2	64
3	79
4	79
5	69
6	48
7	46
8	29
Other	157

thought that they needed to know, without any concern for the frequency ratings, there were quite large differences in the amount of vocabulary that occurred in each JACET level.

System Overview

The system was written in PHP and MySQL, and was accessible from a web browser, either on a desktop computer (PC) or mobile phone. Because the course used *Moodle* as a means for learners to practice listening activities, engage in forum discussions and for other activities, the vocabulary system, named *VocabTutor*, was integrated into *Moodle*, so that learners accessed the activities on PC from within *Moodle*. The mobile phone used a separate page that required learners to log in with the same details that they used for *Moodle*. If learners changed their password in *Moodle*, this was also immediately reflected in the login so that learners did not need to remember multiple login information. Both the PC and mobile platforms accessed the same database so the content was identical, but a simplified interface was designed for the mobile to counterbalance the problems identified with small screens and keypads (e.g. Thornton & Houser, 2002).

The system was designed so that the interface was completely separated from the content to allow upgrading of either component without needing to redevelop the other, in light of calls by Colpaert (2006) and others (e.g. Cushion, 2004; Ward, 2002). This meant that extra vocabulary items could be added quickly and easily without interrupting the operation of the system, and for minor upgrades and bug-fixes to be made with no effect on the data component. This design also meant that the system could be used at multiple levels simultaneously (i.e. lower or advanced) simply by directing the system to the appropriate data source. While it was only run with the advanced learners at the prototype stage, this feature was included for future planning.

Learners progressed through each lesson in turn, and were not able to proceed to the next level until they had completed the previous one satisfactorily. Vocabulary items from the lesson were presented in random order, and a ''competency'' score was assigned to each item depending on the whether or not they got it correct in the tasks. For words that were encountered the first time, if it was correct the first time, it was given a score of 6, whereas if it was incorrect the first time, it was given a score of 3. The score increased by 1 for each correct attempt, and reduced by 1 for each incorrect attempt, and it was considered as ''known'' when the score reached 8. Items of a lower competency score were recycled with greater frequency. When all items reached a score of 8 or above, the learner was able to go on to the next level.

Vocabulary tasks were designed to include both passive and active knowledge elements that moved through recognition stages to productive ones. There were six different task types: choose the appropriate word for a sentence, choose the appropriate word for an English definition, choose the appropriate word for a Japanese meaning, match a list of words with their English definitions, write a word for an English definition, and write the appropriate word for an English sentence.

Early activities were recognition only until every word had been encountered at least once, after which time learners were required to engage in word production tasks in addition to the receptive tasks. The probability of assigning a word production task increased as the general competency level increased, but it was possible for recognition tasks to be assigned until the level was completed. All distracters for multiple choice questions were automatically generated from the vocabulary set and an alternative distracter database, and matched the target word in part of speech and tense. Because the distracters were automatically generated, there was the concern that two possible correct answers would be given where only the intended word would be marked correctly, so the system was tested just over 150 times to see if this would occur. In this testing stage, there were no occurrences of multiple correct answers, so it was decided that the probability would be very low, and the automatic distracters were used.

Other features that were included in the system were that learners could have lists of problem vocabulary sent to their email address, and they could configure the system to send reminders to them if they hadn't done vocabulary activities on either the mobile or PC for a specified number of days. They could also choose whether they had a smaller, medium or higher number of items included in each task. Example screens for the PC platform are included in Figures 1 and 2, and for the mobile in Figure 3.

As Figure 1 shows, learners can see their progress according to a scale indicating the percentage of the total words in the lesson they had encountered (circled), as well

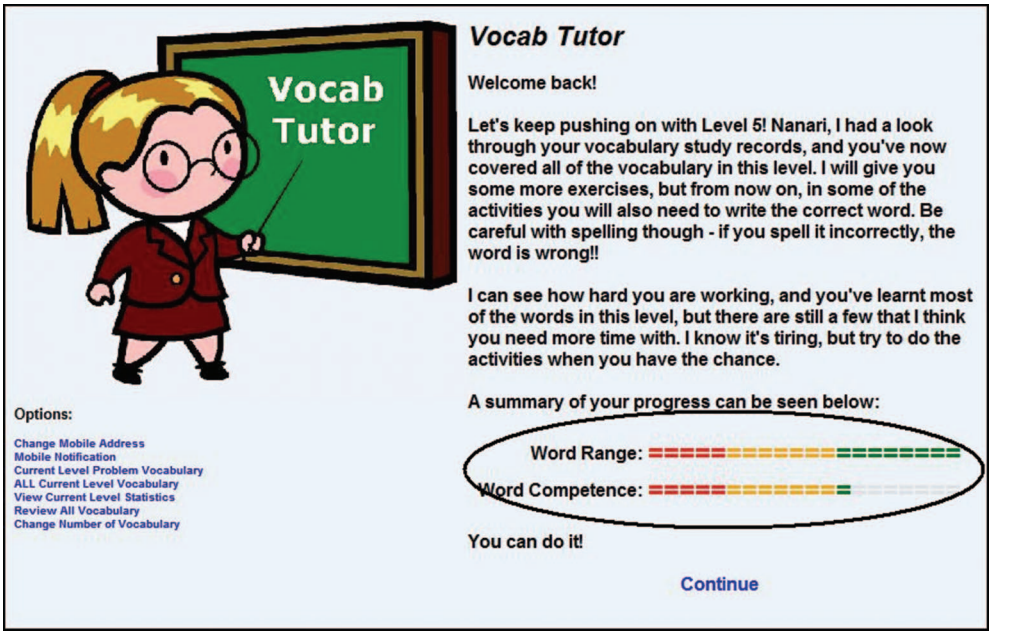

Figure 1. PC introductory screen showing current level progress.

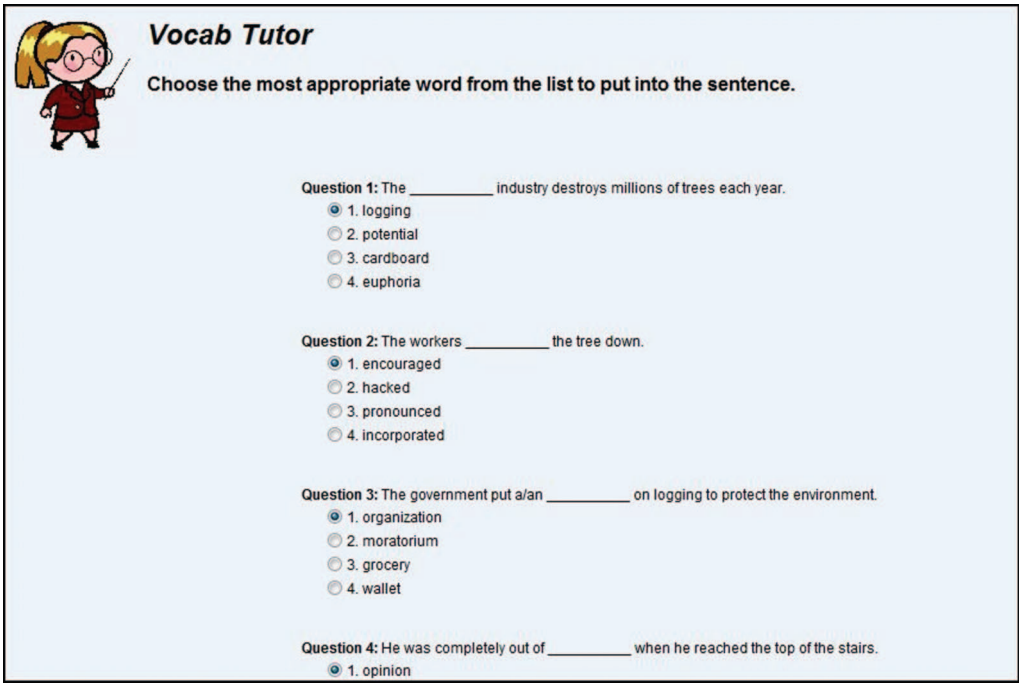

Figure 2. PC task screen.

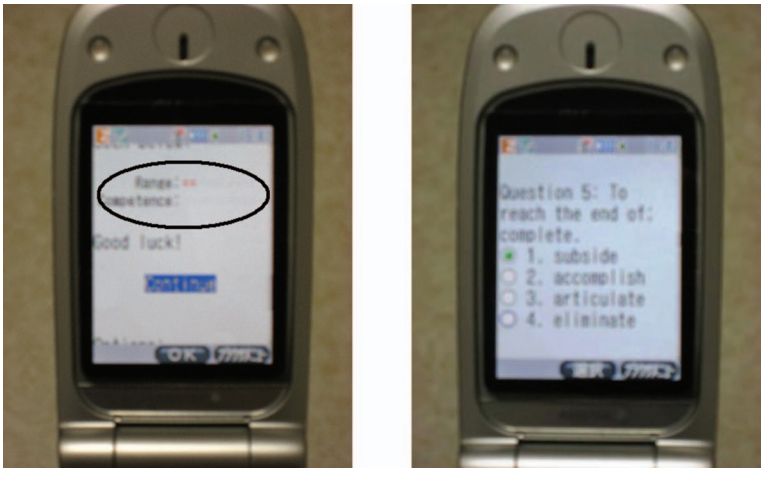

Figure 3. Mobile progress and task screens.

as their overall competency score. The competency scale increased as the number of items classified as ''known'' increased. This same scale is shown circled in Figure 3. Feedback regarding the learner's current level and competence were created from a bank of phrases depending on level, intended to encourage them.

As described above, the tasks for both the PC and mobile platforms were the same, although there were no graphics included in the mobile page in order to reduce the amount of data sent. Once the task was downloaded onto the mobile, the server was not contacted until the responses were entered.

The screen for the mobile was kept as simple as possible to avoid any possible difficulties with learners using older models of phones. The system was tested on each of the major Japanese mobile phone companies' phones in advance of the study. None of the learners gave any indication of experiencing difficulties in displaying the activities on their phones during the study.

Data Collection

Data for the study were collected through the logs kept by the system, and by a simple survey administered at the end of the semester. The logs that were kept were very comprehensive, and included (1) an overall dump of results of all tasks undertaken, (2) a profile of vocabulary indicating each learner's ''competency'' with the item, the result of each time the vocabulary item appeared, and the type of task that was given to the learner, and (3) a profile of each learner's level, number of attempts, time spent on tasks, the platform, scores, and the task type. There was no pre- or post-test given to learners firstly because of the large number of items covered, but also because the items in the vocabulary database were being entered throughout the semester, with entry being completed before the learners reached the level.

The survey was administered in the very last class of the semester, as this was the final opportunity to have all of the learners together. Because testing and other matters were covered during the last class, the survey was kept as simple as possible, and asked the learners about which platform they used most frequently (in attempt to see how honestly they would answer), their preferences for the PC or mobile platform, reasons for their preference if there was one, as well as any suggestions for improvement for the system itself for later development. The results are presented below.

Results

Firstly, the percentages of the total number of tasks that were completed on the mobile phone were calculated, showing that mobile phone access was very low, as shown in Figure 4. Of the eleven learners, six learners failed to use the mobile phone at all for the vocabulary activities, and a further two used it for only 0.6% and 5.2% of the activities, respectively. The remaining three learners used the activities for 38.0%, 40.4% and 87.9%, the last being the only learner who used the mobile platform more than the PC platform.

When the amount of time per task was calculated for the five learners who did use both platforms, the results showed that with exception to Student I, who used the mobile for the majority of the vocabulary tasks, learners spent more time on the tasks on the mobile than on the PC (see Figure 5). For the PC activities, averages ranged

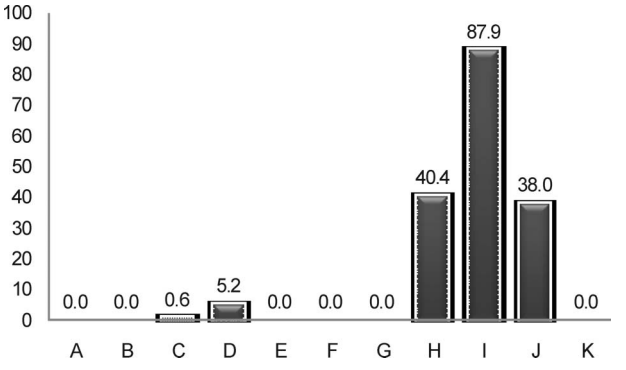

Figure 4. Percentage of all activities performed on the mobile phone.

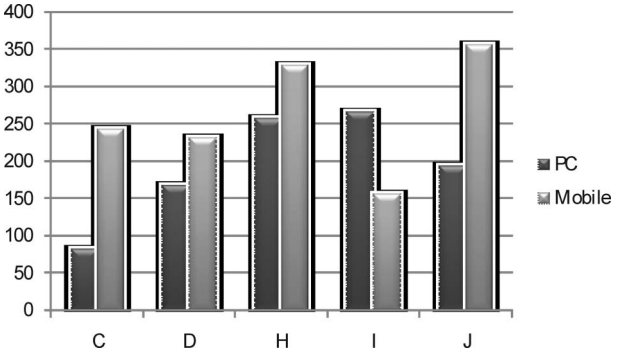

Figure 5. The total number of seconds spent per task on both PC and mobile.

from 80 to 260 seconds per task, but this was as high as 155 to 355 for the mobile-based tasks.

The average score per task was also calculated for each platform, as is shown in Figure 6. The results showed that there was a tendency to gain slightly higher scores on the PC when compared with the mobile, but the small number of students made it difficult to identify any definite trends in this regard.

Of particular interest was the correlation between the total percentage of the assigned lessons completed and the use of the mobile phone. As shown in Figure 7, those learners who used the mobile phone more often were less likely to complete the required lessons. Students H, I and J, who used the mobile the most of the participants in the current study, were also the learners who completed the lowest number of lessons.

Learners were asked which of the platforms that they used more often, and were given a choice between the PC, the mobile, or both if they though they used them about the same. The results, as shown in Figure 8 shows that nearly three quarters of

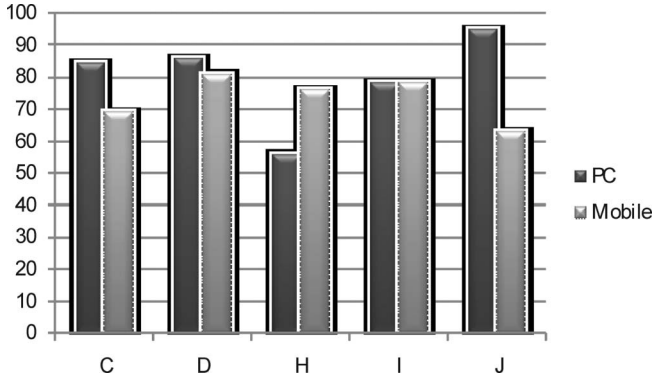

Figure 6. Comparisons of average task scores on both PC and mobile.

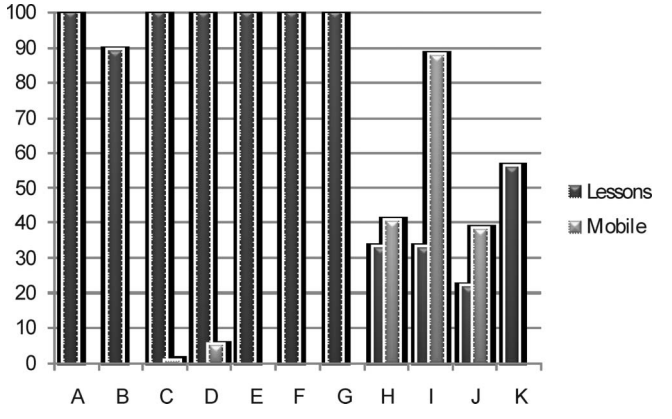

Figure 7. The percentage of total lessons completed compared with percentage of mobile use.

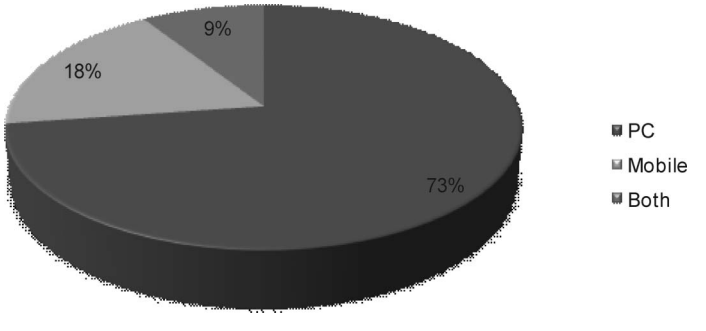

Figure 8. Learner responses to which platform they thought they used more often.

the learners indicated that they thought that they had used the PC more often, which was very much in line with the actual statistics collected (see Figure 4). In all, the learners responded to this question in a way that clearly reflected their actual usage.

Figure 9 shows the results to the question regarding which platform the learners felt was better for learning vocabulary. Of the 11 learners, 6 (55%) indicated that they thought that the PC was better, 2 (18%) indicated that they thought that the mobile was better, while 3 (27%) said that they felt that both were equally good. This result was not entirely consistent with the usage, given that six of the learners never used the mobile platform at all, therefore having no grounds for comparison. Nonetheless, the learners' responses may have been based on their own feelings regarding the platforms regardless of how they actually used them, hence are of interest. The responses to the open questions are included in the Discussion section.

As one aim of the study was to determine the logistical viability of the system, data were also collected to determine whether or not it was possible to draw a diagnostic picture of the vocabulary knowledge of individual students to help them to target their own vocabulary learning. As Figure 10 illustrates, the average error rate (i.e. the percentage of vocabulary items in each level that were incorrect) can provide a picture of a learner's vocabulary knowledge compared against the whole class, as well as identifying whether there are particular blocks of vocabulary that

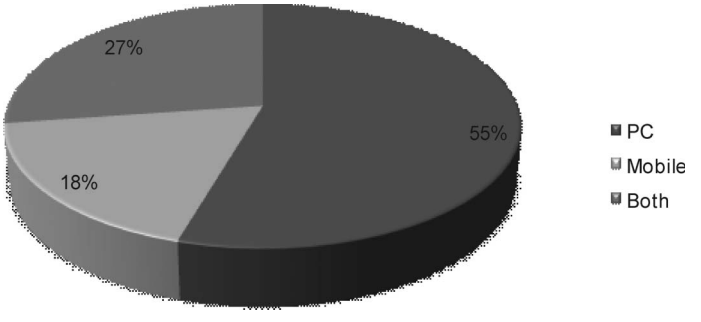

Figure 9. Learner responses to which platform they thought was better for learning vocabulary.

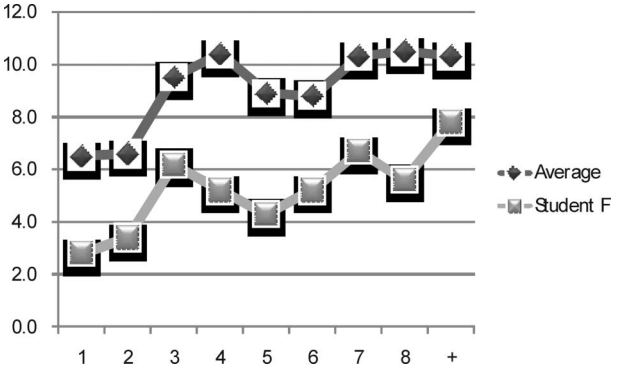

Figure 10. Example of a learner profile showing one learner's error rate compared against the class average.

learners need to concentrate on. As the figure shows, the Student F has a lower percentage of errors across each of the JACET 8000 frequency levels, which, if accurate, would be expected to provide a lower error rate for the more frequent words (levels 1–3) and gradually increase for the less frequent words (levels 6–8, or those not included in the list).

As less than 10% of the words in each JACET 8000 level were presented in the *VocabTutor* to the learners, and considering the small sample size, the accuracy of the measure in the current study must be considered tentative, but the slightly higher error rate for level 3 when compared to the levels before and after it in the profile for Student F indicates that it may be an area that the learner needs to work on.

Discussion

The objective of the study was to examine the use of a prototype mobile phone-based intelligent vocabulary learning system. It achieved this through investigating whether learners who had a choice of completing CALL activities on either a computer or a mobile phone exhibited a preference for one platform or the other, whether there were differences in how the activities were carried out on each platform, and how learners felt about using a mobile phone for language learning tasks. In addition, the study also aimed to determine whether it was possible to collect extensive data about learners that may be able to be used to help them in their language learning that through a PC or mobile-based system.

Access logs indicated that there was a clear preference for carrying out the assigned vocabulary tasks on the computer when compared with the mobile phone, with many learners not even attempting to use the mobile platform. A look at the data revealed that only 6.3% of the total number of activities took place on the mobile phone, although the small number of learners may have resulted in a lower figure due to personal preferences.[2] More than half the learners involved in the study made no attempt to use the mobile phone at all, rather choosing to perform all activities on computer. All but one of the other learners carried out more of the activities more on the computer than their mobile phone. Survey data still indicated a clear tendency towards the computer as opposed to the mobile phone, but were not as definitive as the access log data. When asked about the reason for their preferences, learner responses included the following:

> "I thought the small screen made it too difficult to see properly."
> "I planned to learn vocabulary in a train, but it was too noisy to think."
> "Using my mobile phone with Vocab Tutor can be too expensive."
> "I liked to concentrate for a long time, so the PC was easier."

Reasons for preferring the mobile are listed below:

> "It was fun to practice when I had even little time [sic]."
> "I don't have a computer at my home, but I could study with my cell phone."

Only one learner indicated that they thought that both were useful, citing the following reason:

> "I could choose depending on my feeling and time."

The problem of the small screen was again raised as a problem by learners, despite the fact that the interface was designed to try to maximize the limited screen space. This contrasted with the result by Thornton and Houser (2005), although it is possible that the rather difficult nature of the tasks, as stated informally by learners, may have contributed to this. Only one learner indicated that cost was an issue, so presumably they were using a pay-per-packet system rather than a flat rate one. The other reasons listed by the learners above are related to the learning environment itself. The mobile phone allows learners to carry their language learning resources with them anywhere, but simply having access to such resources does not guarantee the quality of the environment. Learners who seek quiet environments that allow them to study for extended periods of time may find that the best place to do this might be the comfort of their regular study area, and hence the mobile becomes a redundant tool if there is a computer present.

In contrast, preferences for the mobile phone were related to lack of access to a computer (meaning that the mobile was the only viable alternative available to them), and to the freedom that the mobile phone affords to practice in small bursts when the time is available regardless of location, which has often been used as a rationale for using mobile technologies. The statement from the learner who felt that having both platforms allowed them to choose depending on their particular circumstances at the time is powerful, and adds weight to the importance of providing learners with choices to suit their backgrounds and preferences (see Levy & Stockwell, 2006).

It is difficult to determine why there was such a large lean towards the computer platform compared with the mobile phone. The survey data shed some light on the result, but fails to account for those learners who did not use the mobile phone at all. Indeed, a limitation of the study is that learners were not asked in advance whether they intended to use the mobile platform. An informal question in class at the outset indicated that learners generally seemed to think that the idea of using the mobile platform was interesting and exciting, but they were not explicitly asked about what their planned usage would be. Taking this into consideration, it is possible that many learners felt that the mobile platform was useful as a potential tool, but nonetheless had no intention of using it themselves.

For those learners who did attempt to use the mobile platform but then chose the computer in preference, the range of possibilities is wider. The results suggested that learners generally spent more time per task when they used a mobile phone, but achieved lower scores than when the tasks were completed on the computer. Learners themselves may have sensed this while completing the tasks, and then selected what they found to be easier, faster, or would allow them to score higher.

Personal Uses vs. Learning Uses

Considering that many students at Japanese universities spend a significant amount of time using their mobile phones each day for sending and receiving email, reading the news, and accessing other information for entertainment, one would conclude that screen size does not seem to particularly worry students during private use. Despite this, it is consistently claimed to be a problem for language learning (e.g. Thornton & Houser, 2002), and the current study was no exception to this. Such a result suggests that there may be a disparity between what learners are willing to accept for their own personal uses, and when the usage is related to their study. There are a number of possibilities for this. Firstly, the cognitive burden placed on learners during study activities would be expected to be higher than during the personal activities listed above. In this case, the argument that the small screen makes activities difficult may indeed be a valid one.

Another possible factor is the expectations that learners hold of the technology. In the same way that not all learners embraced computer technologies as a study tool at the same rate, as mobile technologies for learning purposes become more commonplace, the line between private and learning—in the minds of the learners—may become less distinct, and with it a widening acceptance of learning through mobile devices.

In any case, the small sample size makes generalizations difficult, but the study indicates that there is, at the very least, a potential for such tendencies. Further research into learners' preconceived ideas regarding the use of mobile technologies and how this compares with their actual usage patterns and the associated reasons is essential.

Conclusion

This preliminary study suggests that the intelligent mobile-based system described here had the potential to provide learners with sophisticated vocabulary learning activities through mobile devices that they already possess, as well as to store information about the learners that may be used to assist them with their vocabulary learning. Even with the small sample in the current study it was possible to determine that there were differences in the amount of time spent by learners to complete the tasks on the mobile phone compared with a desktop computer, and that learners tended to achieve better scores when using a computer. These outcomes may be a characteristic of the system itself, giving rise to a need to design an even more modified mobile interface that requires less effort on the part of the learners to use, even when a higher cognitive burden is placed on them.

An unexpected outcome of the study was, however, the low usage of the mobile platform compared with the computer. The obstacles to the use of the mobile phone may be categorized as technological (i.e. students' concerns about the small screen size and costs) or they may be psychological (i.e. the failure of the majority of the students to attempt the mobile activities at all), or perhaps a combination of the two,

where learners may have held preconceived ideas about the inconvenience of the mobile interface or the potential costs.

Technological advances have meant that the cost of mobile phone-based Internet access is gradually decreasing, and this may also play a role in making mobile technologies more accessible to learners. Moreover, as the concept of learning via mobile devices becomes more widespread, with it is likely to be an increased acceptance of using tools for learning purposes that have typically been associated with more personal usage. While technologies have developed to the point where database-driven intelligent systems can be provided to learners through mobile phones, there are new challenges to design interfaces that can reduce the impact of their smaller screens and keypads, yet at the same time maintaining the degree of sophistication that teachers and learners are coming to expect from technology-based language learning tools. At the same time, there is a need to determine whether there are psychological barriers that may impede learners' acceptance of mobile technologies, and if so, how we can deal with them to ensure a sound foundation on which to develop the possibilities of learning on the move.

Notes

1. Frequency lists are only as accurate as the data they are compiled from, and as such may or may not be an accurate representation of the actual frequency of words in a language.
2. At the time of writing, a second larger study was underway, where 75 lower-level learners used the same system described here, but with a smaller range of vocabulary. At a point where 60% of the activities were completed, the logs indicated that only 11.3% of all activities were performed on the mobile phone.

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