

## Personalization for Kanji Learning Using Mobile-based Email

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This paper describes an adaptive learning system using mobile phone email to support the study of Kanji learning. In our study we try to resolve a common problem which usually occurs in the mobile-based email or SMS language learning systems. To achieve this goal, we have adopted the methods of adaptive learning in our system, such as sending the contents to a learner following his or her interests, adjusting the difficulty level of the tests to suit the learner's proficiency level and adapting the system to his or her learning style. Furthermore, our system has already been evaluated by the learners and the results show that most of them benefited from our system and would like to continue using it.

### 1. Introduction

Mobile Learning is thought to be very effective for language learning. Cui & Wang explained that possibility of learning languages at any time and at any place is highly desirable for busy learners and M-Learning can facilitate learners with the advantages of learning at anytime and at anywhere [1]. In the last two decades, quite a lot of MALL (Mobile Assisted Language Learning) systems were reported in the literature. Among all MALL systems, a kind of them, which are based on mobile phone email or SMS, has attracted more attention than the others. Mobile phone email and SMS (short message service) are text communication service components of cell phone. They are very popular among the mobile phone users. For example, in Japan above 60% users have more than 10 mobile phone emails every day [2]. Because such widely used, they are thought to be the most ubiquitous and stable mobile technologies [3]. In our research, we call these mobile phone email or SMS language learning systems as MESLL systems. Simon So analyzed the reasons for the popularity of the MESLL systems are that the discrete messages could be provided in a short and succinct manner and readily available for learners such as in commuter trains or buses. He also said that the learning process is not as interrupting or disturbing as other media like audio or video [4]. Since quite a number of papers can be found in this research area, only part of them could be described here.

Levy & Kennedy have developed an SMS system in Australia [5]. It helps the Italian beginners to learn Italian vocabulary by sending a short message containing some words, idioms, definitions and example sentences to the learners at a certain time every day. Favorable evaluation and outcomes were reported.

In Japan, Thomson & Houser created a similar system using mobile-based email to promote the students' English vocabulary learning [6]. They sent five words at timed intervals to the students, comparing the results with the study of distributed hard copy and web-based learning.

Cavus & Ibrahim also developed a system to help undergraduate students to learn technical English language words at the Near East University in Northern Cyprus [7].

The results of all these studies indicate that the mobile-based email or SMS functions are very effective for the language learning especially for the vocabulary learning. However, some common defects of these studies are pointed out by several researchers. For example, Kukulska-Hulme and Shield said that many of the studies ignored the 'anytime, anywhere' affordances supposedly offered by mobile devices and messages were sent to learners at time,

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on set days rather than learners being able to obtain this information as and when they wanted it [8]. Peter Mellow summarizes that there are three models among mobile phone email or SMS learning systems which are ‘push’, ‘pull’ and ‘interactive’ modes [9]. According to Peter Mellow, the majority have been in the ‘push’ mode which means the institution pushes out messages to all students in a course. However, he told us that not all students would want, or use the information contained in that message and it could be perceived as ‘mobile phone spam’. We concluded their views as two problems of MESLL systems. The first one is that because the text messaging service is in push mode that the texts are sent by the server, not requested by the clients like HTTP (Hypertext Transfer Protocol), so many studies just employ mobile devices as a means of delivering content to learners and ignored the biggest advantages of M-Learning. The other problem is that such studies usually send the same contents to all learners at set time, which makes it easy to be perceived as “mobile phone spam”. In our research, we will try to straighten out these two problems.

In our study, we will take Japanese Kanji as our research object. The reasons for this lie in two aspects. The first one is that it is very difficult but important to learn Kanji for the learners who take Japanese as a second or foreign language [10]. It is said to be difficult, because there are approximately 2,000 characters of Kanji used in daily life in Japan and the foreigners who do not use Kanji in their mother languages are not used to handling such large sets of character [11]. It is also important for the learners, because Kanji is the basic element of Japanese words and it plays an important role in reading or writing in Japanese. Another reason is that in 2008 the Japanese government announced that Japan aimed to host 300,000 international students by 2020 [12]. Therefore, it is easy to see that the need of learning Japanese increases sharply and how to help these foreigners to learn Kanji quickly and effectively is becoming a very important social problem.

The rest of this paper is structured as follows: in the next section, we will describe the issues regarding the implementation of this system. In the third section, the adaptive model of our system will be detailed on three aspects. Then the experiment of our system and the results will be personated. Finally, conclusions and future work are summarized.

## 2. System implementation

### 2.1 Main process of the system

Our system is aimed to help the Japanese learners with the study of Kanji. In order to avoid increasing the instructor’s workload, we design our system to be a quiz based application that can automatically create blank fill quizzes of Kanji reading from JLPT vocabulary list. The JLPT (Japanese Language Proficiency Test) is a standardized criterion-referenced test to evaluate and certify the Japanese language proficiency of

non-native speakers. And it has four levels, with level 4 the most basic and level 1 the most difficult. In our study, in order to provide the learners with the advantages of “anytime and anywhere” we developed a “request” mode as the supplement of “push” mode. In the case of request mode, the learners can obtain a quiz email at anytime and anywhere only by sending a request mail to the system. Figure 1 shows the main flow of the system. The process can be divided into four steps:

- First, the learner can send an empty mobile phone email with a constant subject to the system to request a test. For instance, the subject is “単語テスト” which means “vocabulary test”.
- In the second step, the system will deliver the Kanji test email created by the Test Composer function of the system to the learners. This step can be provoked by two kinds of actions: a request email sent in request mode or it is the time for the set time in push mode.
- In the third step, the learner will reply to the test by typing the answers into the brackets and sending them back to the system.
- Finally, the system will check the answers, record the test information and return the feedback to the learner including the right answers, English meanings, and some example sentences. If he or she wants, the learner can request for more.

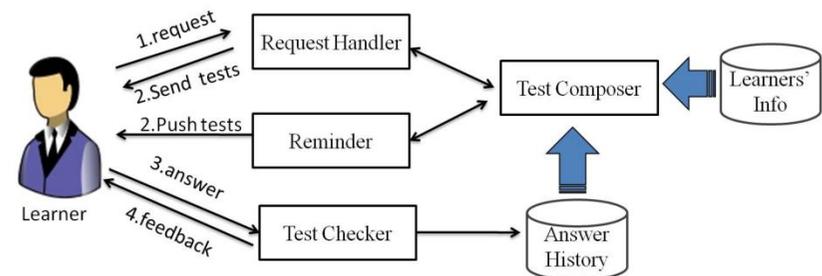


Figure 1 the flow of the system

This is the whole process of our system. With two modes, the learners can not only fully enjoy the advantages of “anytime, anywhere” offered by the request mode but also be promoted by the reminder function.

### 2.2 System architecture

Figure 2 shows the architecture of our system. As you see, the system has a hierarchical modular architecture organized on three layers:

- (1) Database layer: it consists of word data, learners' info, and test logs. The word data mainly contains the correct rate and the frequency of each word. The former comes from the learners' results of tests, while the latter is mainly from the news. In fact, one function of this system is designed to access some RSSs (Really Simple Syndication) of several big Japanese news websites, such as Asahi News and Yomiuri News, to calculate the frequency of each word in the news every day. As for the learners' info, it consists of the learners' interests, their JLPT levels and some customized settings. The logs of the tests include the results of learners' tests, the times that learners requested and answered the tests and so on.
- (2) Adaptive layer: in truth, this layer is the model we have built to adapt the system to different learners. More details about it will be introduced in the next section.
- (3) Function layer: this layer includes the main functions of this system, like pushing a test as a reminder, processing the request mail, composing a test and checking the results of each test. Among them, composing a test is the core function. When the system creates a test for a learner, not only is his or her JLPT levels and interests taken into account, but also his or her answer history. Concretely speaking, the words that the learner has answered correctly will not be sent to him or her again and the wrong ones will be sent again.

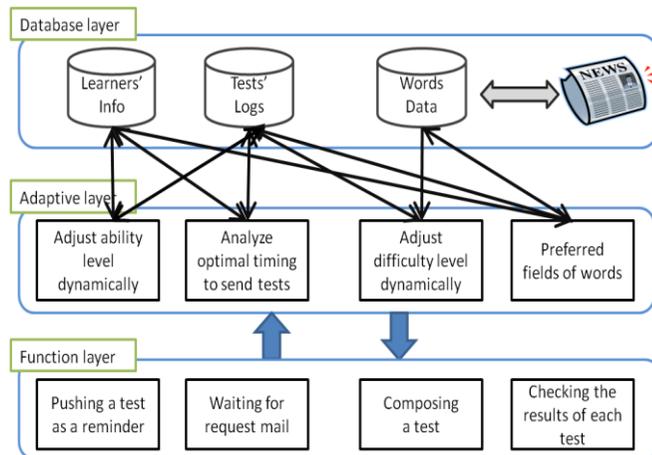


Figure 2 system architecture

### 3. Adaptive model

As mentioned above, Peter Mellow reported that not all students would want, or use the information contained in the message and it could be perceived as 'mobile phone spam' [9]. We analyze that this problem can be accounted for in four ways: (1) the learners do not have any interest in the texts which they received; (2) the materials are too difficult or too easy for them; (3) the time that they received the materials is not good for them; (4) the learners are too busy to answer them. From the former three reasons, we consider that the essence of the problem is that most existing MESLL systems lack of adaptability. Because, if the systems are adaptive enough, they can adapt the contents to the learners based on their interests and ability levels. They can also analyze every learner's learning style to determine a best-fit time to send the materials. Because adaptive learning has great advantages in providing students with specific and personalized knowledge, we decided to build an adaptive learning model in our research. Usually, some certain methods are always adopted by many adaptive learning systems, such as monitoring student's activity, interpreting the results, understanding students' requirements and preferences, and using the newly gained information to facilitate the learning process [13]. These methods are also applied in our system.

#### 3.1 Correspond with learners' interests

To help the learners like the materials they received, we think that the system needs to understand their requirements and preferences. To achieve this goal, we found two facts which helped us out. One is that in daily life every learner has his or her special interests in certain fields. For example, when it comes to watching or reading news, some people are enthusiastic about sports while others prefer to read about politics. The other is that frequently used words differ in different fields. For instance, "serve a ball", "baseline", "defense" are always heard on sports news channels whereas words like "unemployment", "dispute", and "profit" belong to the economic field. These facts gave us the idea that we could maybe send learners words and example sentences from the learners' interested fields.

However, defining the field that a certain word might belongs to is not easy. The method we adopted was to search the words used most frequently in different fields, because our system can access the RSSs of Japanese news websites to calculate the frequency of each word used in different kinds of news. To put it differently, after a learner customized his or her favorite field, the system will look for the frequent words used in that field and then create a test for him or her. When the system sends the example sentences to the learners, these sentences will be from the learners' favorite field too. In our system, we have provided the learners with six fields of the words: sports, culture, politics, economic, entertainment and science which are on the basis of the categories of the RSSs.

### 3.2 Dynamical adjustment

As mentioned above, in order to make the difficulty level of the tests suit the learners, we send the tests to the learners based on their JLPT levels. However, we find that sometimes there may be a mismatch between the learner's proficiency level and the difficulty level of the tests. For example, the proportions of some words answered correctly in the same level are below 30% while others are above 80%. The same thing happens to the learners: some learners can get 90 points in a test but others can only get 60 points or even lower. So even though the questions sent to the learners are set with respect to the learners' JLPT levels, the fact tells us that the difficulty levels of the questions do not suit every learner well.

What we proposed is to adjust both the difficulty levels of the questions and the learners' ability levels dynamically to make the two parameters match each other. For instance, in Figure 3 we take the level 2 as an example. As you see, from the JLPT level which is called the basic level, we have developed an additional level: a dynamic level which is adjusted by the learners and questions' correct rates. If one learner's correct rate is above 80%, his or her dynamic level will be up to level 3. If the learner's correct rate is below 30%, his or her dynamic level will be down to level 5. If the correct rate is between 30% and 80%, his or her dynamic level will stay on the level 4. The difficulty levels of the questions are processed in the same way. When the system composes a test for a learner, the dynamical level of the learners' ability must be the same with that of the questions' difficulty.

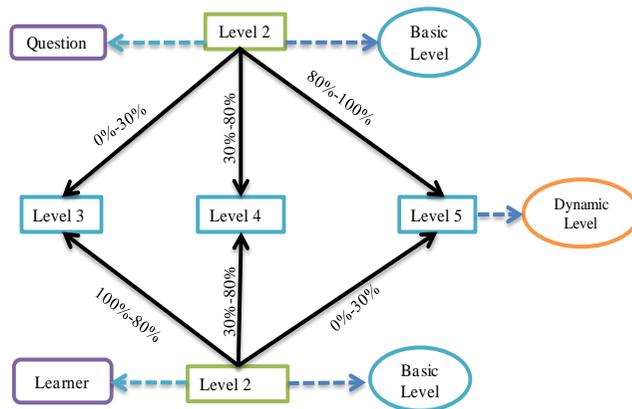


Figure 3 dynamically adjust

### 3.3 Determine a proper time to send the tests

As a coin has two sides, though the push mode may interrupt the learners' daily lives, it can also prompt the learners to study more. Hence, we hope to improve the push mode by using the methods of adaptive learning like monitoring the learners' learning activities to determine an appropriate time to send the tests. Levy & Kennedy's questionnaire tells us that it is very difficult to determine every learner's preferred receiving timing, because every learner has individual demands [5]. However, we find that many learners have their own learning style. For example, the data in Table 1 which comes from the experiment we have done shows one learner's reply times in different periods of a day and from the data of Table 1 we can presume that this learner prefers to receive the tests between 20:00 to 22:00 when he or she may be returning home by train. Consequently, analyzing a learner's answer history can help us to speculate that learner's preferred receiving timing. Another fact also aroused our notice that many people's lives are stable during a certain period of time, like one month or one semester and after that their life regularity is likely to be changed. For example, a college student's life regularity is easily affected by the courses that she or he chooses. So based on these two facts, we have proposed a method as follows:

Firstly, we separate one day into several parts and then the system will analyze one learner's answer history in the latest cycle (like one month or a semester) and calculate the number of times that he or she replied the tests in each phase. The result is like Table 1.

Then we will know the peak period of a day when he or she used our system most frequently and we can calculate the average time of his or her reply time in that period. For example, in view of the data in Table 1 we should calculate the average time between 20:00 and 22:00.

The third step will use the same way to find out the peak period before the latest cycle started, and then calculate the average time too.

Finally, the two average times will be compared. And if the difference is beyond one hour, we think that this learner's life style has been changed and the result is determined only by the latest value. On the contrary, if the values are near enough, the result will be depended on both.

The following formula shows this algorithm:

$$t = \begin{cases} \frac{\text{sum}(t_1)}{c_1} & \left| \frac{\text{sum}(t_1)}{c_1} - \frac{\text{sum}(t_2)}{c_2} \right| > 1(h) \\ \left( \frac{\text{sum}(t_1)}{c_1} + \frac{\text{sum}(t_2)}{c_2} \right) \times 0.5 & \left| \frac{\text{sum}(t_1)}{c_1} - \frac{\text{sum}(t_2)}{c_2} \right| \leq 1(h) \end{cases}$$

Note that in this formula,  $t$  is the time that the system sends the tests. And  $t_1$  stands for a reply time in latest cycle and  $c_1$  means the number of times that the learner replied in the peak period during this cycle. For example, in Table 1  $t_1$  is a time value between 20:00 and 22:00 such as “21:13” while  $c_1$  is 7 which is the number of times in the peak period. Similarly,  $t_2$  stands for a reply time value during the peak period before the latest cycle and  $c_2$  means the number of the times that he or she used before the latest cycle started.

Table 1 a learner's reply time and times

Reply time	0:00 ~ 7:00	7:00 ~ 9:30	9:30 ~ 11:00	11:00 ~ 13:30
Number of times	0	3	0	0
Reply time	13:30 ~ 17:30	17:30 ~ 20:00	20:00 ~ 22:00	22:00 ~ 24:00
Number of times	1	1	7	2

## 4. Evaluation and results

### 4.1 Experiment design

An experiment has been conducted to evaluate this system. Through this experiment, we have two objectives: the first one is to confirm whether the “request” mode imported into the system can motivate learners better, the second one is to check whether the adaptive model of the system is adaptive and intelligent enough for learners. For these purposes, we organized ten non-natives to use our system for a month which started from March 23 to April 23 in 2009. Most of participants had lived in Japan for less than one year and they had not undergone any classes for Japanese learning. Before the experiment started, the participants were asked to register in our system to allow us to get their personal information. This information includes the learners’ interest, their JLPT levels, and their preferred receiving time and so on. Then they were asked to take a pretest which contained Kanji questions at four different levels. Based on the scores they got, we divided them into two groups. For the learners in Group 1, they could enjoy all the functions of this system whereas for the learners in Group 2, we send them the tests at set time without considering their interests and dynamical levels. After the experiment was over, all of them were asked to take a post test and fill out our questionnaire.

### 4.2 Result

Table 2 shows the two groups’ average scores between pretest and post test. As you can see, after the experiment, the learners in both groups have improved their average scores and

obviously the learners in Group 1 scored better as their average score went up by 6 points while that of Group 2 went up by only 4.4 points. From the result, we can learn that with the help of the MESLL system, both groups’ ability has been strengthened and the learners who used adaptive MESLL system made better progress. From Table 3 which is the result of the questionnaire, we can also find that the answers given by the Group 1 are better than those obtained from Group 2. This demonstrates that the users in Group 1 get more benefit than the ones in Group 2.

Table 2 two groups' average score of pretest and post test

	Pretest	Post test	Increment
Group 1	81.6	87.6	6
Group 2	81.2	85.6	4.4

Table 3 Two groups' results of the questionnaire (Full marks is 5)

No.	Question item	Avg. (G1)	SD (G1)	Avg. (G2)	SD (G2)
Q1	Do you have interest with the contents you received?	4.2	0.32	4	0.64
Q2	Would you like to continue using our system?	4.4	0.48	3.6	0.88
Q3	Do you think the difficulty level of the tests suits your ability very well?	3.6	0.48	3.2	0.64
Q4	Have you felt that the more you use our system, the better the difficulty level suits your ability?	3.4	1.28		
Q5	Do you think the timing you received the test is appropriate for you?	3.6	0.48	3.6	0.72
Q6	Have you felt that the more you use our system, the better the tests sending timing suits you?	3.8	0.64		

In order to check whether our system is adaptive and intelligent enough for learners, the three kinds of adaptability of our system will be examined by the results of the questions in our questionnaire and the statistics on how the learners have used the system. Firstly, we will investigate whether the learners like the words and the sentences that they received each day. Since this question is very subjective, we think the answer can just be got from the questionnaire. In Table 3, the result of Question 1 shows that both the average score and the

SD value of group 1 are better than those of group 2. It indicates that the system has improved the learners' motivation by matching the materials with the learners' interests.

For the other two ones, we find that the results of two groups on Question 3-6 are not so inspiring because all of them are under 4 and there are almost no differences between the two groups' results. It demonstrates that the learners are not so stratified with the adaptability of the system. But we want to point out a fact that in our system the learners' ability levels and the sending time are adjusted by their answer history. In other words, the more answer history the system has analyzed, the better the results will be. Thereby, we analyze that learners did not feel that neither the difficulty level of the tests nor the sending time fit them well enough is because that they did not use our system so often. The fact that we sent 25 tests to every learner and only 44% of them have been answered can prove our conjecture. Because we did not get the results that we expected from the answers of Group 1, we turned our focus on the case of the person who answered the tests most frequently in Group 1.

As our experiment lasted 4 weeks, we have calculated this person's correct rate in each week. As Figure 4 shows, in the first 2 weeks this learner's correct rate are always above 80% and we think the tests were too easy for the learners. In the last 2 weeks the correct rate dropped under 80% which we think is suitable for this learner. This change shows that our system can adjust the learners' ability and the difficulty of the questions very well, if the learners use this system often enough. Similarly, we also calculated this learner's time lag between the time he or she received the tests and the time he or she replied the tests. We think if the time lag is under 1 hour, the timing we sent the test is very good for the learners; if it is between 1 hour and 2 hours, it can be acceptable; if it is beyond 2 hours, the timing is very bad for the learner. From Figure 5, we can understand that compared with the first 2 weeks, the situation was becoming better in the last two weeks. This trend makes us believe that if this learner uses more, the timing will get more appropriate.

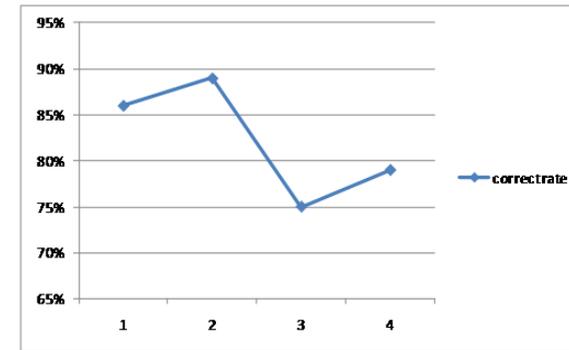


Figure 4 the correct rate in every week

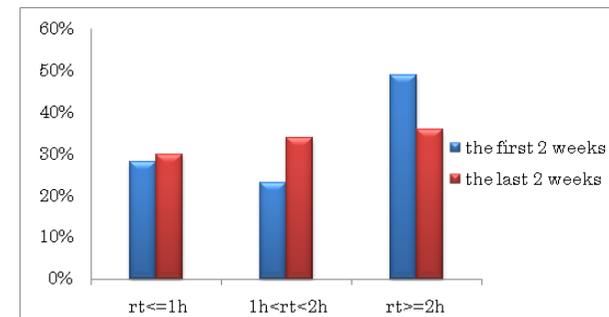


Figure 5 the time lag

In our questionnaire, we also asked them why it happened that they did not reply to the tests. The main reason is that they forgot to answer which occupies 41%. This also tells us that the learners did not feel that the timing is appropriate enough to remind them. There are also 23% of learners complaining they were too busy to answer them. The reason that sending timing is not good enough occupies 14%. Few learners did not answer the tests because of some other reasons. In addition, through the questionnaire the learners provided us with some good proposals. For example, one suggested that reminder could be sent twice, once in the morning and once in the evening. Another two learners commented that they wanted to practice more tests about verbs. All these things tell us that we can improve the method of determining the optimal timing and make use of more features of Kanji, such as using the part of speech of the words.

## 5. Conclusion and future work

This paper described an adaptive learning system for the vocabulary study via mobile-based email. In our study, we provided a request mode as the supplement of push mode. With the two modes, learners can not only fully enjoy the advantages of “anytime, anywhere” offered by the request mode but also be urged to learn more by push mode. Besides, we build an adaptive model to make up the defect that learners sometimes take the messages as “mobile phone spam”. We evaluated our system in an experiment and the results show that the learners who used the adaptive MESLL system achieved better than those who used a common MESLL system. In future, we plan to support more kinds of languages’ vocabulary, such as English or Chinese.

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