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Development of Personalized and Context-aware Model in Learning Log System

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Abstract: In this paper, we describe a personalization and context-awareness model based on learning log system. It is able to notify the learners of the location-based knowledge surrounding him in accordance with both their needs and context, detect learners' learning styles using their context history and recommend learning objects for them regarding their learning styles. What's more, by monitoring learners' reaction on the recommendation message, the model can improve its prediction. We also conduct a preliminary experiment to observe what kind of benefits it can bring to learners. The results reveal most of the learners benefit from the context-based notification and learning-style based recommendation.

Keywords: personalized learning, learning log, context-aware learning, language learning

Introduction

Since many years ago mobile technology has been believed holding out great promise for learning [1]. However, some of its limitations such as the small screen size, the high cost of 3G network and so on stopped the technology from growing as fast as we expect. Until the last few years, a real great revolution is occurring in the mobile device world with the release of the new generation smartphones represented by iPhone launched by Apple Inc. and the open sourced Mobile OS Android released by Google. Since the new generation smartphones accommodate users with many advanced functions such as the multi-touch interface, full browser, GPS, millions of applications and so on, the number of smartphones users is increasing very sharply recently. Another key feature of smartphones is that they are equipped with a range of sensors such as the accelerometer, ambient light sensor, GPS, microphone, camera, compass and so on. Several years ago, researchers forecasted that the mass of mobile smartphones equipped with sensors could be turned into a giant distributed sensing system, allowing users to benefit from information gathered via other phones and users [2].

Yet, in our research we intend to primarily investigate the capabilities of the sensors of smartphones in context-aware and personalized mobile learning. Precisely speaking, we propose a personalization and context-awareness model which can monitor and analyze learners' activities and context and recommend learning objects for learners taking into account both their learning needs and their context. Meanwhile, the model can track their contextual data as context history when they study and catch their personal learning styles through analyzing their context history. Finally, it will utilize their learning styles to support individual learners' learning. In this paper we will put our main emphasis on introducing the details of this model.

Furthermore, our research model is based on a system called learning log system which allows learners to log their learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data and so on, and share and reuse them with others [3].

The ambitious goals of this system are lying in helping users to easily record their learning experiences, reminding them to recall what they have learned based on the context, recommending others' learning experiences for them, finding out individuals' learning styles and supporting their learning in accordance with personal learning style. The model we propose is responsible for the latter four goals. In section 2, we will highlight the main functions of the system in detail.

The rest of the paper is constructed as follows. In section 2, we introduce the Learning Log system and a primary scenario of its use. In section 3, the personalized learning and context-aware model is presented in terms of its three dimensions. Besides, the workflow of the model is explained as well. Section 4 shows a preliminary experiment on the model and the future work derived from the participators' comments. At last, conclusions are given.

1. Learning Log system

With the evolution of the mobile devices, our lives are changing gradually. For example, usually we take memos or notes (such as schedules, planners or task lists) in our pocketbooks. But now more and more People prefer to record these messages with their cell phones. Obviously, it is a simpler way, since the information can be contained in much more ways like texts, photos, audios and videos. Many researches have focused on facilitating this kind of "informal note taking", such as [4], [5]. However, besides informal notes we also take formal notes. For example, most of the language learners have a vocabulary notebook as shown in Figure 1. We call these kinds of notes as formal notes. In this paper, formal note is defined as a recorded form of knowledge or learning experience acquired in our daily lives and this kind of notes serves as memory storage for notable or important knowledge to review, to remind and to reflect. Learning log system is a system proposed for supporting such formal notes taking and the "learning log" is defined as the electronic record of these notes organized in the form defined by the system.

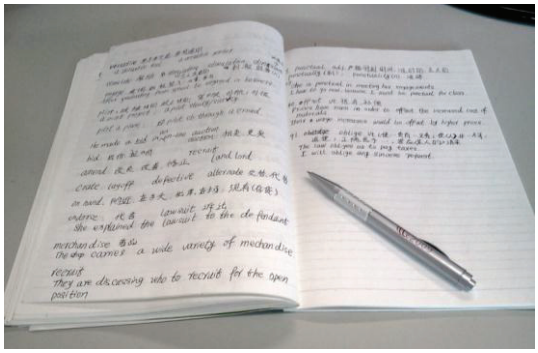

Figure 1: Language learning notes

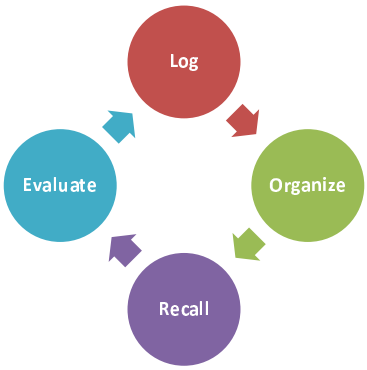

Figure 2: LORE model

Learning log system is constructed based on a LORE model which is shown in Figure 2. It aims to aid users to simply capture what they learn, review and reflect their past learning logs, reuse the knowledge when in need, be reminded at right time at right place and be recommended others' learning logs. It adopts an approach of user created content to share knowledge among users. The following parts list several basic functions of the system and describe a typical scenario of its use.

1.1 Log what we have learned

This function provides an easy way for the learners to upload their learning logs to the server whenever and wherever they learn. A well-organized form of learning logs is defined. It includes four basic elements to illustrate a learning log, which are the time when the learning occurred (when), the knowledge (what), the sequence recorded in texts, photos, audios or videos that the learning should comply (how), and the location where the learning occurred (where). Besides, the logs can be organized by tag and category. Figure 3(1) is the interface of adding a new learning log and Figure 3(2) is an example of learning log. One more property we need to explain is whether a learning log is location based or not. The purpose of this is to remind learners with the location context. This is because the place where we learned usually can remind us what we have learned there. For example, if we learned the Japanese names of vegetables in a supermarket, when we enter the supermarket next time some of what we have learned may come into our mind again.

1.2 Recall what we have learned

Learning log system is also designed to help learners remember what they have learned. Compared with only viewing what we have learned, being asked in quizzes is thought to have a greater impact on confirming whether learners have mastered the knowledge or not. For this reason, the system is proposed to provide users with quizzes after they learned something. Three types of quizzes can be generated automatically by the system, which are yes/no quiz, text multiple-choice quiz and image multiple-choice quiz. Figure 3(3) shows an image multiple-choice quiz generated based on the meta-data of learning logs.

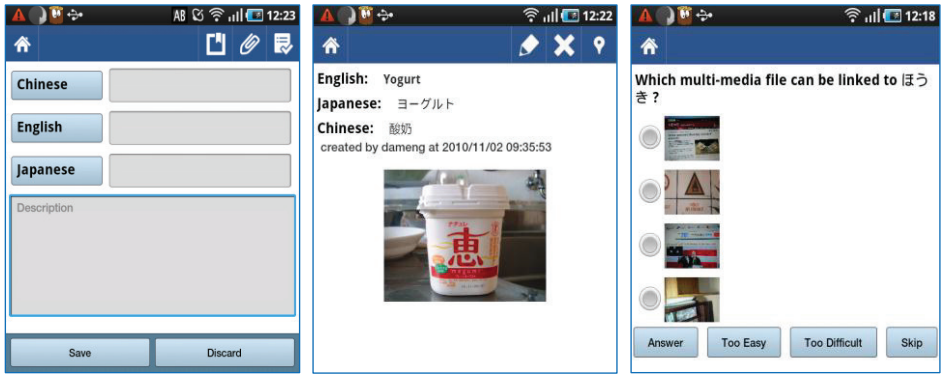

Figure 3: (1) Add ULLO (2) A learning log (3) Quiz

(4) Navigator

(5) A path to learning logs

1.3 Location based knowledge awareness

Another function of Learning Log system is LL navigator. It is a function built on mobile augmented reality allowing the learner to navigate through the learning logs. It provides the learner with a live direct view of the physical real-world environment augmented by a real time contextual awareness of the surrounding objects. While a learner is moving with his

mobile phone, the system sends an alert on the phone as soon as entering the region of learning logs according to the GPS data. This view is augmented, associated with a visual compass, and overlapped by the nearest objects in the four cardinal directions (Figure 3(4)). Also, it offers the learners a list of all surrounding objects. When the learner selects one or more of these objects, the Google map will be retrieved, and marked with the learner's current location and the selected objects. Moreover, the system shows a path (route) for the learner to reach to the objects locations (Figure 3(5)). This assists the learner to acquire the location-based knowledge around him/her and to recall his/her past learning logs.

1.4 The Scenario of Using Learning Log System

Up to now, the learning log system mainly focuses on language learning field. One typical scenario of its use is to assist foreign students learning Japanese in Japan. In this case, Japanese learners, who face rich learning contexts every day, can gain abundant of knowledge from their daily lives in different kinds of situations, such as shopping in the market, seeing doctor in the hospital, having a haircut in a barbershop, visiting the museum and so on. As mentioned, one objective of learning log system is to support learning in these contexts. Besides, lots of these learners have their personal learning styles, such as studying Japanese on the commuting train, or studying Japanese before they sleep. Learning log system is also responsible for aiding these kinds of learning styles. This paper is based on the case study under this scenario.

2. Personalization and Context-awareness model

As mentioned in the beginning of the paper, we propose a model for personalized and context-aware learning with two objectives:

(1) The system can be aware of learner's current context and after analyzing the context it can determine whether to notify him the location-based knowledge he have learned near his current location or the surrounding knowledge uploaded by others which may interest him.
(2) The system can catch individual learner's learning style by making use of the context data obtained when the learner studies. If a learner's learning style exists, the system can persuade him/her to study based on the learning style.

In a word, this model aims to help learners recall their past knowledge by quizzes at a proper time in a related context, recommend suitable knowledge for them based on their current context and their needs and prompt them to learn when the context is including their favorite learning styles. Furthermore, this model consists of three dimensions, which are learners' current context information, learners' preferred learning styles and the attributes of learning material. The followed sections we will introduce theses three dimensions respectively in detail and finally we will talk about the flow of this model.

2.1 Learners' context

A lot of study on context-aware computing can be found in the literature. Here we want to highlight some of them. For example, [6] has developed a location-aware system called commotion that link users' personal information to their locations in daily lives. [7] presents a system to deliver dynamical message to users according to their schedule, location and so on. [8] describes a similar system using the context information involving time, place and

more sophisticated pieces of context. From the above projects, it is easy to find that lots of context-aware computing researches employ the location and time to sensor users' state but some other contextual information are rarely used and the context history which is also believed to be useful has not been fully utilized [9]. For these two reasons we proposed our model. We divide the context into three parts:

(1) Learner's activity: Learner's activity involves their motion (e.g. walking, running, travelling on the train or bus or keeping stationary) and what they do with the devices (e.g. listening to the music through earphone, surfing on the internet, and doing learning with the learning system and so on).
(2) The status of device: The status of device includes the battery, the Internet connection (3G, Wi-Fi or no connection), and the model of the ringtone (vibrate status or ringtone).
(3) The environment. The environment involves the location, time, temperature, weather and so on.

Based on the above information, we firstly analyze whether the context is appropriate to draw the users' attention. For example, whether the battery is enough, whether the Internet is connected, whether it is too late for the users and whether the user is moving in a high speed. If these conditions are satisfied, the system then will notify the users their surrounding knowledge and remind them their past knowledge if these learning objects are existed based on their location context. Finally, the system will check whether the notification is responded. If responded, the contextual information will be recorded as context history. Such kind of information will be reused for analyzing the learners' learning styles. We will introduce this part in the next section.

2.2 Learners' Personal Learning Styles and Preferences

What are the learning styles? Harold Pashler defines this term as that individuals differ in regard to what mode of instruction or study is most effective for them [10]. A variety of learning styles have been supported by many systems. For example, [11] developed an English learning recommender system capable of proving ESL students with reading lessons that suit their different interests to increase their motivation. [12] presents a personalized mobile English vocabulary learning system, which recommends appropriate English vocabulary for learners according to individual learner vocabulary ability and memory cycle. In our model, these personal attributes are also included, such as learners' memory cycle, learners' ability and learners' interests and so on. For instance, the respective learner's ability and interests can be retrieved based on the content analyzing method. In other words, the system monitors each learner's action such as what kind of knowledge s/he recorded recently, what kind of other learners' knowledge s/he looked through, what kind of quizzes s/he corrected or mistook and so on. By analyzing these data, learner's learning preferences including his/her capability and learning interests can be achieved.

However, besides these kinds of learning styles that is usually supported by many systems, we think some more personal learning styles that can only be detected by mobile learning and ubiquitous learning should be supported. These learning styles involve where a learner usually studies (such as home, school or fast-food restaurants), whether a learner has a habit of studying on the commuting train and when a learner prefers to study (e.g. after waking up in the morning or before sleeping at night) and so on. In our opinion, these kinds of learning styles play a very important role on our learning because usually they are related to learners' daily customs and habits. What's more important, these learning styles can be easily obtained by analyzing the context histories, which are thought to be important but rarely be used [9]. For example, the system can make use of the contextual data including the speed and the time to detect whether a learner commutes by train or bus and whether s/he

would like to study when commuting. Besides, the system can also find the learners' preferred studying places and time phases by analyzing the GPS information and the time of studying. After achieved the learners' learning styles, the system can recommend the messages to the learners when they entered those environments and by checking the learners' response rate the system can also modify its prediction.

2.3 Learning Contents

In this study, learning contents are referred to the learning logs stored in the system. For one learner, the learning objects can be separated into three types: his/her own learning logs, the ones that s/he has looked through and the ones recommended by the system. Regarding the former two types, systems will provide quizzes for learners to recall them. But for the last type, the system should tailor the contents to suit individual learners' needs according to the difficulty of them. We use a dynamical way to adjust a learner's ability level and the difficulty level of the learning materials which refers from the [13]. Both learners' ability level and the difficulty level of the quizzes are affected by the correct rate. As the multiple-choice quizzes are generated from the learning logs the learners have learned, the selected wrong choices are also calculated. The system manages to match the difficulty level of the learning contents with the learners' ability level.

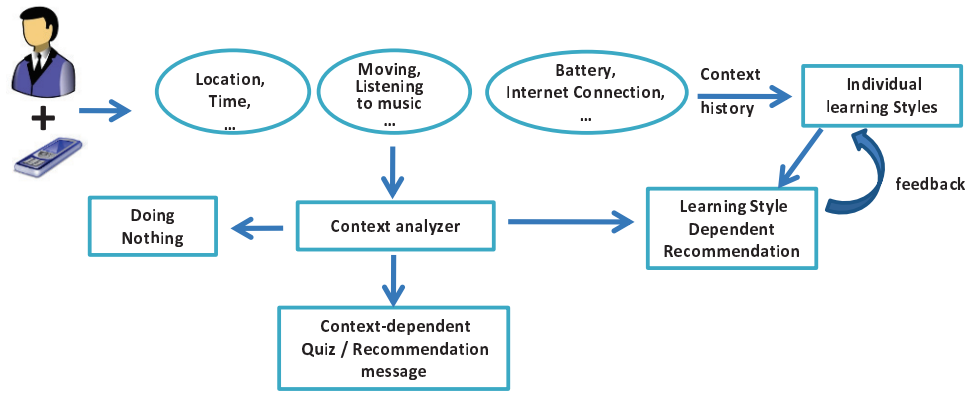

Figure 4: The workflow of the personalization and context-awareness model

2.4 The Workflow of the Model

Figure 4 demonstrates the whole processing flow of the personalization and context-awareness model. It follows the below steps:

(1) The model collects a learner's context information from three parts: his/her activity, the status of device and the environment.
(2) The model analyzes the context and check status of the device: for example, how much battery is left and whether the internet is connected. If the availability is low, the system will do nothing.
(3) If the device has a high availability, the system will check whether there is location-based knowledge surrounding the learner. If existing, the system will provide location-dependent quizzes or recommendation messages for him/her.
(4) If there is no location-based knowledge for the learner, the model will examine if the learner is in his/her preferred learning context. If so, the model will show messages to persuade him/her to study.

(5) All the data of the context is remained as context history to approach individual learner' learning styles. Finally the learner's response to the learning style based recommendation is used to improve the learning style detecting method.

3. Evaluation and Future Works

In order to evaluate our model, we conducted a preliminary experiment. Through this experiment, firstly we intend to investigate whether the learners can retain what they have learned by linking the context to their past learning logs and whether others' learning logs are meaningful for them by notifying them the context-based learning logs. Secondly, we hope to make it clear whether the system can find out each learner's individual learning styles and support them well. Finally, we are eager to know what kinds of other benefits the model can bring for learners and what kinds of improvement are demanded.

In this experiment, we organized ten foreign students to use the learning log system for two weeks. The participators are from China (3), Taiwan (1) and Korea (6). The device adopted is Galaxy Tab SC-01C produced by Samsung. Before the experiment started, they were given one week to get used to the smartphones and the system. Then, they spent two weeks to use the system and after that we interviewed them one by one. We expect to acquire the results from the interviews and the statistical analysis on the learners' data of using the system. Here we pick up the typical messages including the positive and the negative:

- When I am free at home, sometimes I receive recommendations of reviewing what I have learned. It is very suitable and helpful.
- It is very useful to use it on bus.
- It was suitable to be recommended in the past. But I suggest you to consider more parameters, because it is not easy to catch the real context with few aspects.
- It is not good enough, since sometimes I am alarmed when I am very busy.
- Because the Galaxy Tab is a little big, I seldom take it out. So it is meaningless for me.
- It is not so useful the People who do not usually take the devices out.

Besides the messages, they also evaluated the learning-style based recommendation function and the score is 3.8 (A five-point Likert-scale is used, the responses to which were coded as 1 = strongly disagree through to 5 = strongly agree.). From the messages and the score, we can infer that most of the learners who have personal learning styles can benefit from the recommendation messages from the system and while part of them have a low opinion of the function, for the judgment of the system on the learners' context is not appropriate. This is a problem to solve in the future. As for the context-based notification function, the result can be gained from the users' reaction on the recommendation messages. During the two weeks, the system sent 7 pieces of messages for the learners and 4 of them have been responded. The high response rate surpassing 57% is very encouraging. Through the interview, we also received a lot of advices on the functions they demand and we list all of them:

- It will be very helpful if I can get support from the system when I go to hospital, supermarket, and barbershop and so on. Moreover, we need not only the words, but also some daily sentences.
- I need Japanese support when I have lunch in the restaurant or go shopping.
- For example, when I see something such as exercise machines and computer, the function that teaches me how to use them is very useful for me.

These comments reveal that these learners are eager to get help instantly in lots of situations of their daily lives. It points out one of our future work on the context-based recommendation that the model can recommend the learning objects based on a similar

context. For example, if one learner learned how to express headache in a hospital, when he go to another one the system can also send him/her a message to review the way of speaking headache. Another function posed by the learner is to help them a real work in daily life such as to demonstrate how to change a toner cartridge for a printer. This is another issue we will explore soon.

4. Conclusion

In this paper, we introduced a personalization and context-awareness model on the basis of learning log system. This model aims to assist learners to review what they have learned and recommend others' learning experience for them by utilizing the context. Also, it can detect learners' learning styles by analyzing their context history and prompt them to review past knowledge according to their learning styles. Finally, the attributes of the learning objects are also considered in the model. We conduct a preliminary experiment to examine our model and the results illustrate learners can benefit rom our model well both from the context-based notification and the learning-style based recommendation.

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