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SCROLL: Ubiquitous Learning Log の記録と再利用の支援について

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本稿では、日常生活での学習の体験をラーニングログとして蓄積し、他の学習者と共有することで、知識やスキルの獲得を支援する、協調学習の情報基盤について述べる。特に、その場所や時間など学習者の周囲の状況に適した情報を学習者に知らせるための、個人適応の方法について論じる。また、大学の講義で評価を行った結果を示す。

SCROLL: Capturing and Reusing Ubiquitous Learning Log

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This paper proposes a ubiquitous learning log system called SCROLL (System for Capturing and Reminding Of Learning Log). Ubiquitous Learning Log (ULL) is defined as a digital record of what you have learned in the daily life using ubiquitous technologies. It allows you to log your learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data, and to share and to reuse ULL with others. Using SCROLL, you can receive personalized quizzes and answers for your questions. Also, you can navigate and be aware of your past ULLs supported by augmented reality view. The initial evaluation of applying this system in an undergraduate English course is illustrated.

1. INTRODUCTION

CSUL (Computer Supported Ubiquitous Learning) is defined as a technology enhanced learning environment supported by ubiquitous computing technologies such as mobile devices, RFID tags, and wireless sensor networks [11]. CSUL takes place in variety of learning spaces, e.g., classroom, home and museum. Also it provides the right information using the contextual data like location, surrounding objects and temperature.

The main characteristics of CSUL are shown as follows [11],

(1) Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all learning processes are recorded continuously every day.

(1) Accessibility: Learners have access to their documents, data, or videos from anywhere. That information is provided based on their requests. Therefore, the involved learning is self-directed.

(2) Immediacy: Wherever learners are, they can get any information immediately. Thus, learners can solve problems quickly. Otherwise, the learner can record the questions and look for the answer later.

(3) Interactivity: Learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication. Hence, the experts are more reachable and the knowledge becomes more available.

(4) Situating of instructional activities: The learning could be embedded in our daily life. The problems encountered as well as the knowledge required are all presented in their natural and authentic forms. This helps learners to notice the features of the problem situations that cause particular relevant actions.

One of the application domains of CSUL is language learning. For example, TANGO [10] supports learning vocabularies. The idea of this system is to stick RFID tags on real objects instead of sticky labels, annotate them (e.g., questions and answers), and to share them among others. JAPELAS [10] aims to support foreigners to learn Japanese polite expressions according to surrounded persons and the place. JAMIOLAS [12] supports learning mimetic words and onomatopoeia using wireless sensor networks. Those CSUL applications are intended to be used all the time. This is one of the features of CSUL called "permanency". However, little attention has been paid to this aspect.a

The fundamental issues of CSUL are: (1) How to record learning experiences that happen at anytime and anyplace; (2)How to share and reuse them in future learning. To tackle

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these issues, LORAMS (Linking of RFID and Movie System) [13] was proposed. There are two kinds of users in this system. One is a provider who records his/her experiences into videos. The other is a user who has some problems and is able to retrieve the videos. The system automatically links between physical objects and the corresponding objects in a video and allows to share it among users. By scanning RFID tags, LORAMS shows the user the video segments that include the scanned objects. Although this system is useful in certain environments, it is not easy to be applied in practice at any place at the moment. Therefore, we started more practical research called "ubiquitous learning log (ULL)" project in order to store intentionally what we have learned as ubiquitous learning log objects (ULLOs) and consequently reuse them.

Figure 1: Example of learning log.

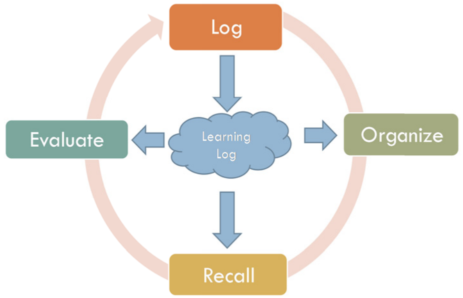


Figure 2: LORE model in SCROLL

How are we learning from past learning log? For example, we take notes, e.g., vocabularies, idioms, sentences in a language learning situation (Figure 1). Whereas, they will not remind us of the knowledge learned, nor the situation where the knowledge was used. We think this process can be enhanced using mobile devices. Therefore, this paper proposes a system called SCROLL (System for Capturing and Reminding of Learning Log), which supports the learners to record, share and reuse ULLOs using mobile devices.

For example, if you visit another country, you may learn some vocabulary or culture there. But you may forget what you learned after coming back your home. However, if you record your ULL using SCROLL and visit the same place again, you would be reminded of your past learning log and its context by SCROLL. This paper describes the design, the implementation and the initial evaluation of SCROLL

2. RELATED WORKS

2.1 Life-log

Life-log is a notion that can be traced back at least 60 years [1]. The idea is to capture everything that ever happened to us, to record every event we have experienced and to save every bit of information we have ever touched. For example, SenseCam [4] is a sensor augmented wearable stills camera; it is proposed to capture a log of the wearer's day by recording a series of images and capturing a log of sensor data. MyLifeBits [3] stores scanned material (e.g.: articles, books) as well as digital data (e.g.: emails, web pages, phone calls, and digital photos taken by SenseCam). Ubiquitous Memory system [6] is a life-log system using a video and RFID tags. Also, Evernote (www.evernote.com) is a tool to save ideas using mobile devices such as Android and iPhone. The most common idea of those projects is to use life-log data for memory aid, however, SCROLL aims to utilize life-log data for the learning process.

2.2 Learning log and e-portfolio

Originally, the term "learning log" was used for personalized learning resources for children [19]. The logs were usually visually written notes of learning journals, which could become an integral part of the teaching and learning program and had a major impact on their drive to develop a more independent learner. Research findings indicated that journals were likely to increase meta-cognition and reflective thinking skills through students who become more aware of their own thought processes [17, 18]. Also the term "electronic portfolio (e-portfolio) or digital portfolio" is used for a collection of electronic evidences maintained by a learner. Our approach focuses on how to enrich learning log or e-portfolio, and to promote retention and meta-cognition by using mobile, ubiquitous and context-aware technologies.

2.3 Mobile language learning

One of the application domains for mobile learning is the language learning, because it is based on situated and collaborative activities, that could occur wherever and whenever people have problems to solve or knowledge to share [16]. Especially, vocabulary is basically used for communication [7] and often seen as the greatest source of problems by second language learners (when the students travel, they do not carry grammar books but they carry dictionaries.) [14]. Thus, mobile learning has been identified as one of the natural directions in which language learning is expected to move [15].

Miller and Gildea [9] compared the way children are taught words from dictionary definitions and a few exemplary sentences with the way vocabulary is normally learned outside the school. They noted that people generally learn words outside school. Therefore, SCROLL captures what the learners have learned in- and out-class. Also advanced second language readers can learn more vocabulary when they are given the meaning of unknown words through marginal glosses or when they look up meaning in a dictionary than when no external information concerning unknown words' meaning is available [5]. Therefore, SCROLL provides online dictionary for the learners to find the meaning of unknown words and also gives quizzes increased the learning opportunity. The effect of three annotation types (text-only, picture-only, and a combination of the two) on second language incidental vocabulary retention in a multimedia reading setting was compared [14]. The results indicated that the combination group outperformed the text-only and picture-only groups on the immediate tests. Hence, SCROLL allows the learners to link vocabulary and its photo.

3. SYSTEM DESIGN

3.1 Design

In this paper, ubiquitous learning log (ULL) is defined as a record of what a learner has learned in the daily life using ubiquitous technologies. ULL is considered as a set of ULLOs. The learning can also be considered as the extraction of meaningful knowledge from past ULL that serves as a guide for future behavior [2]. Figure 2 shows the learning processes in the perspective of the learner's activity model called LORE (Log-Organize-Recall-Evaluate).

(1) Log what the learner has learned: when the learner faces a problem in the daily life, s/he may learn some knowledge by him/herself, or ask others for a help in terms of questions. The system records what s/he learned during this process as a ULLO.

(2) Organize ULL: when the learner tries to add a ULLO, the system compares it with other ULLOs, categorizes it and shows the similar ULLOs if exist. By matching similar objects, the knowledge structure can be regulated and organized.

(3) Recall ULL: the learner may forget what s/he has learned before. Rehearsal and practice can help the learner to recall past ULLOs and to shift them from short-term memory to long-term one. Therefore, the system assigns some quizzes and reminds the learner of past ULLOs.

(4) Evaluate: it is important to recognize what and how the learner has learned by analyzing the past ULL, so that the learner can improve what and how to learn in his future. Therefore, the system refines and adapts the organization of the ULLOs based on the learners' evaluation and reflection.

All the above learning processes can be supported by SCROLL.

3.2 Linking formal and informal learning

Using this system, teachers can understand what their students learned outside the class (informal settings). For example, they ask their students to record the words that they have learned into SCROLL as ULLOs. In the next class, they make a reflection using their students' ULLOs. Through this process, they can check whether the ULLOs given by their students are correct or not, and allow their students to share their knowledge. In this way, SCROLL enhances and integrates both formal and informal learning.

4. PERSONALIZED AND CONTEXT-AWARE LEARNING

To support individual learner's personalized learning based on his/her current context is another feature of SCORLL system. Our strategy is to build two models: personalization model and context-aware model and both models are interrelated and interact on each other.

4.1 Personalization model

To build the personalization model, the system needs to collect each learner's learning meta-data and monitor their learning action. Then based on these data the system will analyze and predict individual user's learning preferences. Specifically, the system should obtain each learner's learning meta-data based on the Android client of SCROLL system, e.g. the learner's location, time and moving speed and so on. The system can also monitor 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 when is the best time for him or her to remember a new knowledge after s/he recorded it into the system and so on. By analyzing these data, the system can understand lots of each learner's learning preferences, such as his or her learning interests, capability (what s/he is good/bad at), attitude, where and when this learner usually study, what kind of situations s/he would like to learn (on train, walking or inactivity) and so on. With individual learner's learning preferences, the system can support every user's context-aware learning better.

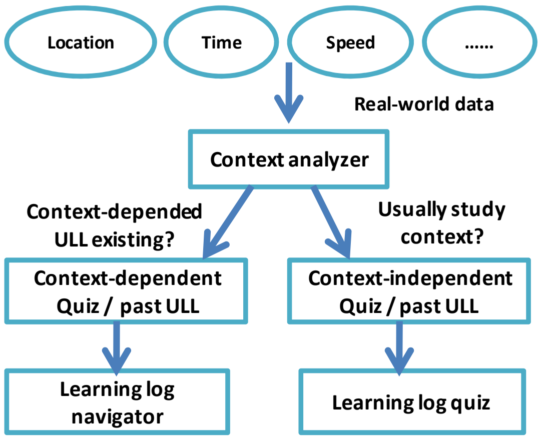


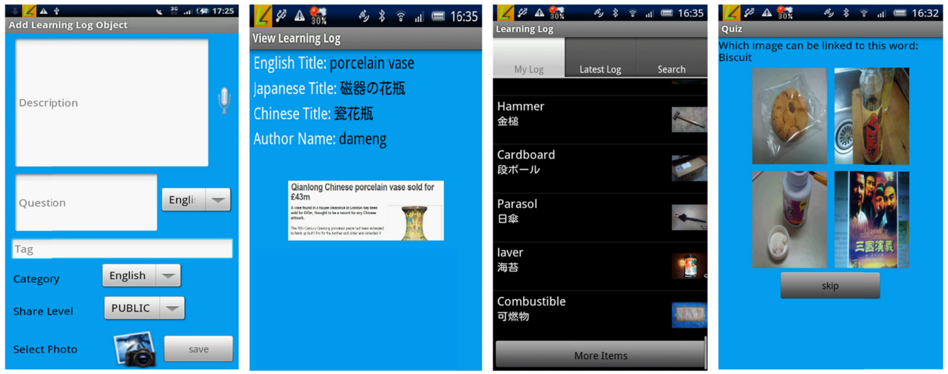
Figure 3: Context-aware model

4.2 Context-aware model

As shown in Figure 3, the Android client of SCORLL system will send a learner's current real-world context data such as location, time and speed to the server and the context analyzer of the system will make some judgments. For example, the system will judge whether his/her current location is where s/he usually study, whether current time is when s/he usually study, whether his/her moving speed is possible for him/her to learn and whether there are some ULLs around him or her which may arouse his/her learning interests. If there are some ULLs around him or her, the learner would get some messages from the system and can be navigated to those ULLs with Learning Log Navigator; if the learner's current time and location is when and where s/he usually study and his/her moving speed is possible to study, the system will recommend some quizzes to him/her. Moreover, if the messages or quizzes are responded by him or her, the context-data will be analyzed for improving the accuracy of his/her learning preferences predicted by the system.

5. IMPLEMENTATION

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC browser and general mobile phones. This section we will introduce the implementation of several components of SCROLL system.



(1) Add ULLO (2) An example (3) ULL List (4) Quiz

Figure 4: SCROLL Interface of Android mobile phone.

5.1 ULL recorder

This component provides an easy way for the learners to upload their ULLOs to the server whenever and wherever they learn. In order to add a ULLO, the learners can take its photo, ask questions about it and attach different kinds of meta-data with it, such as its meanings in different languages (English, Japanese and Chinese), comments, tags and location information. Also the learner can select whether the new ULLO can be shared or not. Figure 4(1) is the android interface of adding a ULLO. Figure 4(2) shows an example of ULLO.

Besides, it is possible to look through others' shared learning objects and to re-log them which means that the learner can take others' ULLOs as his/her own. In other words, the learner can obtain a lot of knowledge from the other learners even though he has not experienced that knowledge by himself. By sharing ULLOs with the other learners and re-logging the other learners' ULLOs, the acquisition of the knowledge is enhanced.

5.2 ULL finder

If learner registers a new ULLO, the system checks whether the same object has been already stored or not by comparing the name fields of each object using a thesaurus dictionary. Also, as shown in Figure 4(3) & 6(1) the learner can search ULLOs by name, location, text tag and time. Using this function, learners can understand what, where and when they learned before. In the future works, the visualization of the ULLOs will be developed.

5.3 ULL reminder

Quiz function is designed to help the learners remind what they have learned. Figure 4(4) & 6(2) show two types of multiple-choice quizzes generated based on the meta-data of ULLOs by the system. The system classifies the ULLOs for each learner into 5 types: this learner's own new ULLOs, the ULLOs whose quizzes has been answered correctly, the ULLOs whose quizzes has been mistaken, the ULLOs that he or she looked through frequently and the ULLOs that are in the learner's preferred category. Different type of ULLOs has different reminder interval. For example, the new logs will be reminded after stored 1 day and the right quizzes will be shown in 5 days firstly and then a month, a year. Quizzes cannot only be practiced by learners themselves but also could be notified by setting receiving time on the server or be recommended by the context-aware function.

Figure 5: Learning log navigator (camera view (left); path to ULLOs (right)).

5.4 ULL Navigator

LL navigator provides mobile augmented reality that allows the learner to navigate through the ULLOs. Like Wikitude and Sekai-Camera, 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 ULLOs 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 5, left). Also, it provides the learners with 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 5, right). This assists the learner to acquire new knowledge by discovering the existed ULLOs and to recall his ULLOs. In order to reduce the power consuming of the phone battery, the light-mode (blank screen) is developed. In this mode, the phone camera is turned off, and the system displays only information about the surrounding objects. Moreover, by touching the phone screen, a menu will be displayed; it provides the learners with additional facilities, such as displaying a list of all surrounding objects and photos capturing (Camera-mode).

5.5 ULL Time Map

Figure 6(3) is the web interface of the ULL Time Map. Time map function is designed to help the learners to reflect what they have learned. To review all past ULLOs, user can scroll the timeline above and then the map below will display the ULLOS recorded during learners' selected period. With the time and location contextual data, it is helpful for the learners to remind their learning history.

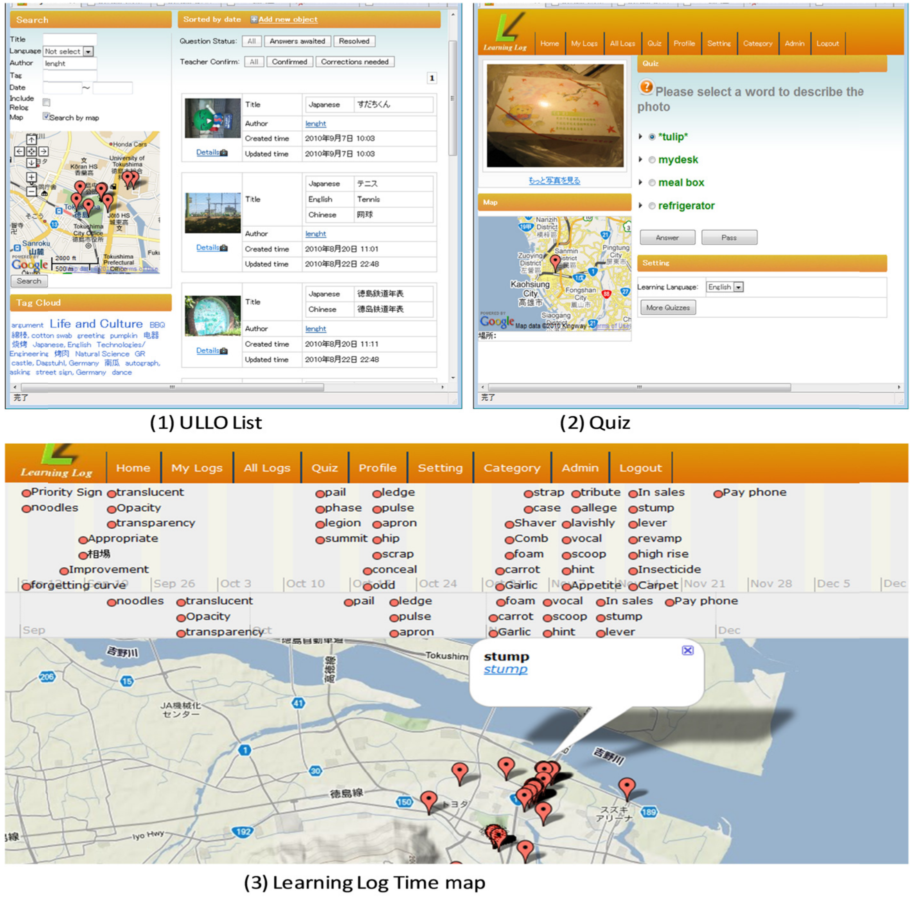


Figure 6: Web interface

6. EVALUATION

6.1 Method

The study group consisted of 20 Japanese university-sophomores (17 males, 3 females) who were taking the communicative English class at the university. The major of the students was engineering and they ranged in age between 19 and 21 years. All the students underwent an initial test one week before the evaluation started. The test was a 60-item pre-test of words selected by the teacher. They were the names of the things easily found in our daily life such as staplers, rulers, glues, etc. The students were divided into 2 groups with the equal English proficiency according to the pre-test result. Each group consisted of 10 students and engaged in learning vocabulary listed in the pre-test, where Group A used smart phones (7 Sony-Ericsson Xperia and 3 HTC-03A) and SCROLL, while Group B learned the words in a conventional way, e.g., using a paper dictionary without technology. Since Group A has never used a smart phone, about one-hour briefing session was held for Group A students have to help them understand how to use smart phones and SCROLL. Evaluation was carried out over a period of two weeks. At the conclusion of the phase, the subjects underwent a post-test, the same vocabulary test as the pre-test. The full mark for pre- and post-test was 60. Further data was collected from the participants by means of questionnaires and the log data contained in the server.

6.2 Results

Since it turned out that only 5 subjects (hereafter Group A1) out of 10 of the test group used smart phones and SCROLL during the trial, the rest of the 5 subjects (hereafter Group A2) were added into group B in the data analysis. The pre- to post-test differences between the mean test scores for Group A1 (with SCROLL) and for Group B (paper-based, without SCROLL) are shown in Table 1, along with the standard deviations for each test result. The analysis was undertaken using one-tail test. There was a significant improvement from pre- to post-test for both groups. Also, statistically significant difference was detected between A1 and B+A2. This indicates that the A1 students learned new words more efficiently and effectively by using SCROLL. If we look at the students whose pre-test scores were under 21, the pre- to post-test difference in A1' and (B+A2)' were shown in table 1. The mean score of A1' was significantly increased (p=.006964 < .01). On the other hand, no significant difference in the pre- to post-test results was found between A1'' students and (B+A2)'' students whose pre-test scores were more than 21 (p=.39187>.1). This indicates that vocabulary learning using SCROLL was highly effective for poor performers or beginners compared with high-achieving students.

According to the users' logs in SCROLL, the A1 students uploaded ULLO 15.6 times and did quizzes 112.6 times on average. The quantitative data suggest that some serious students engaged greatly with SCROLL for vocabulary learning. The correct answer rate of ULLO quizzes was 92.9%. A slight difference (4.1%) was found in the percentage of correct answers between the quizzes from ULLO uploaded by themselves and by somebody else. The former (96.3%) was better than the latter (92.3%).

The questionnaire result is shown in Table 2. The highest mean score was 3.25 when asked whether it was useful to register a ULLO. From the questionnaire response, there was no student of Group A1 who did not want to share ULL. Also some students commented that it was helpful to see the images uploaded by other students. However, for some students, it seemed troublesome to use them because its short duration of battery or unstable Internet connection. Another explanation for the poor engagement is that even though they received the briefing, some did not understand fully how to use them. These are probably part of the reasons why 5 students of Group A did not show any involvement in SCROLL. Thus our next evaluation is being more carefully planned.

Table 1: Pre- and post-test results (full mark: 60).

GROUP	PRE-TEST	POST-TEST	PRE -POST DIFFERENCE	T- AND P-VALUE
A1 (N=5)	M = 19.50 SD = 5.24	M = 53.20 SD = 6.33	M = 33.70 SD = 11.29	t=2.01018 p=.029821*
B+A2 (N=15)	M = 19.50 SD = 4.63	M = 41.00 SD = 12.92	M = 21.50 SD = 11.88	
A1' (beginner) (N=3)	M = 16.17 SD = 1.04	M = 57.67 SD = 2.24	M = 41.50 SD = 3.28	t=2.920406 p=.006964**
(B+A2)' (N=10)	M = 16.90 SD = 2.46	M = 36.85 SD = 12.01	M = 19.95 SD = 12.30	
A1'' (advanced) (N=2)	M = 24.50 SD = 4.95	M = 46.50 SD = 0.71	M = 22.00 SD = 5.66	t=0.289608 p=.39187***
(B+A2)'' (N=5)	M = 24.70 SD = 3.29	M = 49.30 SD = 11.40	M = 24.60 SD = 11.66	

*<.05, **<.01, ***>.1

Table 2: Result of the five-point-scale questionnaire.

Question	Mean	SD
Was registering ULLO useful for growing your English vocabulary?	3.25	1.49
Was Smart Phone with SCROLL useful for vocabulary learning?	3.13	1.25
Was this system enjoyable?	3.00	1.31

7. CONCLUSION

This paper proposes a ubiquitous learning log system in order to enhance sharing and reusing past learning experiences. The system runs on Web browser, Android and email platform. According to the initial experiment, SCROLL was effective in learning English vocabulary, since statistics shows a significant difference between the control group and the experiment group. Since this system is intended to be used in general domains and for life- long learning, we will apply it in other application domains, e.g., math, physic, and science education and conduct a long-term evaluation with an enough number of subjects in the future work.

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