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SCROLL: SUPPORTING TO SHARE AND REUSE UBIQUITOUS LEARNING LOG IN THE CONTEXT OF LANGUAGE LEARNING

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One of the challenges of CSUL (Computer Supported Ubiquitous Learning) research is capturing what learners have learned with the contextual data, and reminding the learners of it in the right place and the right time. 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 learners have learned in the daily life using ubiquitous technologies. It allows the learners to log their 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, they can receive personalized quizzes and answers for their questions. Also, they can navigate and be aware of their past ULLs supported by augmented reality view. The initial evaluation of applying this system to undergraduate English course is illustrated.

Keywords: Ubiquitous and mobile learning; ubiquitous learning log object; life log.

1. Introduction

CSUL (Computer Supported Ubiquitous Learning) or context-aware ubiquitous learning (u-Learning) is defined as a technology enhanced learning environment supported by ubiquitous computing technologies such as mobile devices, RFID tags, and wireless sensor networks (Hwang *et al.*, 2008; Ogata & Yano, 2004a). CSUL takes place in a 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 (Ogata & Yano, 2004a),

(1) Permanency: Learners never lose their work unless it is purposefully deleted. In addition, all learning processes are recorded continuously every day.
(2) Accessibility: Learners have access to their documents, data, or videos from anywhere. If that information is provided based on their requests, the learning involved is often self-directed.
(3) Immediacy: Learners can get any information immediately wherever they are. Thus, learners can solve problems quickly. Otherwise, learners can record the questions and look for the answers later.

(4) 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.
(5) Situating 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 (Ogata & Yano, 2004b) supports learning vocabularies. The idea of this system is to stick RFID tags to real objects instead of sticky labels, annotate them (e.g. questions and answers), and to share them among others. JAPELAS (Ogata & Yano, 2004b) aims to support foreigners to learn Japanese polite expressions according to surrounded persons and the place. JAMIOLAS (Ogata *et al.*, 2006) supports learning mimetic words and onomatopoeia using wireless sensor networks. Also many CSUL systems were developed in the domains of nature science (Chu *et al.*, 2010; Hwang *et al.*, 2011; Hwang *et al.*, 2010) and complex science experiences (Hwang *et al.*, 2009). 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.

The fundamental issues of CSUL are:

(1) How to record learning experiences that happen anytime, anywhere?
(2) How to share and reuse them in future learning?

To tackle those issues, LORAMS (Linking of RFID and Movie System) (Ogata *et al.*, 2008) was proposed. There are two kinds of users in this system. One is a provider who records her/his 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 sharing 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.

How can we learn from our past learning log? For example, we may take notes what we learned (Figure 1). But they do not actively remind us of what we learned, nor the situation where we learned them if the notes have not been taken in detail. 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 learners to record, share and reuse ULLOs using mobile devices.

For example, if we visit some other countries, we may learn some words or cultural things there. But we are likely to forget what we learned after coming back home. However, if we could record our learning log using SCROLL and visit the same place again, we would be reminded of our past learning logs and their contexts using SCROLL. This paper describes the design, the implementation and the initial evaluation of SCROLL.

Figure 1. Note for language learning.

2. Related Works

2.1. *Life-log*

Life-log is a notion that can be traced back at least 60 years ago (Bush, 1945). 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 (Hodges *et al.*, 2006) 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 (Gemmell *et al.*, 2006) stores scanned material (e.g. articles and books) as well as digital data (e.g. emails, web pages, phone calls and digital photos taken by SenseCam). Ubiquitous Memory system (Kawamura *et al.*, 2007) is a life-log system using a video and RFID tags. Also, Evernote (www.evernote.com) is a tool for saving 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" is used for personalized learning resources for children (Wikipedia, n.d.). The logs are usually visually written notes of learning journals, which could become an integral part of the teaching and learning program and have 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 (Ma & Kelly, 2006). Also the term "electronic portfolio (e-portfolio) or digital portfolio" is used for a collection of electronic evidence 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 language learning, because it is based on situated and collaborative activities that could occur wherever and whenever people have problems to solve (Sharples, 2000). Especially, vocabulary is basically used for communication (Ma & Kelly, 2006) and often seen as the greatest source of problems faced by second language learners (when the students travel, they do not carry grammar books, they carry dictionaries (Yoshii & Flaitz, 2002).

Miller and Gildea (1987) compared the way that 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 inside and outside 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 are available (Hulstijn *et al.*, 1996). Therefore, SCROLL provides online dictionary for the learners to find the meaning of unknown words and also gives quizzes to increase the learning opportunity. The effects 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 were compared (Yoshii & Flaitz, 2002). The results indicated that the combination group outperformed the text-only and picture-only groups on the immediate tests. Hence, SCROLL enables the learners to link words and visual information.

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 (Daudelin, 1996). 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 her/himself, 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 in the same context or others in idle moments 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 her/his 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 future. Therefore, the system refines and adapts the organization of the ULLOs based on the learner's evaluation and reflection.

All the above learning processes can be supported by SCROLL.

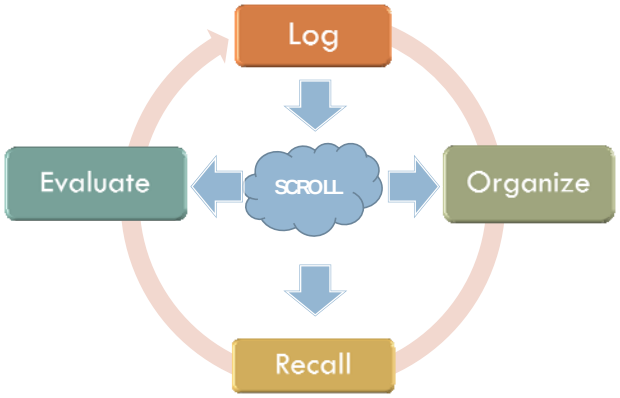


Figure 2. LORE model in SCROLL.

3.2. *Linking inside-class and outside-class learning*

Using this system, teachers can understand what their students learned outside the classroom. For example, they ask their students to record the words that they have learned in 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 inside class and outside class learning.

4. Implementation

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC and general mobile phones (Figure 3).

4.1. *System architecture*

The server side runs on Linux OS and it is programmed using Java and PostgreSQL. The client side is working on Google phone and PC web browser. The developed software for Google phone is a native java application based on Android SDK (Software Development

Kit). The users can register and take quizzes by sending a message using mobile phone email like SMS and i-mode.

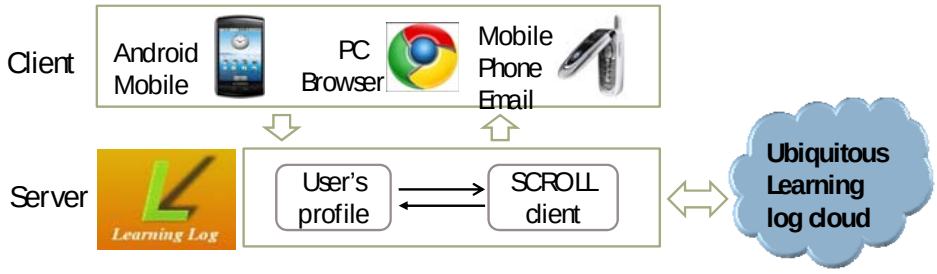


Figure 3. System configuration of SCROLL.

4.2. *Database*

The database on the server side consists of two main parts:

(1) User's profile: It contains the learner's personal information such as name, email address, nick name, native language, target language that the user is currently learning.
(2) Learning log object: It contains information about the learning object such as photo, barcode ID, location, comment, tag and question.

4.3. *Android interface*

This section describes the Android user interface of each component.

4.3.1. *ULL recorder*

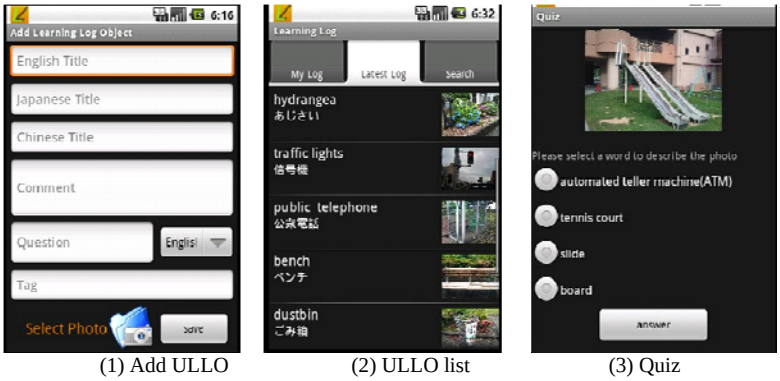
This component facilitates the way for the learners to upload their ULLOs to the server whenever and wherever they learn. As shown in Figure 4(1), in order to add a ULLO, the learners can take its photo, ask questions about it and attach different kinds of meta-data with it, such as its meanings in different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

4.3.2. *ULL finder*

The list of the learner's ULLO is shown in Figure 4(2), which helps him to recall all his past ULL. Besides, it allows him to be aware of the others' learning objects and to re-log them; it means that the learner can make a copy of them into his log. Therefore, 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 other learners and re-logging the other learners' ULLOs, the acquisition of the knowledge is enhanced. As shown in Figure 4(3), the system generates simple multiple-choice quizzes based on the

meta-data of the stored ULLOs. For example, the idea of "quiz with image" is to ask the learner to choose a word to describe the image given by the system. The system immediately checks whether his answer is correct or not. These quizzes are generated according to his profile, location, time and the results of past quizzes and help the learners to recall what they have learned.

The quiz function is designed not only to help the learners to reinforce what they have learned, but also to recommend what other learners have learned and to remind them of what they learned in the past according to their current location and their preferred time. In order to achieve these targets, they can practice with the quizzes whenever they want. In addition, they can send their location information to the server all the time. Therefore, the sever side can automatically assign quizzes for them based on their location and time information. It notifies them to check the quiz by showing an alert message and vibrating the mobile phone. Whenever they move around an area where they have encountered some objects, the system will send them quizzes regarding those objects. Furthermore, they can set a time schedule to receive the reminder quizzes.



(1) Add ULLO (2) ULLO list (3) Quiz

Figure 4. SCROLL Interface of Android mobile phone.

4.3.3. *ULL navigator*

ULL navigator provides mobile augmented reality that allows the learners to navigate through the ULLOs. Like Wikitude [www.wikitude.org] and Sekai-Camera [sekaicamera.com], it provides them 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 shows an alert on the phone as soon as he enters 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). It also provides him with a list of all surrounding objects. When he selects one or more of these objects, the Google map will be retrieved, and marked with his current location and the selected object. Moreover, the system shows a path (route) for him to reach to its locations (Figure 5, right). This assists him to acquire new knowledge by discovering the existed ULLOs and to recall his own

ULLOs. In order to reduce the power consumption 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 him with additional facilities, such as displaying a list of all surrounding objects (Object-list) and recording photos (Camera-mode).

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

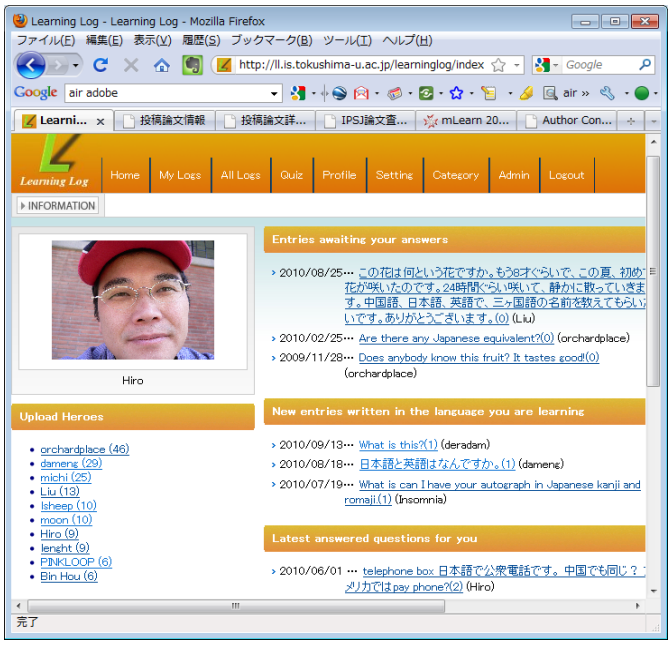


Figure 6. Home page for PC web browser.

4.4. *Web interface*

Figure 6 shows the home window of the web version of SCROLL. The user can see the current status of this system, for example, who uploaded ULLO most and new entries of ULLOs. Basically the interface is written in English. If the user sets Japanese or Chinese as his mother language or the language that he wants to learn, then Japanese or Chinese characters appear in this window.

Figure 7 (left) shows a window for creating a new ULLO. The user can select public or private, and category. He is supposed to enter the name of the object. The word can be translated to another language by the translate button. Photo, barcode, RFID can be registered in a ULLO. The location where the photo taken is derived by the Exif data of the photo. The user can ask a question to others using a question column. Then the question will appear in other users' home window.

Figure 7 (right) shows an example of registered ULLOs. If the user presses "Relog" button, this object will then be included in his "my log". The Q&A (question and answer) and comments about this ULLO are also listed in the window.

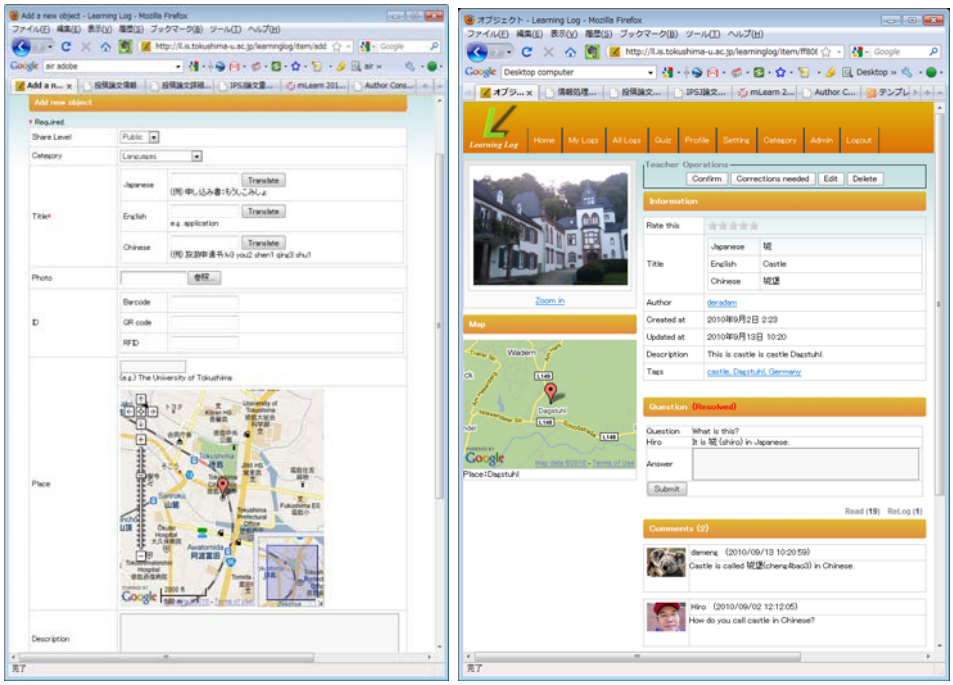


Figure 7. Registration window for a new ULLO (left) and an example of ULLO (right).

Figure 8 (left) shows the list of all the ULLOs stored in the system. The user can search some ULLOs by title, language, author, tag, date and location. Also tag clouds are shown in the bottom left of the window. The list is also filtered out by the confirmation by teacher.

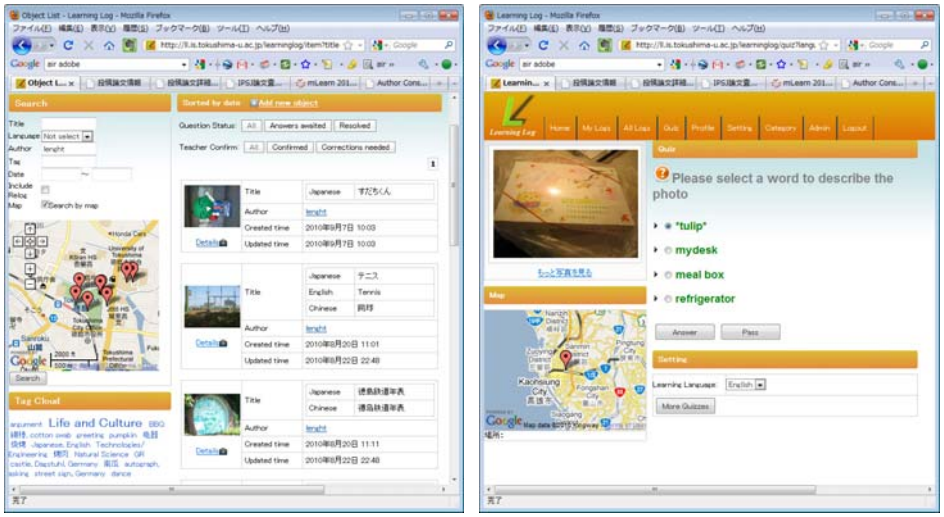


Figure 8. Search results of ULLO (left) and quiz (right).

Figure 8 (right) shows a multiple-choice quiz, which is generated by the system. If the user presses the answer button, the right answer will appear. If the user thinks this is not a good quiz, s/he presses the pass button. Then, the quiz will not appear again.

5. Evaluation

5.1. *Method*

The study group consisted of 20 Japanese university-sophomores (17 males and 3 females) who were taking the communicative English class at the university. The major of the students was engineering and they were aged between 19 and 21. 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 had never used smart phones, a briefing session in about one hour was held for Group A students to help them understand how to use smart phones and SCROLL. Evaluation was carried out over a period of two weeks. At the end of the trial, the subjects underwent a post-test, the vocabulary test as same 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.

5.2. *Results*

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

Group	Pre-test	Post-test	Difference between pre- and post-test
A1	M = 19.50	M = 53.20	M = 33.70
(N=5)	SD = 5.24	SD = 6.33	SD = 11.29
B+A2	M = 19.50	M = 41.00	M = 21.50
(N=15)	SD = 4.63	SD = 12.92	SD = 11.88
A1’ (beginner)	M = 16.17	M = 57.67	M = 41.50
(N=3)	SD = 1.04	SD = 2.24	SD = 3.28
(B+A2)’	M = 16.90	M = 36.85	M = 19.95
(N=10)	SD = 2.46	SD = 12.01	SD = 12.30
A1’’ (advanced)	M = 24.50	M = 46.50	M = 22.00
(N=2)	SD = 4.95	SD = 0.71	SD = 5.66
(B+A2)’’	M = 24.70	M = 49.30	M = 24.60
(N=5)	SD = 3.29	SD = 11.40	SD = 11.66

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 of Group A1 (with SCROLL) and of 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 an improvement from pre- to post-test for both groups. Also, a difference was detected between A1 and B+A2. This indicates that the A1 students learned new words more efficiently and effectively by using SCROLL. We closely examined the students whose pre-test scores were under 21. The pre- to post-test differences between A1' and (B+A2)' were shown in Table 1. The mean score of A1' was increased. On the other hand, no difference in the pre- to post-test results was found between A1'' students and (B+A2)'' students whose pre-test scores were over 21. This indicates that vocabulary learning using SCROLL was highly effective for poor performers or beginners, comparing with high-achieving students.

Table 2. Result of the five-point-scale questionnaire for Group A1.

Question	Mean score /5	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

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 the students were 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 of the 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.

6. 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 for learning English vocabulary. Since this system is intended to be used in general domains and for life-long learning, we will apply it to other application domains, e.g. math, physics, and

science education and conduct a long-term evaluation with an enough number of subjects in the future work.

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References

Bush, V. (1945). As we may think. *The Atlantic Monthly*, *176*(1), 101–108.

Chu, H. C., Hwang, G. J., Tsai, C. C., & Tseng, J. C. R. (2010). A two-tier test approach to developing location-aware mobile learning systems for natural science course. *Computers and Education*, *55*(4), 1618–1627.

Daudelin, W., M. (1996). Learning from experience through reflection. *Organizational Dynamics*, *24*(3), 36–48.

Gemmell, J., Bell, G., & Lueder, R. (2006). MyLifeBits: A personal database for everything. *Communications of the ACM*, *49*(1), 88–95.

Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., Smyth, G., et al. (2006). SenseCam: A retrospective memory aid. *Proc. of UbiComp 2006: Ubiquitous Computing*, 177–193.

Hulstijn, J. H., Hollander, M., & Greidanus, T. (1996). Incidental vocabulary learning by advanced foreign language students: The influence of marginal glosses, dictionary use, and reoccurrence of unknown words. *Modern Language Journal*, *80*(3), 327–339.

Hwang, G. J., Chu, H. C., Lin, Y. S., & Tsai, C. C. (2011). A knowledge acquisition approach to developing Mindtools for organizing and sharing differentiating knowledge in a ubiquitous learning environment. *Computers and Education*, *57*(1), 1368–1377.

Hwang, G. J., Chu, H. C., Shih, J. L., Huang, S. H., & Tsai, C. C. (2010). A decision-tree-oriented guidance mechanism for conducting nature science observation activities in a context-aware ubiquitous learning environment. *Educational Technology and Society*, *13*(2), 53–64.

Hwang, G. J., Tsai, C. C., & Yang, S. J. H. (2008). Criteria, strategies and research issues of context-aware ubiquitous learning. E*ducational Technology and Society*, *11*(2), 81–91.

Hwang, G. J., Yang, T. C., Tsai, C. C., & Yang, S. J. H. (2009). A context-aware ubiquitous learning environment for conducting complex science experiments. *Computers and Education*, *53*(2), 402–413.

Kawamura, T., Fukuhara, T., Takeda, H., Kono, Y., & Kidode, M. (2007). Ubiquitous Memories: A memory externalization system using physical objects. *Personal and Ubiquitous Computing*, *11*(4), 287–298.

Ma, Q., & Kelly, P. (2006). Computer assisted vocabulary learning: Design and evaluation. *Computer Assisted Language Learning*, *19*(1), 15–45.

Miller, G. A., & Gildea, P. M. (1987). How children learn words. *Scientific American, 257*(3), 94–99.

Ogata, H., & Yano, Y. (2004a). Context-aware support for computer-supported ubiquitous learning. *Proc. of IEEE International Workshop on Wireless and Mobile Technologies in Education*, 27–34.

Ogata, H., & Yano, Y. (2004b). Knowledge awareness map for computer-supported ubiquitous language-learning. *Proc. of IEEE International Workshop on Wireless and Mobile Technologies in Education*, 19–26.

Ogata, H., Misumi, T., Matsuka, Y., Moushir, M. E.-B., & Yano, Y. (2008). A framework for capturing, sharing, retrieving and comparing learning experiences in a ubiquitous learning environment. *Research and Practice on Technology Enhanced Learning*, *3*(3), 297–312.

Ogata, H., Yin, C., & Yano, Y. (2006). JAMIOLAS: Supporting Japanese mimicry and onomatopoeia learning with sensors.. *Proc. of IEEE International Workshop on Wireless, Mobile and Ubiquitous Technology in Education, WMUTE'06*, 111–115.

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. *Computers and Education*, *34*(3-4), 177–193.

Wikipedia. (n.d.). *Learning log*. Retrieved 16:13:18, from http://en.wikipedia.org/wiki/Learning_log

Yoshii, M., & Flaitz, J. (2002). Second language incidental vocabulary retention: The effect of text and picture annotation types. *Computer Assisted Language Instruction Consortium Journal*, *20*(1), 33–58.