S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education. (In Press)

Ubiquitous Learning Log: What if we can log our ubiquitous learning?

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Abstract: 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.

Keywords: ubiquitous learning, ubiquitous learning log object, life log.

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 [9]. CSUL augments learning in the real world by presenting information on personal mobile devices through the Internet and surrounding environment like physical objects and sensors.

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 [11] 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 advantages CSUL called *permanency* [10]. It means that learners never lose their work unless it is purposefully deleted and all the learning processes are recorded continuously every day. However, little attention has been paid to this aspect.

The fundamental issues of CSUL are:

(1) How to record and share learning experiences that happen at anytime and anyplace.

(2) How to retrieve and reuse them in future learning.

To tackle those 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 them 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 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. This paper describes the design, the implementation and the initial evaluation of SCROLL.

Figure 1: Note for language learning.

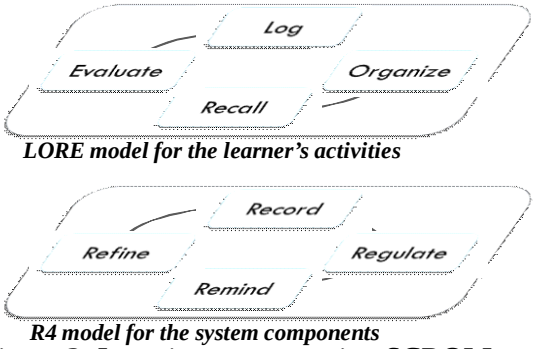


Figure 2: Learning process using SCROLL.

1. Related works

1.1 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. SCROLL, however, aims to utilize life-log data for the learning process.

1.2 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 "digital 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.

1.3 Mobile language learning

One of the application domains for mobile learning is the language learning, because it is based on situated and collaborative activities, which could occur wherever and whenever people have problems to solve or knowledge to share [15]. 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, they carry dictionaries.) [14]. Thus, mobile learning has been identified as one of the natural directions in which language learning is expected to move [16].

Miller and Gildea [8] 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 [13]. 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.

2. Design of the system

2.1 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, shown in the upper layer of figure 2) and the model of the system components called R4 (Record-Regulate-Remind-Refine, shown in the lower layer):

(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 has 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.

2.2 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.

3. Implementation

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

3.1 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.

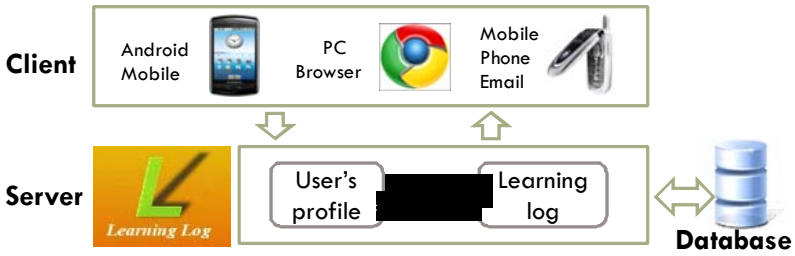


Figure 3: System configuration of SCROLL.

3.2 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. An example of ULLO is shown in the right of Figure 4. When a learner was walking around the university, he learned a new English word "fire hydrant" at a street sign. Then, he took its photo and uploaded it to SCROLL with Japanese name, English name, tag and location data. If he would like to know the Chinese name of "fire hydrant", he could register a ULLO with a question. Consequently, the system showed the question in the main window (see left of figure 4) for other learners whose native language is Chinese.

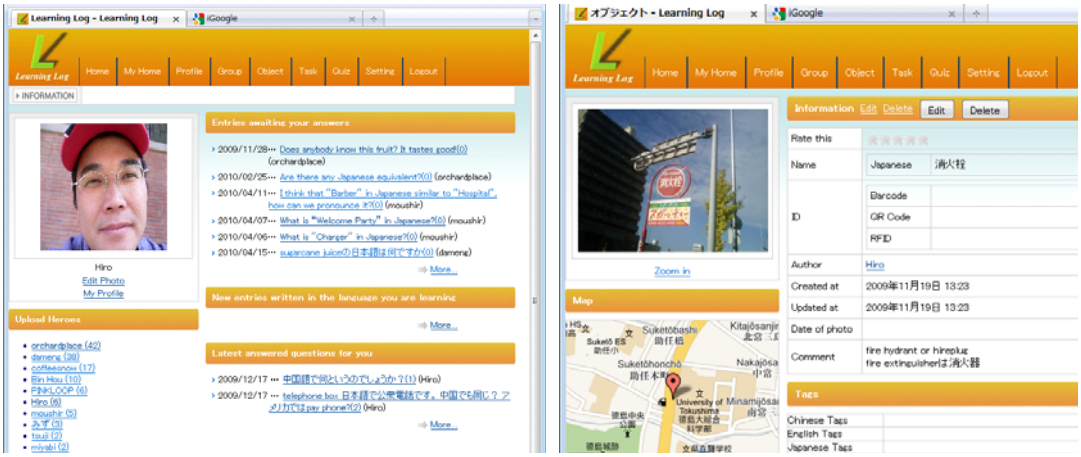


Figure 4: Interface for PC web browser. (main window (left); ULLO (right)).

3.3 System interface

This section describes the Android user interface of each component.

3.3.1 ULL recorder

This component facilitates an easy way for the learners to upload their ULLOs to the server whenever and wherever they learn. As shown in Figure 5 (2), 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.

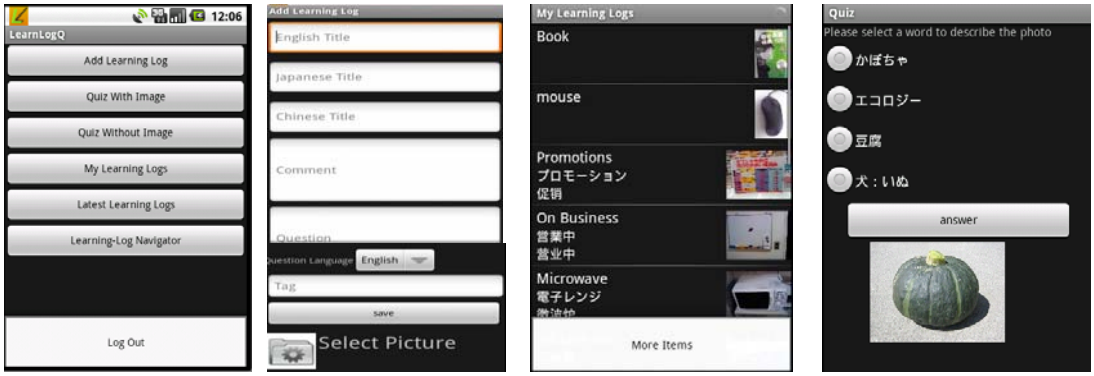
3.3.2 ULL finder

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, 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.

3.3.3 ULL reminder

The list of the learner's ULLO is shown in Figure 5(3), 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 the other learners and re-logging the other learners' ULLOs, the acquisition of the knowledge is enhanced. As shown in figure 5(4), 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 practice what they have learned, but also to recommend what the other learners have learned and to remind them to re-learn their past knowledge according to their current location and their preferred time. In order to achieve these targets, the learner can practice with the quizzes whenever they want. In addition, the client can send the learners' location information to the server all the time. Therefore, the sever side can automatically assign quizzes for the learner based on the location and time information. It notifies the learner to check the quiz by showing an alert message and vibrating his/her mobile phone. Whenever the learner moves around an area where he has experienced some objects, the system will send him quizzes regarding that objects. Furthermore, the learner can set a time schedule to receive the reminder quizzes.



(1) Start window (2) Add ULLO (3) My ULLO list (4) Quiz with image

Figure 5: SCROLL Interface of Android mobile phone.

3.3.4 ULL Navigator

LL navigator provides mobile augmented reality that allows the learner to navigate through the ULLOs. Like Wikitude [www.wikitude.org] and Sekai-Camera [sekaicamera.com], 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 6, 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 6, 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).

Figure 6: Learning log navigator (camera view (left); path to ULLOs (right)).

4. Evaluation

4.1 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.

4.2 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.

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

Group	Pre-test	Post-test	Pre and Post difference	t-value, p-value
A1	M = 19.50	M = 53.20	M = 33.70	
(N=5)	SD = 5.24	SD = 6.33	SD = 11.29	t=2.01018
B+A2	M = 19.50	M = 41.00	M = 21.50	p=.029821*
(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	t=2.920406
(B+A2)'	M = 16.90	M = 36.85	M = 19.95	p=.006964**
(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	t=0.289608
(B+A2)''	M = 24.70	M = 49.30	M = 24.60	p=.39187***
(N=5)	SD = 3.29	SD = 11.40	SD = 11.66	

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

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%).

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

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

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.

5. 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, physics, and science education and conduct a long-term evaluation with an enough number of subjects in the future work. Also we will design and develop the functions for awareness, reflection and evaluation by making learning process visible.

Acknowledgements

This research work was supported by JST PRESTO, and the Grant-in-Aid for Scientific Research No. 18700651 and 21650225 from the Ministry of Education, Science, Sports, and Culture in Japan.

References

[1] Bush, V. (1945). As We May Think, *The Atlantic Monthly*, 176(1), 101-108.
[2] Daudelin M.W.(1996). Learning from Experience through Reflection, *Organizational Dynamics*, 24(3), 36-48.
[3] Gemmell, J., Bell G., & Lueder, R. (2006). MyLifeBits: a personal database for everything, *Communications of the ACM*, 49(1), 88-95.
[4] Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., Smyth, G., Kapur, N., & Wood, K.R. (2006). SenseCam: A Retrospective Memory Aid, P*roc. of UbiComp 2006*, 177-193.
[5] Hulstijn, J.H., Holl&er, M. & Greidanus, T. (1996). Incidental Vocabulary Learning by Advanced Foreign Language Students: The Influence of Marginal Glosses, *Dictionary Use, & Reoccurrence of Unknown Words*, *The Modern Language Journal*, 80(3) 327-339.
[6] Kawamura, T., Fukuhara, T., Takeda,et al. (2007). Ubiquitous Memories: a Memory Externalization System using Physical Objects, *Personal and Ubiquitous Computing*, 11(4), 287-298.
[7] Ma, Q. & Kelly, P. (2006). Computer Assisted Vocabulary Learning: Design & Evaluation, *Computer Assisted Language Learning*, 19(1), 15-45.
[8] Miller, G. A., & Gildea, P.M. (1987). How children learn words. *Scientific American*, 257, 94–99.
[9] Ogata, H., & Yano, Y. (2004). Knowledge Awareness Map for Computer-Supported Ubiquitous Language-Learning, *Proc. of IEEE International Workshop on Wireless & Mobile Technologies in Education (WMTE 2004)*, 19-26.
[10] Ogata, H., & Yano, Y. (2004). Context-Aware Support for Computer-Supported Ubiquitous Learning, *Proc. of WMTE 2004*, 27-34.
[11] Ogata, H., & Yano, Y. (2006). JAMIOLAS: Supporting Japanese Mimicry & Onomatopoeia Learning with Sensors, *Proc. of WMUTE 2006*, 111-115.
[12] Ogata, H., Misumi, T., Matsuka, Y., El-Bishouty, M.M. & Yano, Y. (2008). A Framework for Capturing, Sharing, Retrieving and Comparing Learning Experiences in a Ubiquitous Learning Environment, *Int'l J. of Research and Practice on Technology Enhanced Learning (RPTEL)*, 3(3), 297-312.
[13] Yoshii, M. & Flaitz, J. (2002). Second language incidental vocabulary retention: The effect of picture & annotation types, *Computer Assisted Language Instruction Consortium Journal*, 20(1), 33-58.
[14] Segler, M.T., Pain, H., & Sorace, A. (2002). Second Language Vocabulary Acquisition & Learning Strategies in ICALL Environments, *Computer Assisted Language Learning*, 15(4). 409 – 422.
[15] Sharples, M. (2000). The Design of Personal Mobile Technologies for Lifelong Learning. *Computers & Education*, 34, 177-193.
[16] Stockwell, G. (2007). Vocabulary on the move: Investigating an intelligent mobile phone-based vocabulary tutor, *Computer Assisted Language Learning*, 20(4), 365 – 383.
[17] McCrindle, A.R. & Christensen, C.A. (1995). The Impact of Learning Journals on Metacognitive and Cognitive Processes and Learning Performance, *Learning and Instruction*, 5(2), 167–185.
[18] Suwan, S. & White, R. (1994). *The Thinking Books*. Falmer Press.
[19] http://en.wikipedia.org/wiki/Learning_log