Design and Development of the Learning Log Dashboard for a Ubiquitous Learning Environment

March, 2016

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List of Papers

Main paper

[1] "Dashboard for Analyzing Ubiquitous Learning Log"

Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata, International Journal of Distance Education Technologies (IJDET), Vol. 14, No. 3, IGI Global (2016, in press).

Secondary Papers

[1] "Learning Log Dashboard: to see your own progress"

Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata, Proceedings of the 22nd International Conference on Computers in Education (ICCE 2014), pp. 528-532, ICCE 2014 Organizing Committee, Japan, (2014).

[2] "Let's Find Suitable Word Using LAD"

Erdenesaikhan Lkhagvasuren, Kousuke Mouri, Hiroaki Ogata, Kenji Matsuura, Proceedings of the 11th International Conference on Knowledge Management (ICKM 2015), pp. 7-8, International Council on Knowledge Management, (2015).

Co-authored papers

[1] "Japanese Onomatopoeia Learning Support for International Students Using SCROLL"

Noriko Uosaki, Hiroaki Ogata, Kousuke Mouri, Erdenesaikhan Lkhagvasuren, Proceedings of the 23rd International Conference on Computers in Education (ICCE 2015), pp.329-338, Asia-Pacific Society for Computers in Education, (2015).

[2] "Career Support for International Students in Japan Using Ubiquitous Learning Log System"

Noriko Uosaki, Hiroaki Ogata, Kousuke Mouri and Erdenesaikahan Lkhagvasuren, Proceedings of The 15th IEEE International Conference on Advanced Learning Technologies (ICALT2015), pp. 78-82, IEEE, (2015).

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Acknowledgements

This dissertation work is completed at SUM Laboratory in C-Group, the Department of Information Science and Intelligent Systems, Graduate School of Advanced Technology and Science, Tokushima University in Japan. I would like to thank all the people who contributed in some ways to the work described in this dissertation.

I do owe numerous people during the course of my thesis work. I would like to take this opportunity to express my sincere appreciation to them. I am very grateful for spending their precious time on reading my thesis.

First, I would like to express my sincere gratitude to Prof. Tetsushi Ueta, chief examiner of my dissertation committee for his insightful advices and academic support for my research. I would also like to thank the vice-examiners of my committee, Prof. Masami Shishibori and Prof. Kenji Matsuura for their valuable comments and advices.

I would like to express my deepest gratitude to my advisor, Prof. Kenji Matsuura. Without his infinite encouragements, great supports and inspiring advices all through these years, this work would not be possible.

This research work was also supported by suggestions and helpful advices from Prof. Tetsushi Ueta and Prof. Masahiko Sano. I would like to express my sincere gratitude to them.

Very special thanks goes out to Prof. Hiroaki Ogata for his encouragements and giving me this great chance to study in Tokushima University. It is truly made a difference in my life.

I also would like to thank all the members in my research group: Kousuke Mouri, Mengmeng Li, Bin Hou, Noriko Uosaki, Songran Liu, Nakayashiki Yoshihiro, Keita Yamada, Shinya Yoshioka, Yousuke Seki, Nurul Azira Binti Abd Aziz and other staffs and members of SUM in C-Group and B4 Laboratories.

I would like to thank Prof. Hiroaki Ogata again for supporting me with being awarded the MEXT scholarship. Therefore, I did not need to worry about the financial issues while doing my study.

Finally, I would like to thank my parents, husband and sons for their continuous support and encouragement. Without their encouragement and understanding, I would not have been able to pursue my dream.

Chapter 1

Introduction

1.1. Background

Mobile and ubiquitous technologies have been applied to a wide range of learning fields such as science, social science, sport, history and language learning. Learning supported by ubiquitous technologies is called ubiquitous learning.

This paper introduces a research on supporting ubiquitous learning with a dashboard. It is a part of the former project "Ubiquitous Learning Log for You" (Learning Log for You Project, Ogata, Li, Hou, Uosaki, El-Bishouty, & Yano, 2010). The project started in October 2009. Learning log was originally designed for children as a personalized learning resource (Learning log - Wikipedia,the free encyclopedia,n.d.). Learning log was set by teachers to support their children record their thinking and learning (Beck,1998). In this learning log, the logs were visually written notes of learning journals.

Moreover, Ogata et al. develop a system named SCROLL (System for Capturing and Reminding Of Learning Log) in order to help learners log their learning experiences with photos, audios, videos, and sensor data. Each recorded object in SCROLL is called ubiquitous learning log object (ULLO) that is shared with others. A ubiquitous learning log object (ULLO) is a digital record of what a learner has learned in the daily life using ubiquitous technologies (Ogata, Li, Hou, Uosaki, Moushir, & Yano, 2010). For instance, a ULLO can be an English word or a part of Japanese sentence taken down by a language learner. Ubiquitous learning log (ULL) is a set of ULLO.

SCROLL enables learners to receive personalized quizzes and to answer them. Moreover, SCROLL is a client-server application and it runs on different platforms including mobile phones and PCs. The target learners of SCROLL are international students in Japan.

Regarding to Ogata's work (Ogata, Li, Hou, et al., 2010), even though it is easy to capture the learning data ubiquitously with the aid of technology development, reusing and retrieving the learning data are still problematic.

This research explores the value of the displaying, analyzing, reusing learning data and tracking self-reflection of learners' learning activities in a ubiquitous learning environment. Here the learning data includes both the knowledge data and the meta-data of learning such as the geographic location, time and so on.

1.2. Objectives

Last decade, a lot of researchers have been investigating the development of the ubiquitous learning environments (Chu, H. C. 2014; Hoppe, Joiner & Sharples, 2003; Hwang et al., 2008; Ogata & Yano, 2004; Sharples, Taylor, & Vavoula, 2007; Wu, Hwang, & Chai, 2013; Li, Zheng, Ogata & Yano). For example, Chiou et al. report their ubiquitous learning system which enables students to study butterflies using PDA (Personal Digital Assistance) at a butterfly museum in natural science course in Taiwan. With their developed system, the learners can learn and identify the features of butterflies (Chiou et al., 2010). In this way, most of the research projects on ubiquitous learning offer an advantage in association with the real world objects.

Nevertheless, their studies focus mainly on gathering the learning histories using up-to-date technologies. Moreover, there haven't been enough research works related with reflection of learners' and analysis of ubiquitous learning histories in the environment.

In this research, the focus is how to apply ULLs regarding analysis and feedback for students at first. In addition, then, how to track learning activities and analyze them in traces of reflection thereof are studied. However, there are little contributions directly following these motivations.

Therefore, this paper originally proposes a learning log dashboard (L2D) system in the study (Lkhagvasuren, Mouri, Ogata & Matsuura, 2016). The main objective of this paper is to design and develop L2D system applied for a ubiquitous learning environment. Concrete targeting domain is a language learning. It reuses, analyzes and visualizes traces of learning activities in order for learners to promote awareness and enable them to reflect on their own activity and induce them to recall what they have learned.

By implementing the system in real world, this paper aims to contribute in solving the main problem, as mentioned before: lack of studies in the ubiquitous learning analytics (ULA). In other words, studies in the ULA haven't been realized yet to display, analyze and trace self-reflection of their own learning activities with their contexts in accordance with their learning situations in the real world. Therefore, this paper proposes the value of the displaying, analyzing and tracing self-reflection of learners' learning activities in the ubiquitous learning environment.

1.3. Dissertation outline

This dissertation is organized as follows.

- Chapter 1 is introduction. The background and objectives of this research are introduced in this chapter.
- Chapter 2 describes related works. This chapter introduces several applications for mobile and ubiquitous learning. They provide technology enhanced vocabulary learning and learning analytics dashboard applications.
- Chapter 3 introduces the former project - Ubiquitous learning log for you in detail. This research uses most of the learning functionalities of the previous work – SCROLL (System for Capturing and Reminding Of Learning Log), so it is necessary to introduce the whole project.
- Chapter 4 explains the design and implementation of this research. The user interface is also introduced in this chapter.
- Chapter 5 introduces an evaluation. Both the design and results of the experiment are presented. The effectiveness of the system is investigated in this chapter.
- Chapter 6 concludes this dissertation. Both conclusions and future work are given out.

Chapter 2

Related Works

How to reuse learning logs and how to track and analyze traces and reflection of the learners' activity are two main issues to explore in this research. Therefore, this chapter firstly reviews the previous works in this field.

As mentioned in chapter 1, Ogata et al. (2014) report that it is important for learners to recognize what and how they have learned by analyzing and visualizing past ubiquitous learning logs, so that they can improve their learning (Ogata et al., 2014). Similarly, Aljohani and Davis (Aljohani et al., 2012) describe learning analytics called Ubiquitous Learning Analytics (ULA) in order to analyze enormous learning data including contextual information. One of issues of ULA is how to visualize, analyze, recommend and trace learners–to-context and learners-to-context-based learning logs interactions. To tackle these issues, Mouri et al. analyze ubiquitous learning logs using spatio-temporal data mining and social network analysis (Mouri et al., 2015a, 2015b, 2015c). Their studies found relationships between learners and ubiquitous learning logs. By detecting the relationships based on ULA, their developed system succeeded to recommend proper contexts to learners.

However, studies in the ULA haven't been realized yet to display, analyze and trace self-reflection of their own learning activities with their contexts in accordance with their learning situations in the real world. Hence, this paper proposes the value of the displaying, analyzing and tracing self-reflection of learners' learning activities in the ubiquitous learning environment.

2.1. Mobile and ubiquitous technologies

Mobile generally means portable and personal. Hence the mobile technology can refer any portable devices that you can carry easily with you wherever you go.

New communication technologies such as 4G (fourth generation), Bluetooth have enabled various kind of devices which are portable (e.g., laptop computers, PDA (Personal Digital Assistance), smart phones, iPad, GPS (Global Positioning System) devices). These technologies enable users to access information that correspond to their needs on an "anytime, anywhere" basis, so then it comes to be called ubiquitous.

Nowadays, the challenge of future computer systems is not only to supply information "anytime and anywhere", but also to recommend optimal content to the user as a proper way at right time.

The word “ubiquitous” means being or existing everywhere at the same time. Poslad describes that "ubiquitous computing" enables information to be made available everywhere and supports human usage of ICT (Information and Communication Technology) systems (Poslad, 2011).

Ubiquitous computing evolution has recently been accelerated by improving the emergence of flexible software architecture, open networks, Wi-Fi technologies, advanced electronics, continuous increasing in computing power and improved battery technology. Using those technologies, an individual learning environment could be embedded in daily real life (Ogata & Yano, 2004).

Ubiquitous computing also helps in making it possible to have people interact with everything around them. It is because the computing devices are integrated into the surrounding environment. Everything that is in the ubiquitous computing environment can be accessed by ubiquitous technology including sensor technology and identification technology and other technologies (cf. Figure 2.1).

A mobile learning technologies based on practical usages were started in early 2000s (Ogata & Uosaki, 2012). It provides wide range of approaches and patterns such as providing learning contents by mobile phone short message service (SMS) (Levy & Kennedy, 2005; Cavus & Ibrahim, 2009), emails (Houser, Thornton & Kluge, 2002), connecting people of same interest (habit and hobby) and creating learning communities to encourage lifelong learning.

In today's world a great revolution is occurring in the mobile device with the release of new generation smart phones represented by iPhone and Android. The new generation smart phones accommodate learners with many advanced functions such as the virtual keyboard, GPS navigation, a full browser, screen capture, multi-touch, video calling and record notes. It allows learners for immediate access to data online wherever one is at home, library or on the road. Moreover, those functions to support learners to share knowledge with others and remind them what they have learned via the learning content (Li at al., 2011).

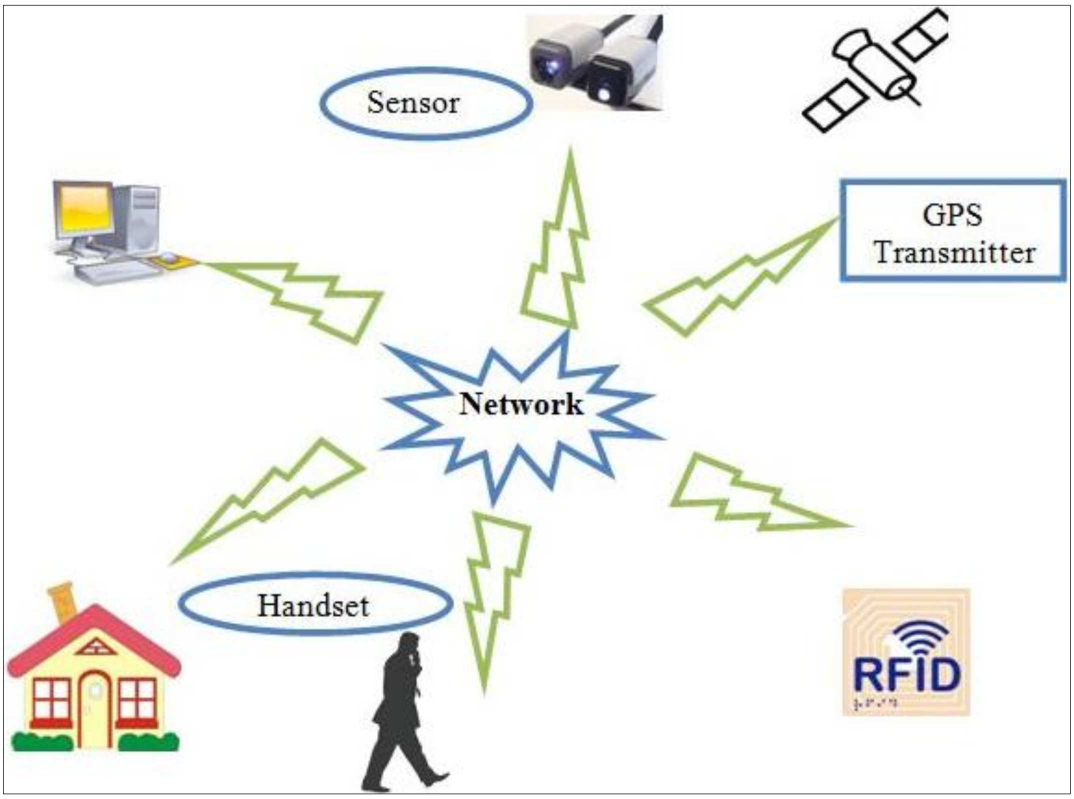

Figure 2.1. Ubiquitous learning

2.2. Mobile and ubiquitous learning

There are many definitions for mobile and ubiquitous learning. One of the most common and proper definition for ubiquitous learning is that 'learning using ubiquitous technologies to facilitate learning' and most accepted definition is 'learning in anywhere and at any time' (Hwang, Tsai & Yang, 2008; Shih, Chu, Hwang & Kinshuk, 2010; Ogata & Yano, 2004a).

Ubiquitous learning (often abbreviated as u-learning) is based on ubiquitous technology. A ubiquitous learning environment enables anyone to learn at anyplace at anytime. In the evolution of the new technologies, learning styles have developed from electronic learning (e-learning) to mobile learning (m-learning) and from mobile learning (m-learning) to ubiquitous learning (u-learning) (Yahya, Ahmad & Jalil, 2010).

When the ubiquitous technology is used in learning environment, it is usually named Computer Supported Ubiquitous Learning (CSUL) or Ubiquitous Learning. According to Ogata and Yano, the main characteristics of ubiquitous learning are shown as follows (H. Ogata & Yano, 2004):

1. **Permanency:** Unless the learner deletes his/her own work, it is not lost. Moreover, all the learning processes are recorded all the time.
2. **Accessibility:** Learners can access their learning materials from anywhere and anytime based on learner's request. Hence, ubiquitous learning involved is self-directed.
3. **Immediacy:** With the aid of flexible accessibility of ubiquitous learning, learners can get any information immediately. It enables learners to find what is needed and to solve problems quickly.
4. **Interactivity:** Learners can communicate and ask information from experts, teachers or peers who use the form using real time or non-real time communication ways. Therefore, the knowledge become more available.
5. **Situating of instructional activities:** Learners can combine learning with their daily life. The problems and knowledge are natural or authentic. By identifying problems, learner can make relevant actions properly.

Main difference between m-Learning and u-Learning is that m-Learning enables learners to learn at anytime, anywhere but it is not connected with learner's context. But u-Learning provides the proper and right information according to the learner's context by getting information from the surrounding environment (Ogata, 2010).

Table 2.1. Researches categorized by the target learning field

Field	Citations
Science	Hwang et al. (2010), Chu, Hwang & Tsai (2010)
History	Hwang & Chang (2011)
Zoo/Museum	Chiou et al. (2010), Hall, T. & Bannon, L. (2006), Reynolds, Walker & Speight (2010), Kusunoki et al. (2002), Suzuki et al. (2009), Hlavacs (2005).
Sport	Chi (2005); Gotoda et al. (2009); Gotoda et al. (2010); Sugano et al. (2006).
Communication	Bollen et al. (2004); Lan et al. (2008); Ogata et al. (2008); So (2009).

To date, a lot of learning fields such as science, history, sports (cf. Table 2.1) have applied ubiquitous technology. Moreover, most often language learning field has been applying ubiquitous technology and this paper will supply details in Section 2.3. A comparison of u-learning and m-learning is shown in Table 2.2 (Liu 2009).

In addition, using those technologies allows the learning environment to be embedded in the daily life. This paper approach is technology enhanced language learning. Therefore, next subsection describes vocabulary learning.

Table 2.2. Comparison of u-learning and m-learning

Characteristic	Ubiquitous learning	Mobile learning
Permanency	The learning process, learner behaviors and environmental situations are recorded in the learning system permanently.	The learning process, learner behaviors and environmental situations are recorded in the learning system permanently.
Accessibility	Network is ready in the whole environment. The learners can access information from any location and at any time.	The learners must link with networks to access information.
Immediacy	The learners can immediately access useful information in real time and get an immediate response from the learning environment.	The learners must spend considerable time accessing learning contents.
Interactivity	The learners not only interact with teachers, peers, learning devices, digital content, real environment and virtual objects in real world, but also collaboratively complete a common task and share their experiences with each other.	The learners can only interact with teachers, peers, learning devices and digital content.
Situation	The learning environment understands the situation of the learners by detecting their status via the sensor network. The learners can gain authentic knowledge in real environment.	The learning environment cannot understand the situation of the learners.
Calmness	The learning devices are quiet, invisible agents that recede into the background of the learning environment.	The learners get learning content by operating the learning devices.
Adaptability	The learners use any devices to learn in the changed learning environment.	The learners use specified devices to learn in the fixed learning environment.
Seamlessness	The learning process is not interrupted when the learner is moving.	The learning process is interrupted when the learner's position changes.
Immersion	The learners experience real feelings and emotions as they do in real world through interacting with the virtual objects and the environment.	The learner can only employ mobile devices to interact with the virtual objects and the environment.

Table 2.2. Comparison of u-learning and m-learning. Adapted from "A context-aware ubiquitous learning environment for language listening and speaking" by Liu, T. Y. 2009. *Journal of Computer Assisted Learning*,*25*(6), 515-527. Copyright by John Wiley & Sons.

2.3. Vocabulary learning

Vocabulary teaching and learning are a very challenging and difficult process while learning any new language. Therefore, learners try to find which vocabulary learning method is more useful or even the best one. However, not surprisingly, their first way is to try to memorize every word that they do not know.

It is argued that vocabulary should be learned "explicitly" and "implicitly". Implicit learning is related with natural, effortless and meaning focused learning and specially based on incidental learning. Explicit learning implies that learning requires more intentional mental effort than simply engaging in meaning focused activities (Ma & Kelly, 2006). This section provides the literature review of vocabulary learning which is supported with computers, and it describes mobile and ubiquitous vocabulary learning.

2.4. Technology enhanced language learning

Vocabulary is the important component of second language (L2) proficiency. Learners learn new words and phrases so that they can improve their listening, speaking, reading and writing skills. Learners can enlarge their vocabulary formally at the classroom and informally outside of class activities. Moreover, learning vocabulary is one of the most commonly learning area, which can be taught by technologies and the range of the use of technologies is broad including millions of applications, online activities and computer mediated communication (CMC) technologies. Ma and Kelly (2006) describe three types of CALL (computer assisted language learning) based vocabulary learning applications: *multimedia packages with vocabulary*, *written texts with electronic glosses* and *dedicate vocabulary programs*. Multimedia packages are commercialized programs. The criticism is often made about that these programs are lack of pedagogical basis and their operation is not closely connected with learners (background information, such as the age, sex, cultural background, other foreign language knowledge). Written Texts with Electronic Glosses are probably the most popular type in research-based programs. These programs are written texts with hyperlinks and equipped with an electronic dictionary.

However, written texts with electronic glosses are productive vocabulary learning that this type of program cannot address adequately. Dedicate vocabulary programs are often based on research. For instance, Groot (2000), where the three stages of acquiring a new word in the mental lexicon: "noticing", "storage" and "consolidation", are simulated by the CALL program "CAVACO". The learning process is composed of four stages in sequential order: "deduction", "usage", "examples" and "retrieval". Those systems mainly focus to enhance incidental vocabulary learning outside of the classrooms. There are more examples of language learning systems using ubiquitous technologies, such as TANGO (Ogata et al., 2010), JAPELAS (Ogata & Yano, 2004a, 2004b) and JAMIOLAS (Ogata and Yano, 2006).

TANGO (Tag Added learNinG Objects), which allows learners to move with their PDAs (personal digital assistant) and to communicate with the surrounding objects using RFID (Radio-frequency identification) tags. Then it gives some questions to the learner related to the revealed objects that s/he usually uses during the daily life to improve his/her vocabulary ability.

JAPELAS (Ogata and Yano, 2004a, 2004b) facilitates the learners to learn Japanese polite expressions. This system recommends the suitable polite expressions by detecting the social status, the social distance and the formality of the situation.

JAMIOLAS (Ogata, Miyata, Bin & Yano, 2010) provides the learners with the appropriate Japanese mimicry and onomatopoeia expressions, which are derived from the learner’s situation and the sensor data such as the light, the rain, the humidity and the temperature.

Although the systems are useful in certain environments, it's not easy to apply them in practice. Ogata (2011) and his colleagues began to research a more practical research project called SCROLL in Japan in order to store intentionally what learners have learned as ubiquitous learning logs (ULLs) and consequently reuse them. Besides, in the 1980, spaced repetition began to be implemented with CALL software based solution. In order to exploit the psychological spacing effect, spaced repetition is used. Spaced repetition is one of learning technique which includes intervals of time between subsequent review of previously learned material. When a learner must acquire a large number of items and retain them indefinitely in memory, spaced repetition is usually applied (Spaced repetition). Graduated-interval recall is a kind of spaced repetition published by Paul Pimsleur in 1967 (Pimsleur, 1967). Similarly, Leitner (1973) designs his "Leitner system", an all purpose spaced repetition learning system based on flashcards. The Leitner system is a simple implementation of the principle of spaced repetition. For the Leitner system, incorrectly answered cards return to the first box for more active review and repetition, on the other hand correctly answered cards move to the next box (Leitner system) (cf. Figure 2.2).

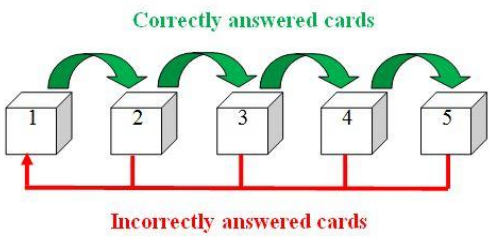

Figure 2.2. Leitner system

The intervals published in Pimsleur's paper were: 5 seconds, 25 seconds, 2 minutes, 10 minutes, 1 hour, 5 hours, 1 day, 5 days, 25 days, 4 months (113 days), and 2 years. Based on this theory, L2D system sends a message to learners that reminded them to recall and practice the previous ULLs.

2.4.1. Mobile and ubiquitous vocabulary learning

According to Sharples (2010), mobile learning is the research of how to harness personal and portable technologies for effective education.

Learners who are learning second language (L2) and mastering any language have to get a lot of input compared to their output. There are many learners who spend long time to learn their target language. The recitation of words, sentences, phrases, grammar, explanation of syntax and reading of papers cannot enhance learners' learning motivation. Therefore, the author believes that by using mobile and ubiquitous technologies, learners can be motivated and encouraged.

Mobile and ubiquitous technologies offer a new way to infuse learning into a daily life. Those technologies can be blended together to support and motivate learners anytime and anywhere. For this reason, mobile and ubiquitous learning environments and activities have been successfully implemented to aid learners language learning.

According to Tan et al. ubiquitous learning supports self-learning and allows learners to get context information. Therefore, ubiquitous learning does not only assist learners to reach their learning goals, but also improve their learning skill to find out new information and solve problems (Tan et al. 2007).

The following can be cited as examples of such environments or activities: a personalized intelligent m-learning system for supporting effective English reading

(Chen & Hsu, 2006), peer-assisted learning system for collaborative early EFL reading (Lan et al. 2007), a highly interactive learning activity to support reading for ESL (English as L2) learners (Chang et al. 2007) and a learning content with both written and pictorial annotation to help learners with higher verbal ability (Chen et al. 2008).

Besides, a lot of studies have developed mobile language learning environments to enhance vocabulary ability (Thornton & Houser 2005; Chen & Chung 2008), to improve reading comprehension ability (Lan et al. 2007; Chen & Hsu 2008), to enhance sentence making ability (Morita 2003), to increase learning opportunities (Stockwell 2007), to eliminate learning time and space limitations (Rosell-Aguilar 2007), and develop a podcast environment for supporting English listening (Edirisingha et al. 2007).

2.4.2. Ubiquitous learning environment

According to Jones & Jo (2004), a ubiquitous learning environment is a setting in which students can be totally involved. To define:

- Ubiquitous= pervasive, omnipresent, ever present, everywhere
- Learning = educational, instructive, didactic, pedagogical
- Environment = surroundings, setting, situation, atmosphere

Therefore, a ubiquitous learning environment (ULE) is a situation or setting of pervasive (or omnipresent) education (or learning).

Besides providing learning any time and everywhere, ubiquitous computing technology should focus on providing convenient learning materials and contents to learners (Ogata, Yin, EI-Bishouty & Yano, 2010). Additionally, ubiquitous learning environment conforms the pedagogical theory of constructivism (Hwang, 2008; Jones & Jo, 2004).

2.5. Learning analytics dashboard applications

According to the 1st International Conference on Learning Analytics and Knowledge, "Learning analytics (LA) is the measurement, collection, analysis and reporting of data about learners and their contexts, for proposes of understanding and optimizing learning and the environments in which it occurs". Moreover, increasing learner motivation and assisting learners with self-reflection on their learning processes is an important driver for learning analytics research. Duval mentions "Learning analytics focuses on collecting traces that learners leave behind and using those traces to improve learning" (Duval, 2011; Santos, Govaerts, Verbert, & Duval, 2012; Santos, Verbert, Govaerts, & Duval, 2013; Siemens & Long, 2011; Siemens et al., 2011; Verbert et al., 2014).

According to Few (2007), "A dashboard is a visual display of the most important information needed to achieve one or more learning objectives, consolidated and arranged on a single screen so the information can be monitored at a glance" (p.1).

It can be said that learning dashboard is a specific class of "personal informatics" applications (Li, Dey, & Forlizzi, 2010). These generally support learners in gathering personal information about several aspects of their life, behavior, habits, thoughts, and interests (Li, Dey, Forlizzi, Höök, & Medynskiy, 2011). Personal informatics applications assist learners to improve self-knowledge by supporting tools for the review and analysis of their personal history. Self-knowledge has many positive effects, for example, supporting insight, increasing self-control

(O'Donoghue & Rabin, 2003), and encouraging positive behavior (Seligman & Darley, 1977).

At the same time, there is a growing related movement, named "quantified self", "self-tracking", "auto-analytics", "body hacking" and "self-quantifying", across several domains, such as medicine (Purpura, Schwanda, Williams, Stubler, & Senger, 2011), sports (Trickler, 2013), learning (Duval, 2011). Quantified self focuses on collecting traces that users leave behind and using those traces to improve their experiences (Duval & Verbert, 2012). Traces are left through online activities, such as Facebook posts, comments, Twitter tweets, by web navigation captured in log files, by registrations from sensors (GPS, accelerometer, etc.).

Up to now, various dashboard applications have been developed to support learning or/and teaching. According to Few, such dashboards present graphical representations of the current and historical state of a learner or a course to support flexible decision making (Few, 2006). For example, FASTDash is developed to enhance team awareness while working on software project. It significantly increases the effort for programmers to gain and observe an awareness of how their shared workspace is being changed and who is changing them (Biehl et al., 2007).

Most of these dashboards are developed to facilitate instructors to gain a better overview of course activity, to reflect on their teaching practice, to reveal learners at risk of dropping out or need additional support to increase their success and confidence in the learning process. The application of these dashboards is in traditional face to face learning, online learning or blended learning settings. Here this paper would like to highlight some learning dashboards. Duval (2011) and his team have done abundant of research in this field. Their studies cover learning activities based on visualization and learning tools which supports self-reflection.

Examples include that the former type can be represented by analyzing and visualizing learner activities (Govaerts et al., 2010) and the development of specific tools and resources in open learning analytics (Siemens et al., 2011). The latter one, which includes Step Up! (Santos et al., 2013), is developed to support both teachers and learners. StepUp! tracks learners' social activities such as twitter, wikis, blogs and web 2.0 tools. In addition, StepUp! aims to help learners and teachers to steer the learning process. Moreover, Verbert et al., overview and discuss future research opportunities of learning dashboards (Verbert et al., 2014).

iTree visualizes contributions of learners by a tree (Nakahara, Hisamatsu, Yaegashi, Yamauchi, 2005). Kosba et al., develop a framework called TADV (Teacher ADVisor) that collects data from a course management system and uses the data to help students and course instructors. TADV also facilitates teachers to successfully manage their distance courses (Kosba, Dimitrova and Boyle, 2005).

SAM (Student Activity Meter) visualizes data tracked in a course for teachers and learners. It also can assist teachers to reveal learners doing well and risk. Figure 2.3 shows time consuming of learners (grey lines) over the course period. The statistics of time spent and document use are shown on the right side. Furthermore, their evaluation results show that there is large potential for visualization of tracking information, not only to help teachers and learners, but also in other fields like personal informatics and quantified self.

Table 2.3. Comparison of the related works

Dashboard	**Target users**		**Tracked data**				Content analyzer
	Teachers	Students	Time spent	Social interaction	Exercise results/quizzes	Location	
Teacher Advisor	+	-	-	+	+	-	-
CALM system	-	+	+	-	+	-	-
Signal	+	+	+	+	+	-	+
StepUp	+	+	+	+	-	-	-
Moodle dashboard	+	-	+	+	+	-	-
L2D	-	+	-	+	+	+	+
Virtual classroom	+	-	+	-	-	-	-
Tell Me More	-	+	-	-	+	-	-
SNAPP	+	-	-	+	-	-	-
SAM	+	+	+	-	-	-	-
iTree	-	+	-	+	-	-	-
Early warning system	+	-	-	-	+	-	-

Note: + =supported; - =not supported.

The Social Networks Adapting Pedagogical Practice (SNAPP) visualizes the evolution of social interactions among learners in online discussion forum interactions (Dawson, Bakharia & Heathcote, 2010). Virtual classroom dashboard is based on visualization techniques and presents current activities of learners in classroom. The dashboard helps teachers to control their learners time spent and it groups the learners by activities and shows each activities by using a bubble and Chernoff faces (France, Heraud, Marty, Carron, & Heili, 2006).

Moodle dashboard is developed in the learning management system that tracks online activities to support educators (teacher and teaching assistants). Educators can watch their students' performance (submitted assignments, grades from practical work, attendances and so on) by using various visualizations (Podgorelec & Kuhar, 2011).

Figure 2.3. The Student Activity Meter (SAM)

Figure 2.3. The Student Activity Meter (SAM). Adapted from " The student activity meter for awareness and self-reflection" by Govaerts, S., Verbert, K., Duval, E., & Pardo, A. In *CHI'12 Extended Abstracts on Human Factors in Computing Systems*, pp. 869-884. Copyright 2012 by Association for Computing Machinery.

A small number of dashboards are developed to support learners. CALM system (Kerly, Ellis, & Bull, 2007) is a dashboard that is developed on top of an intelligent tutoring system. It supports awareness, reflection and sense making. Figure 2.4 illustrates CALM system user interface.

Tell Me More is language learning application which tracks results of exercises and provides feedback of all exercises of program to the student (Lafford, 2004).

“Early warning system” is a system for educators, which is developed by Macfadyen & Dawson (2010). This system reveals the relationship between students' online activities and their academic status. One of the more well-known examples of how student data has been used to enhance learning is the “Signal” dashboard application (Arnold, 2010). The system identifies academic and behavioral issues early and inform students and instructors.

The vocabulary of a learner increase highly by learning many words everyday and sharing them with others. It creates a demand to analyze the ULL to provide learners with suitable learning logs in accordance with their learning habits, context, time and location. Therefore, Learner's Assistant Dashboard (LAD) that is one of the learning analytics tool is proposed (Lkhagvasuren, Mouri, Ogata & Matsuura, 2015). Siemens et al. propose an approach for reinforcing relationship between analytics engine and the dashboard (Siemens et al., 2011). This paper considers the dashboard approach for reinforcing relationships between analytics engine of SCROLL and LAD. That way, learners and teachers can grasp easily their learning status and links among them. The main goal of LAD is to recommend suitable learning logs for learners. Therefore, LAD can help learners to discover related, important learning resources. Furthermore, it is essential to conduct depth researches and experiments on evaluation of LAD's efficiency.

Moreover, it is difficult to solve the issue how to facilitate language learners reveal appropriate learning contents. When learners study with SCROLL, they do not know whether the learning contents are appropriate for them or not. SCROLL has about 28337 learning logs (last checked 2016.01.06).

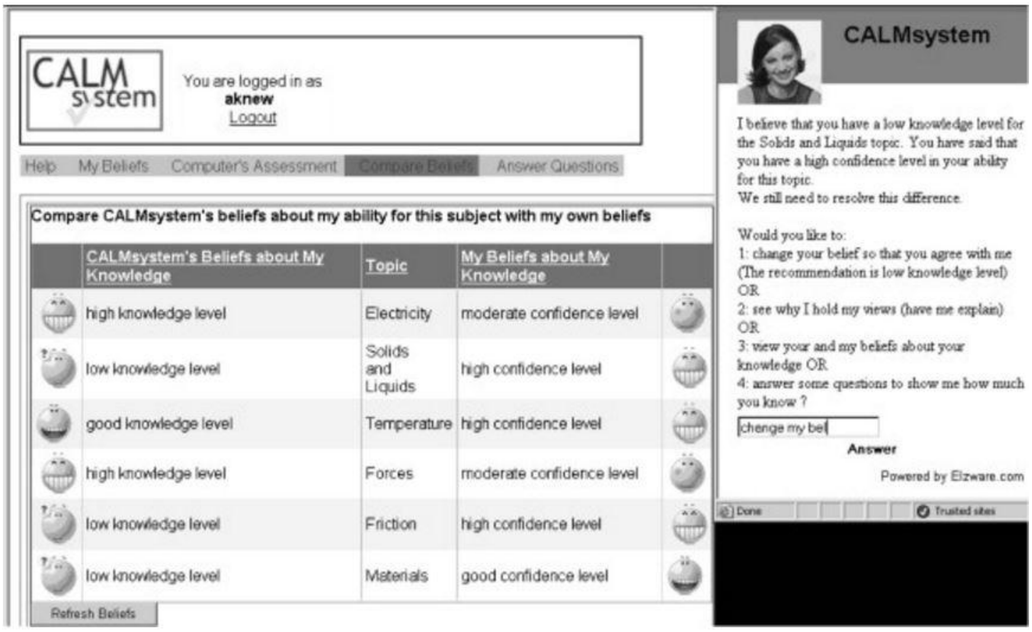

Figure 2.4. The CALM system user interface showing system and user beliefs about the user's knowledge on six topics, and the system chatbot.

Figure 2.4. The CALM system user interface showing system and user beliefs about the user's knowledge on six topics, and the system chatbot. Adapted from "CALMsystem: A Conversational Agent for Learner Modelling", Proceedings of AI-2007, 27th SGAI International Conference on Innovative Techniques and Applications of Artificial Intelligence by Kerly, A., Ellis, R. & Bull, S. 89-102. Copyright 2007 by Springer Verlag.

Main difference of these dashboard and L2D is that data of these dashboard is not used in collecting contextual data, but L2D is used in collecting contextual data. Thereby, L2D can analyze not only learning data accumulated in formal learning but also learning data accumulated in informal learning. By providing personalization and adaptive learning in accordance with the analysis, the author believes this lead to enhancing learners' learning opportunities and language skills. In addition, L2D does not only show learner's activities but also offer a learner to work again on the learning contents according to the analysis. For example, a learner can work on his/her previous incorrectly answered words.

In order to find out how learners learn Japanese language, a questionnaire survey was conducted to the international students who have studied at Tokushima

University. The questionnaire was conducted in October 2015. Twenty international students participated in the questionnaire. It reveals that only 35% (cf. Figure 2.5) felt no difficulty to find suitable words and also 20% (cf. Figure 2.6) felt no difficulty in learning Japanese at all when they are studying Japanese.

L2D uses the ULL of learners in SCROLL to enable learners to see their own progress at a glance such as updates, success, statistics, information and the number of ULL they need to practice. Thus, a learner will repeatedly practice words by the quizzes in order to avoid from repetitive mistakes, and eventually s/he will be greatly improved. Therefore, L2D gives learners an easy way to find the next best thing to do and to increase their motivation. The driver uses a car dashboard to recognize and make decision. Likely dashboard of a car plays a main role in our car driving process; learners will strongly rely on L2D to operate on their learning activity successfully.

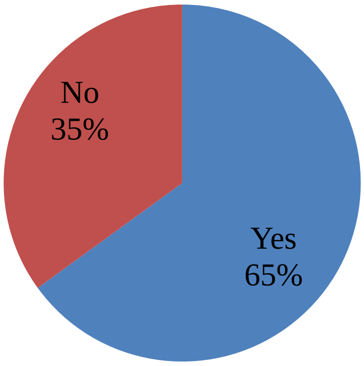

Figure 2.5. Is it difficult for you to find suitable words when you are studying Japanese?

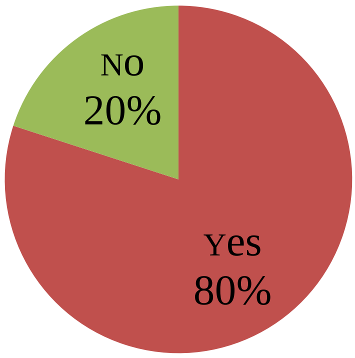

Figure 2.6. Are you feeling difficulty for learning Japanese?

2.6. Learning analytics in mobile and ubiquitous learning environments

As mentioned before, learning analytics is one of the promising techniques that has been developed. LA effectively utilizes the numerous amount of data about its participants, such as learners and teachers, its facilities and curriculum.

The number of smart-phone users worldwide will surpass 2 billion in 2016 (emarketer.com). Therefore, present is the best time to deeply research MLA (mobile learning analytics) and ULA in order to enhance academic achievements as well as solve the academic problems that a student might face. As Aljohani et al. mention, in terms of MLA, even though mobile learners' data creates main source, non-mobile learners' data also plays a role. Currently, ULA analyses data of mobile learners. Furthermore, it focuses on analysis of contextual mobile learners' data. In addition, In many university systems, ULA uses existing non-mobile learners' data. Hence, it can be concluded that ULA is more comprehensive than MLA. In addition, Aljohani et al. propose a Mobile and Ubiquitous Learning Analytics Model (MULAM) for analyzing mobile learners’ data (Aljohani, 2012).

Aljohani & Davis also (2012) develop a Mobile Questioning Answering System (MQAS) to provide a tool that helps learners and teachers to learn more about their academic understanding as well as their progress. Moreover, the teachers need to reveal about the progress of their learners and the effectiveness of their teaching methodologies.

Chapter 3

Ubiquitous Learning Log System

3.1. Overview

As mentioned above, L2D system has been developed with newly functions added to SCROLL. In this section, the base system, SCROLL is overviewed. In addition, since this study is designed on the basis of several theories on human memory, they are introduced in this chapter as well.

Ogata et al. define a ubiquitous learning log object (ULLO) as a digital record of what a learner has learned in the daily life using ubiquitous technologies and propose a model called LORE (Figure 3.1) to show the learning processes in the perspective of the learner's activity (Ogata, Li, Hou, Uosaki, Moushir, & Yano, 2010).

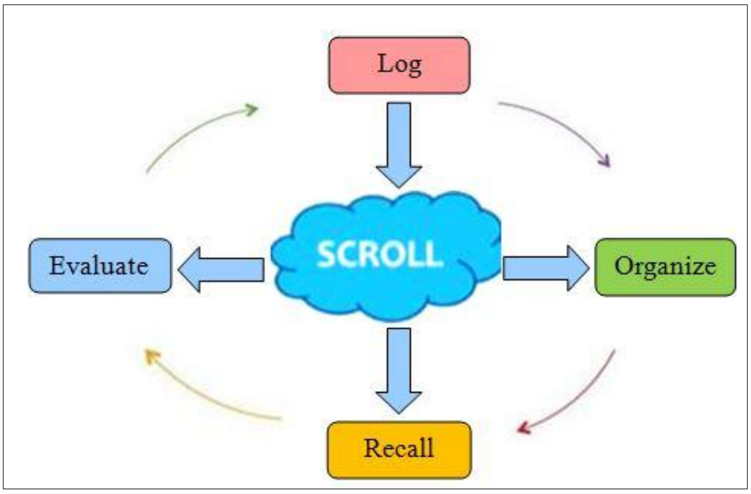

Figure 3.1. LORE Model

Figure 3.1. LORE model. Adapted from "SCROLL: Supporting to share and reuse ubiquitous learning log in the context of language learning" by Hiroaki Ogata , Mengmeng Li, Bin Hou, Noriko Uosaki, Moushir M. El-Bishouty, Yoneo Yano. *Research and Practice in Technology Enhanced Learning*, Vol. 6, No. 2 (2011), pp. 69 – 82. Copyright 2011 by Asia-Pacific Society for Computers in Education.

As it is shown in Figure 3.1, there are 4 processes in LORE model, that is to say there are 4 main functionalities in SCROLL – Log, Organize, Recall and Evaluate.

Log. A learner faces a problem in his/her daily life. Then the learner may learn some knowledge by her/himself or ask for help from other people. Moreover, the learner records what s/he learned during this process.

Organize. The system has several organizing functions. Firstly, when a learner tries to add a ULL, the system makes comparison and shows the similar ULLs if it founds. Another important functions of organizing is categorization. For example, if the leaner learns a new word “Hana”(Japanese word)(it means flower) in department, the word is categorized into “Plant” or “Garden” category. Categorizing everything by system can be sometimes difficult. So the learner can make their own categorization and add tag to ULL. Therefore, the learner can review the learned contents using categories and tags. In order to classify similar objects into one category, the titles, photo contents, locations are compared. Then the learning structure can be organized.

Recall. Sometimes, the learner forgets what s/he has learned. Repetition and practice in same context can help the learner what s/he forgets or past ULLs. As this reminding purpose, the system offers quizzes based on her/his past ULLs.

Evaluate. It is important to identify what and how the learner has learned by analyzing the past ULL, therefore the learner can enhance what and how to master in future.

3.2. The design of SCROLL

SCROLL, which is a kind of ubiquitous learning system, is designed originally to acquire, to access and to share ubiquitous learning logs for retrieving the learners' learning experiences with photos, videos and sensor data (Ogata et al., 2011).

Each recorded object is called ubiquitous learning log object (ULLO). For example, a ULLO can be an English word or a part of Japanese sentence taken down by a learner. Ubiquitous learning log (ULL) is a set of ULLO. The system makes learners share their ULLs. The learners are able to watch other learners' ULLs in "All Logs" and if they like other learners' ULLs, they can "re-log" them to their own pages like "re-tweet" in Twitter.

3.2.1. SCROLL supports Japanese onomatopoeia learning

SCROLL facilitates Japanese onomatopoeia learning (Uosaki, Ogata, Mouri & Lkhagvasuren, 2015). According to JASSO (Japan Student Services Organization), there are around 184,000 international students in Japan by May, 2014. Foreign students are increasing year by year since 2008 when Japanese government started

“Plan for 300,000 Exchange Students”. Since English isn’t used broadly among Japanese local people, foreign students face difficulty in their everyday communication.

Therefore, it's highly required to learn Japanese language to live in Japan. However, learning of this language is not easy because it has several characters and full of onomatopoeia. Learning onomatopoeia is a challenge for learners of Japanese as a second language (Inose, 2007, Asaga et al., 2008; Ho et al., 2010). As mentioned in survey, only 9% of international students have no difficulty to learn Japanese. Therefore, Uosaki et al., aim to support learning with the aid of the developed system.

"Giongo" and "Gitaigo" are the main 2 types of Japanese onomatopoeias. "Giongo" is phonetic expressions that imitate real sounds such as "wan-wan", barking sounds of dogs and "Gitaigo" is mimetic expressions of the states which do not actually produce any sounds such as "mero-mero" meaning madly in love. The "Gitaigo" is translated into English as "Mimicry", but in their paper Uosaki et al use "Japanese onomatopoeia learning" because 1) there is no proper equivalence of "Gitaigo" in English language, 2) "Onomatopoeia" includes both "Giongo" and "Gitaigo", 3) "Giongo" and "Gitaigo" are closely related in terms of usages, structures, morphology, and syntax, 4) "Giong" and "Gitaigo" are usually dealt as one set of learning.

The difficulties in Japanese onomatopoeia learning are mentioned in below (Flyxe, 2002; Inose, 2007):

1) Description: It is hard to explain what the meaning is, especially "gitaigo". It is possible to define it approximately such as its feeling is happy or unhappy, good or bad, but it has more complicated feeling or status. It’s very difficult to distinguish onomatopoeias because of its similarity.

2) Translation: Translating onomatopoeias in other languages is difficult. Some onomatopoeias have equivalences in other languages such as animal sounds: ‘wan-wan” means bow-wow in English. However in most cases it is difficult to find its equivalences in other languages. Because of its difficulty of translation, it is hard to grasp its meaning.

There are few research studies about development of Japanese onomatopoeia learning systems (Ochi & Kawasaki,1997; Ochi et al. 1997; Asaga et al., 2008; Hou et al.,2010; Tomoto et al., 2010). Asata et al. (2008) develop Onomatopoeia Online Example Dictionary System called ONOMATOPEDIA. Although the system had a problem with image search accuracy. Hou et al. (2010) develop Japanese mimicry and onomatopoeia learning assistant system called JAMIOLAS using wearable sensors and sensor network. However, the number of the onomatopoeia words offered by their system was limited to the few terms about temperature and humidity. Hence it can be concluded that advanced technology oriented system limits the learning range. Therefore, the authors try to find an effective way to develop onomatopoeia learning system which includes both of technology advances and manual power.

The authors expect that SCROLL could play an important role in Japanese onomatopoeia learning process. As pilot evaluation revealed that the usability of the system and participants satisfaction are high. Five international students (2 Mongolians, 1 Danish, 1 Swedish, 1 Chinese) participated in the evaluation. Therefore it can be concluded that the system has high usability and participants were satisfied with its application. The comments from the participants are listed and most of them were positive (Uosaki, Ogata, Mouri & Lkhagvasuren, 2015).

Moreover, SCROLL also supports the process of acculturation experiences of students. The results of their research show that retooled mobile and ubiquitous computer system used had measureable benefit in aiding students undergoing the process of acculturation (Cook, Ogata, Elwell & Ikeda, 2015).

SCROLL is designed as a model of system to implement the following types of learning (Ogata, Hou, Li, Uosaki, Mouri & Liu, 2014):

1) Self-directed and personalized learning
2) Reflective learning
3) Collaborative learning
4) Situated learning and experiential learning
5) Seamless learning

3.2.3. Self-directed and personalized learning

The traditional learning is teacher directed learning, and this learning assumes that a teacher has the responsibility on what and how the learner should be taught (Knowles, 1975). However self-directed learning (SDL) is different from teacher directed learning. Brookfield defined "self-directed learning as learning in which the conceptualization, design, conduct and evaluation of a learning project are directed by the learner" (Brookfield, 2009). There are many successful examples that show role of self-directed learning in vocabulary learning.

For instance, Deng and Shao (2011) develop a mobile application-Remword (a digital dictionary installed in mobile phone) that supports English vocabulary learning. The authors examine the use of Remword in a college environment in China. During the experiment, the students spent their personal time to learn English word memorizing. They self-scheduled their time and self-initiated to remember vocabulary from time to time. This learning is more self-directed and is not constrained by any other people or by time and space. Survey and interview data are gathered and the following findings are found (a) students are self-directed and well automate in their vocabulary learning with the affordance of this software in their everyday life. (b) Students indicated high readiness to mobile learning. (c) Challenges are indicated to the sustainability of mobile learning (Deng & Shao, 2011).

Knowles (Knowles, 1975) proposes 4 features of self-directed learning:

a) Because of world population growth, self-direction becomes an important part of educational system.
b) Learner's own educational experience is big resource for learning. Hence, it should be used with other learning resources together.
c) Students' natural learning behavior is based on task or problem solving. Therefore, it is efficient if the learning experiences are organized as task accomplishments or problem solving projects.
d) Learners are mostly motivated by themselves. For example, demand for self-esteem, the eagerness to achieve, the urge to grow, the enjoyment of accomplishment, the craving to know something specific, and curiosity.

Personalized learning means the tailoring of pedagogy, curriculum and learning environments to meet the needs and aspirations of individual learners. Generally technology is used to help personalized learning environments (Personalized learning, 2015).

SCROLL is designed based on two objectives that adopt self-directed and personalized learning:

(1) By being aware of a learner’s current context. Currently, the context includes location and time. For the location information, the system can detect whether a learner is near to the place where s/he uploaded a learning log and whether there are location based learning logs recorded by other learners' close to her/him. If either requirement is met and the availability of the device is high, the system will show her/him a quiz based on the knowledge s/he gained around there or notify her/him the surrounding learning logs added by others.

(2) The system can record the context data when a learner uses the system to study as her/his context history and then catches her/his learning habits by making use of the context history. If the learning habits exist and the circumstance meets the learning habits, the system will show a piece of recommendation message to encourage her/him to review what s/he has learned.

3.2.4. Reflective learning

A main goal of SCROLL is to help learners recall what they have learned after they archived their learning logs. When a learner captures his/her learning log, there are plenty retrieval cues except location based property mentioned above. For example, according to the picture superiority effect (Defeyter et al., 2009; Shepard, 1967), the learning logs with pictures can stay in one’s memory longer.

Moreover, according to the basic research on human learning and memory activity, repeated practicing influenced greatly for long-term information retention. Additionally, comparing with repeated reading, repeated testing has more good learning result (Karpicke, Butler, & Roediger, 2009).

The quiz function includes these beneficial picture and location based features. Three kinds of quizzes will be generated automatically by the system, these are yes/no quiz, text multiple choice quiz and multiple choice quiz with image.

Generally, learners can test themselves by practicing the quizzes. However two more ways that are provoked by the system are provided. The first one is creation of quiz database by system regarding the location where the learner studied. Another one is that a system will prompt to review what s/he learned in quizzes regarding the learner's study habit.

3.2.5. Collaborative learning

Collaborative learning is one kind of learning way in which people study or attempt to study something with each other.

SCROLL is designed also as a collaborative learning. Learning log is a log that a learner has done, therefore collaborative learning in SCROLL is asynchronous model. Any learners in SCROLL are able to share ULLs, and the system will show the shared ULLs to other learners'. Moreover, the learners can ask and answer questions when they share ULLs.

3.2.6. Situated learning and experiential learning

According to Lave & Wenger (1991), situated learning is learning that occurs in the same context environment in which it is applied. Whereas experiential learning is a learning from experience according to Itin's definition (1999). Learning from same context enhances the learning result and past experience leads effective learning.

The learner can acquire knowledge using tasks refer to the activities. Tasks are conducted in environments wherever the learner can learn such as school, hospital, post office. For example, if the system recommends the Japanese word “スイカ (suika)” to the learner, s/he can use it to communicate with supermarket staff such as asking its price, location and so on. It has been evinced that if making speaking practice with native speaker using recommended words, the learner masters the word (Jonassen & Grabowski, 1993).

One kind of task is asking about the information. Learners saving learning logs are responsible for defining what kind of knowledge can be gained by carrying out the task. One learning log can be used in several tasks. Some predefined tasks are provided by system in different contexts in order to reduce the learners’ burden happens during learning log saving process. In addition, tasks can be created by the learners and designed by the system administrator.

The system assigns an appropriate task for a learner depending on difficulty level of task and the learners’ ability. For example, asking that product price can be easy for learners while asking that its recipes can be more difficult. When learners receive learning log and task recommended by the system, they are asked to provide their feedback to the system. For instance, if the task is to find the target object, the learner takes photos of the target object and send it to the system or if the task is to define the location of the target object, they need to collect and fill the environmental information in the system. Only in case the learners send their feedback to the system, it will be proved that they can obtain the knowledge really. In addition to the study feedback, learners also send their feedback if they face problem during task carrying out process by taking the photos, videos, audios or texts of problem and upload it to the system for help. All of these accumulated data is meaningful for other learners.

3.2.7. Seamless learning

In the past decade, the rapid advance of broadband and wireless internet technologies offers us a new learning environment, namely “seamless learning” (Wong & Looi, 2011). It allows learners to learn anytime, anywhere, and provides them with multiple ways of learning throughout the day. By seamless learning, we mean learning which occurs with seamless transitions between in-class and out-of-class learning (Hung et al., 2013).

The American College Personnel Association (1994) indicates the importance of linking students' in-class and out-of-class experiences via providing seamless learning environments to achieve academic success. Based upon the above ideas, Seamless Mobile-Assisted Language Learning Support System (hereafter called the SMALL System) is designed (Uosaki et al., 2012) as a sub-project. The main objective of SMALL is to link learners’ out-of-class learning to their in-class learning. Once a learner uploads a newly learned word to SCROLL, SMALL, runs a search through the previously updated textbook data. If the new word is found in the textbook data, it jumps to the textbook page where this word is used. Another example is that when a user reads an uploaded textbook and clicks a word, then it jumps to the SCROLL system page to show how other learners have learned this word in different contexts in their out-of-class learning. In this way, users’ out-of-class and in-class learning can be intertwined. Learners learn words from contexts. In order to master words, it is important to come across them used in various situations.

3.3. Functionalities

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC and general mobile phones. The server side runs on

Linux(Ubuntu 12.04.2) and the program is developed in Java language, Spring MVC (https://spring.io/) and Mybatis (http://www.mybatis.org). The developed software for Google phone is a native Java application based on Android SDK.

3.3.1. ULL recorder

This component facilitates the way that learners upload their ULLs to the server whenever and wherever they learn. As shown in Figure 3.2 (a), in order to add a ULL, a learner can take a photo, ask questions about it and attach different kinds of meta-data to it, such as description, meanings in different languages. For instance, when the learners input English words and click "Translate" button, then their Japanese equivalents appear so that they do not need to input themselves (cf. Figure 3.2 (a)). The system also supports phonetic aspects of the language. When they click a speaker icon, they can listen to pronunciation (cf. Figure 3.3).

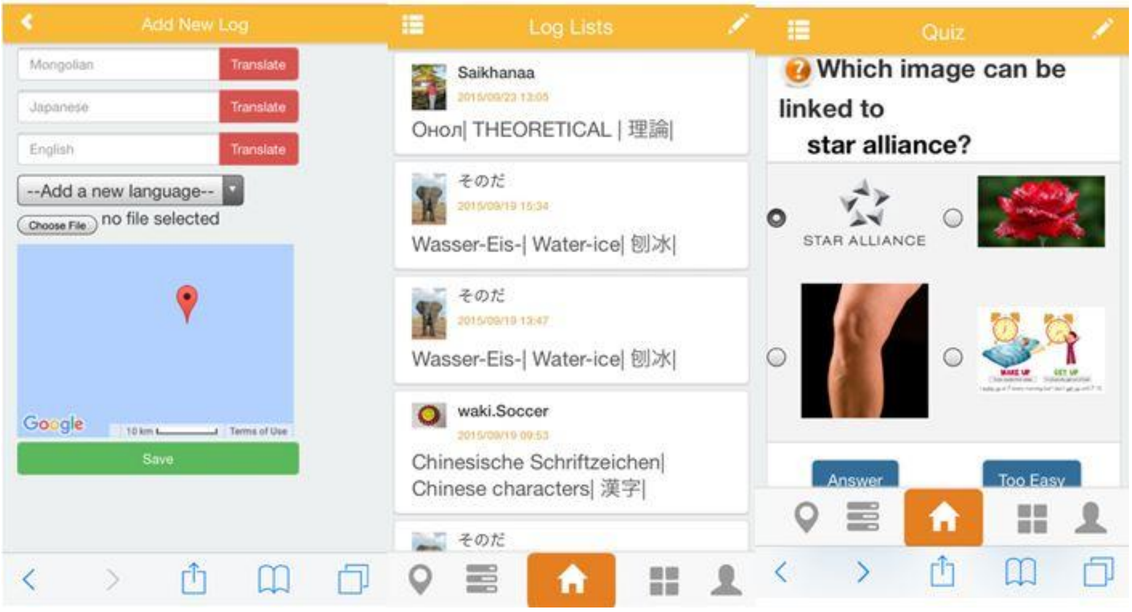

Figure 3.2. SCROLL interface mobile

(a) Add ULL (b) ULL List (c) Quiz

3.3.2. ULL finder

If a learner adds a new ULL, SCROLL checks whether the same object has been already stored or not by comparing the name fields of each object using a thesaurus dictionary. Moreover, a learner can search a ULLs by name, location, text tag and time. Using this function, learners can understand what, where and when they learned before. Figure 3.2 (b) and Figure 3.6 show the list of the learner's ULL, which helps him/her to recall all of the past ULLs. Besides, it allows the learner to be aware of others' learning objects and to re-log them if seemed useful. This means that a learner can make a copy of another learner's learning object into his/her own log. Therefore, learners can obtain a considerable amount of knowledge from others even though they have not experienced that knowledge themselves. By sharing ULLs with other learners and re-logging the other learners' ULLs, the acquisition of knowledge is enhanced.

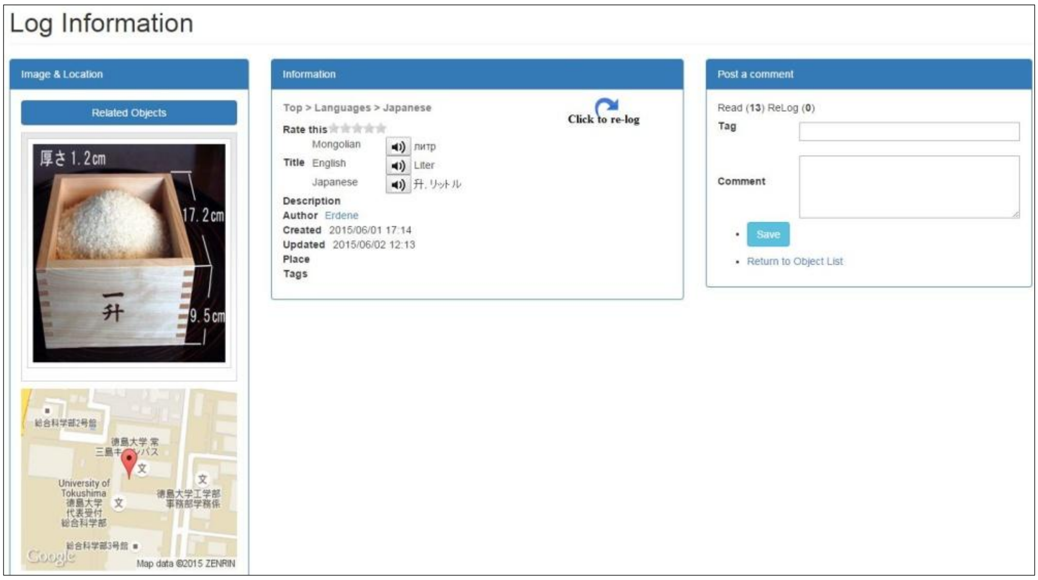

Figure 3.3. An example of learning log

3.3.3. ULL reminder

A main goal of SCROLL is to help learners, who are learning second language, to recall and to remember effectively what they have learned. The quiz function is proposed to play these roles mainly (Li et al., 2011). As shown in Figure 3.2 (c) and Figure 3.5, SCROLL generates multiple-choice quizzes based on the meta-data of stored ULLs.

These quizzes are generated according to the learner profile, location, time and help the learners to recall what they have learned. The quiz function is designed not only to help 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.

As mentioned in Atkinson–Shiffrin memory mode people save information in their short term memory then pass it to long term memory which enables them to remember information for long period. In order to store the information or knowledge in long term memory, people need to take effort such as repeating (Atkinson & Shiffrin, 1968). This is the logical base on which the system is designed to support retaining vocabulary on the ability of long-term by giving quizzes.

Moreover, the quiz function, which makes use of the context data of learning log such as place, time, text, and picture, helps learners to recall and to remember the knowledge. Three types of quizzes can be generated automatically by the system: including yes/no quiz, text-based multiple-choice quiz and image-added multiple-choice quiz. These quizzes are interesting and attractive method for learning. For example, "quiz with image" is designed to ask learners to choose a word in order to describe images given by the system. The system immediately checks whether the answer provided by the learner is correct or not (Ogata et al., 2011). In the quiz, the learner should select the correct image corresponding to the month (cf. Figure 3.5).

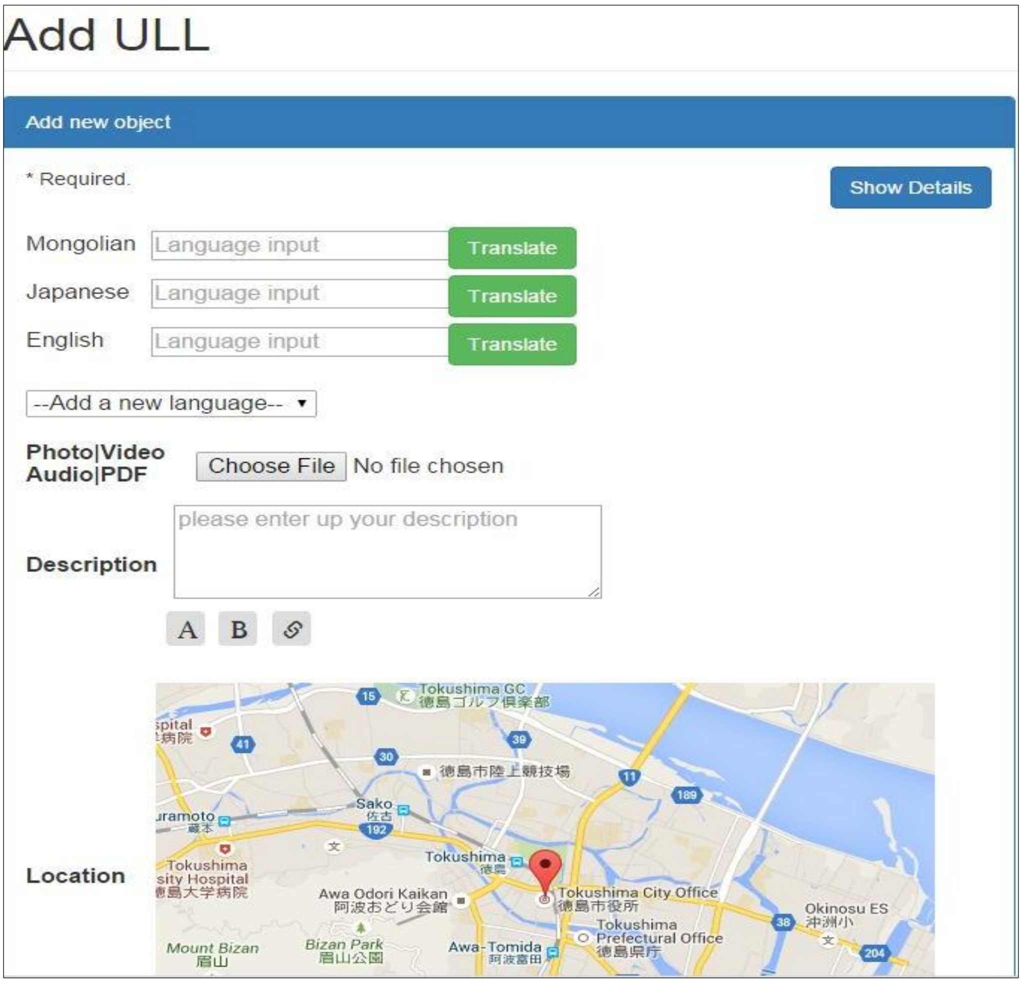

Figure 3.4. Screenshot of adding new ULL

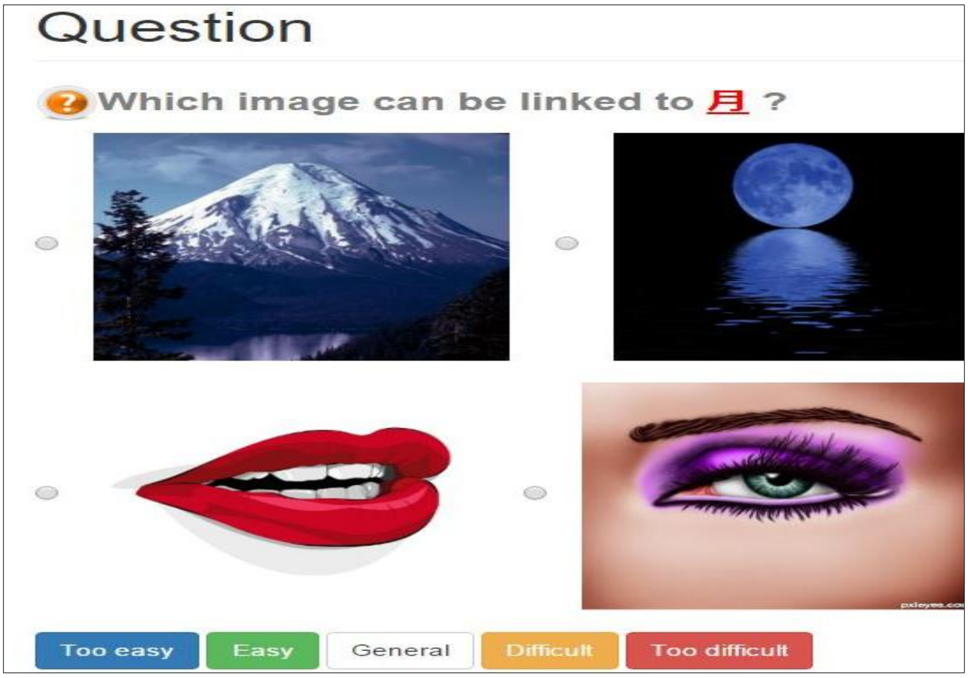

Figure 3.5. An example of quiz

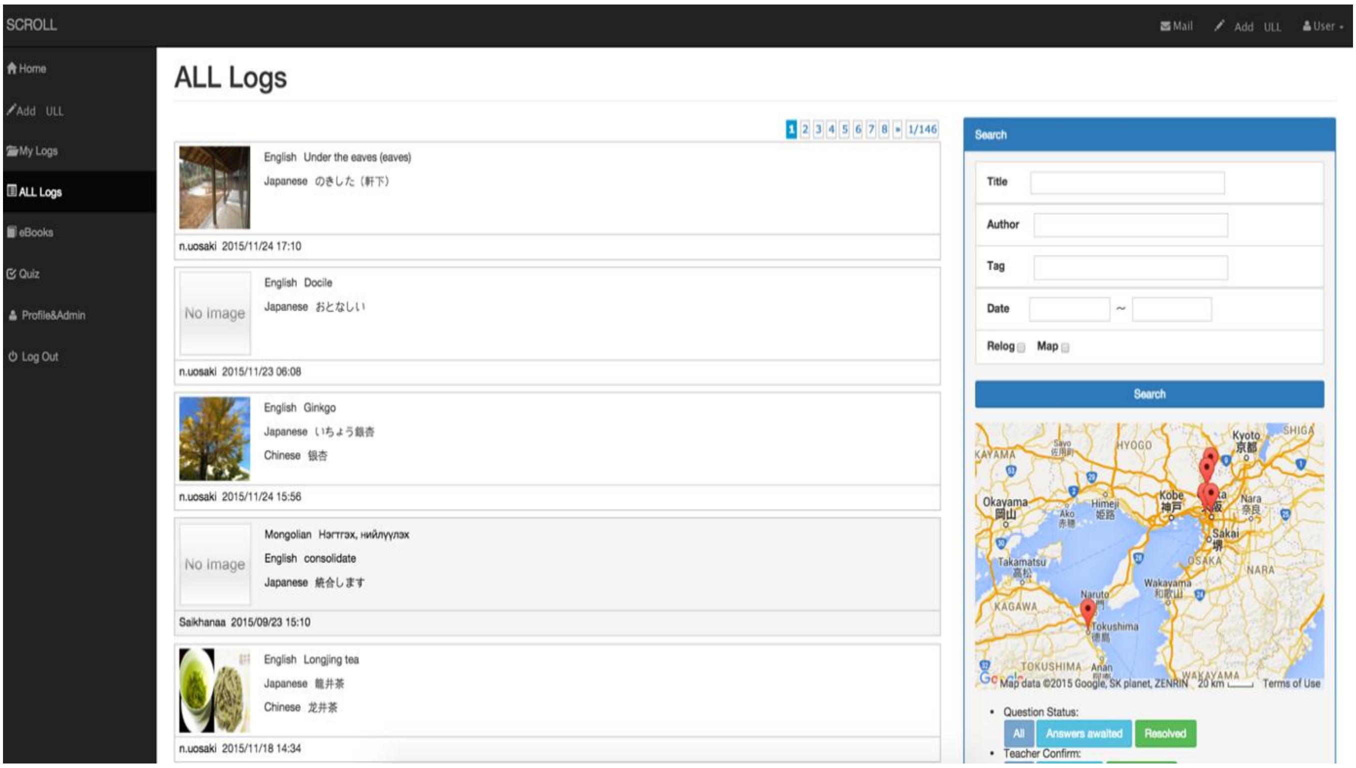

Figure 3.6. ULL List

3.3.4. ULL navigator

ULL navigator provides the learner with an AR (augmented reality) interface with which to navigate through the ULLs in a real-time contextual manner.

When a learner enters a certain geographical location with his/her mobile device, GPS information attached will send an alert through the system to the learner. Once alerted, an AR view will appear clearly highlighting logs that have been recorded in the current area. If a learner should decide to click on a certain log, a Google Map will be retrieved marking the ULL object location and in addition, marking the users themselves in relation to the said log. This function allows for context-specific information to be easily shared amongst users of the system.

Chapter 4

Learning Log Dashboard

4.1. Requirements

The learners of SCROLL acquire lots of knowledge from their daily life, while they’re going to a post office, doing shopping or seeing a doctor at hospital. The learners' vocabulary increase highly by learning many new words everyday and by sharing them with others.

However, learners usually don't look back them then as a result of no repetition, the words are forgotten quickly and their study becomes less effective. Besides, the original quiz function of SCROLL lacks adaptation. Moreover, the issue of CSUL is how to retrieve and reuse learning experiences for future learning (Ogata et al., 2014).

Therefore, L2D system is proposed to tackle the issue and this is what this paper pursues in the research. L2D system offers a set of quiz which is associated with the incorrectly answered learning logs and gives an opportunity to remind the previous learning logs. Moreover, learners are able to concentrate on the words answered incorrectly by recalling and practicing with the aid of the new function.

4.2. Design of L2D

Learning Log Dashboard (L2D) system captures, analyzes and visualizes traces of learning activities in order to promote awareness. L2D system also enables learners to reflect on their own activity and helps to recall some of the learning logs that they have learned (Lkhagvasuren et al., 2014).

L2D system works together with SCROLL. New functions that are shown below are developed on SCROLL for the purpose of promoting awareness and enabling students to reflect on their own activity.

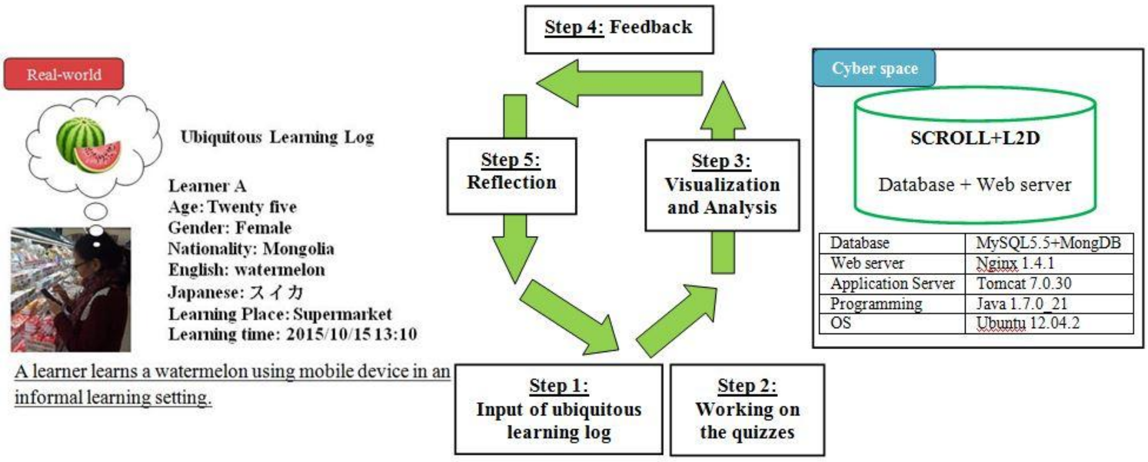

Figure 4.1. The design of L2D

Step 1. Learners can save their experiences as ULLs in photo and video format using their mobile device or computer and SCROLL. The author name, language, time of creation, location (latitude and longitude), learning place and tags are included in ULL. For example, if a learner learns a watermelon at the supermarket, the ULL is saved into the database.

Step 2. The learner can work on quizzes and after finishing it, the learner can see her/his memorized ULL and incorrectly answered ULL.

Step 3. Visualization and Analysis. Learner’s vocabulary increases rapidly by learning many words every day and sharing them with others. From here, a demand to analyze the ULL comes up. Then L2D system analyzes and visualizes learners’ ULL such as correct and incorrect answers. By using activities visualization, it can motivate learners and provides feedback on their work (Janssen, Erkens, Kanselaar & Jaspers, 2007).

Step 4. Feedback. L2D system gives feedback of important information such as the most frequent incorrectly answered words. Memorized learning logs contain learner's last quiz and the learner can see and work on it again.

Step 5. Learners are able to reflect their activity. L2D system reuses, analyzes and visualizes traces of learning activities to promote learners’ awareness. Moreover, it enables learners to reflect on their own activity and helps them to recall what they have learned.

Newly added functions are as follows:

(1) Main characteristics (cf. 4.3)

(2) Workflow of L2D (cf. 4.4)

4.3. Main characteristics

L2D system focuses on both statistical data and contexts on every learner's usage of the system. In other words, this paper focuses on developing L2D system that visualizes the traces in ways that help learners to steer the learning process. L2D system shows the number of (1) learning logs; (2) completed quizzes; (3) memorized learning logs and (4) incorrect answers of the quizzes. It is an easy way to see incorrect answers on a word and control the information on the dashboard.

Repetition with increasing intervals is the learning method that uses increasing intervals of time between successive reviews of previously learned knowledge (Pimsleur,1967). Based on this theory, L2D system sends a quiz to the learner.

Figure 4.1 shows the model and role of L2D system. Analytics engine analyzes incorrect answers, then recommends associated learning logs. Figure 4.2 shows a screenshot of L2D. Learners usually repeat a mistake on one word even though they worked on quiz previously. Learners especially who are studying Japanese letters and characters should practice more to memorize it.

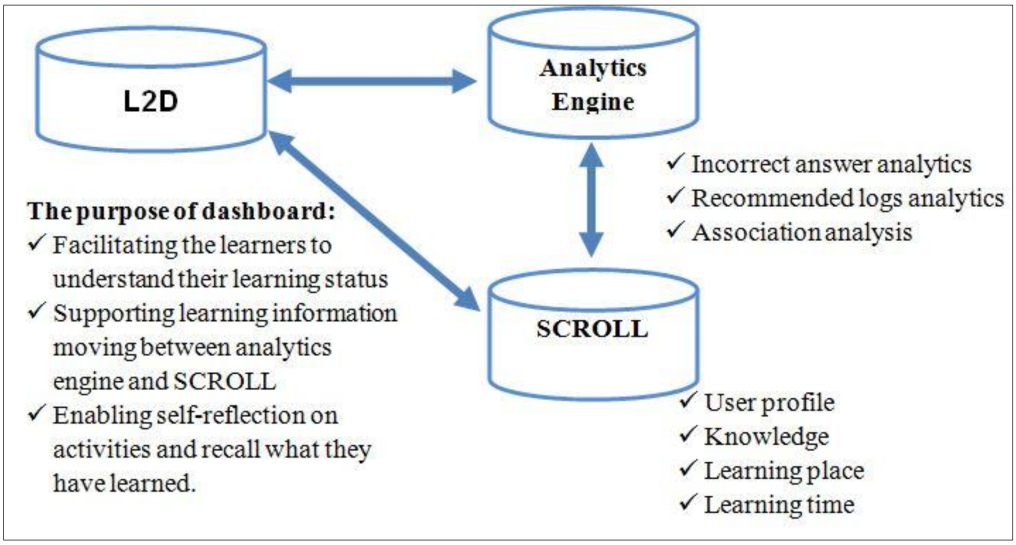

Figure 4.2. L2D model and role

Figure 4.2. L2D model and role. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Moreover, L2D system shows the results of the past quizzes for each learner represented by green, yellow and red indicator, just like a traffic signal. These colors remind the learner about the increasing number of incorrect answers.

Figure 4.3 shows the information of learning logs that a learner answers a quiz incorrectly (once twice, or more than 3 times). Learners are also able to see their progress at a glance such as their achievements, statistics, their progress and the number of learning logs they need to practice. Thus, a learner will repeatedly practice words by the quizzes and eventually the learner will be greatly motivated. At that time learners are able to concentrate upon the words answered incorrectly.

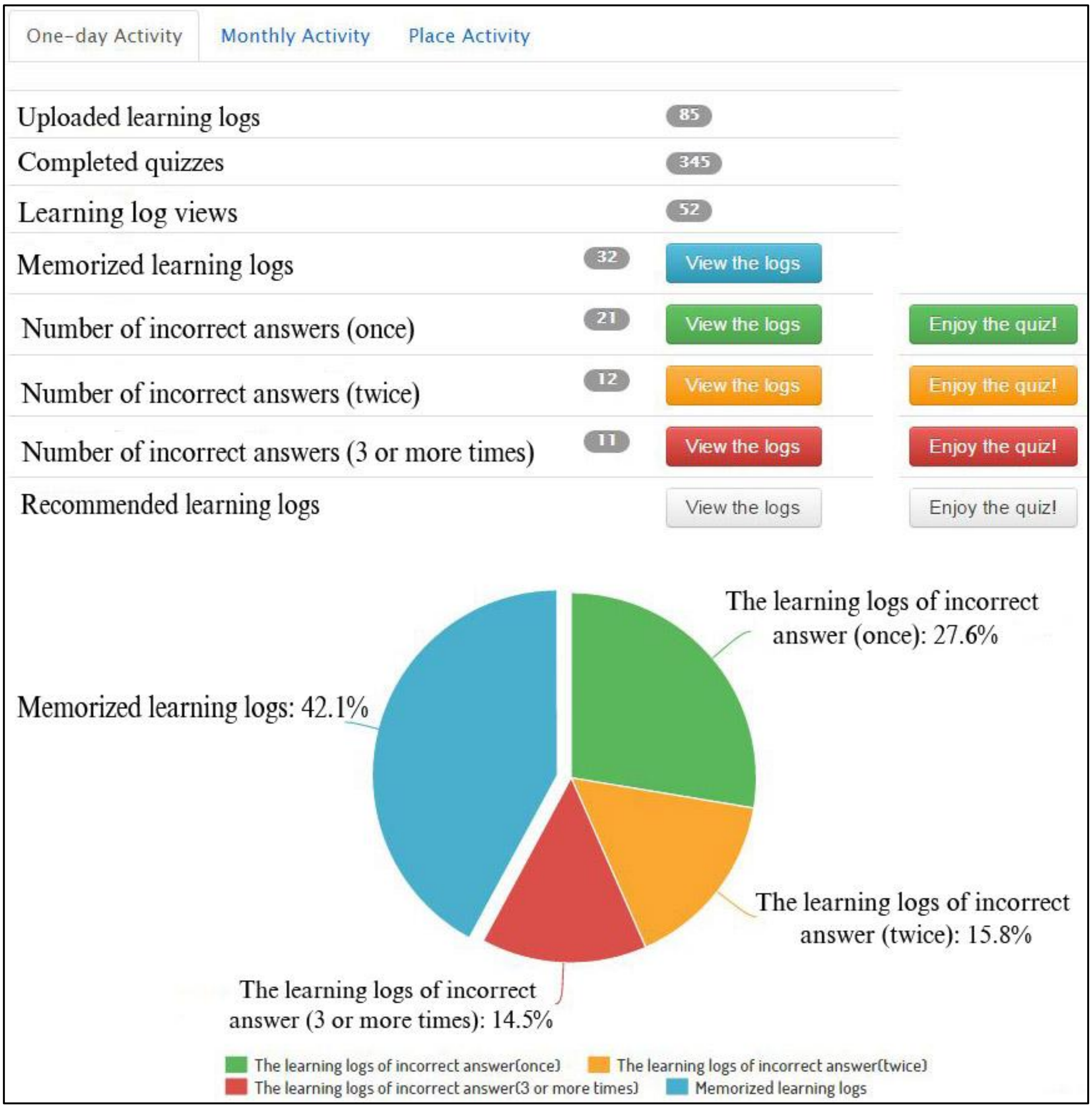

Figure 4.3. Screenshot of L2D

Figure 4.3. Screenshot of L2D. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

If a learner clicks on the "Enjoy the quiz" button in green color, L2D system automatically provides a set of quiz. The set of quiz contains learning logs of a learner who answered incorrectly once. According to the colors of the buttons a learner can work on quizzes. For example: red color button provides the set of quiz that contains learning logs of a learner who answered incorrectly 3 or more times. If the learner skips the set of quiz without completing it, L2D system reminds her/him about the necessity of completion of the task via a message to encourage her/him to study. The learner eventually will know all of the words by heart.

L2D system presents a table that indicates the quiz overview of each learner. Figure 4.4, Figure 4.5 and Figure 4.6 show the information of learning logs of a learner who answered incorrectly once, twice and three or more times. If the learner successfully performs the quiz, then the learning logs of correct answers move to the memorized section.

Learners can distinguish learning logs according to represented colors displayed in a lower-right corner. If a learner answers incorrectly for the first time the learning log will be marked as green and for the second time the color will be turned into yellow. If the learner makes a mistake at the third time, the color will be changed into red as shown in Figure 4.6. It reminds the learner of what s/he has to concentrate deeply on his/her tasks and needs to practice more. If a new learner has not added a ubiquitous learning log to the system yet, all L2D fields will show 0 as their default value. L2D system uses a pie chart to handle memorized learning logs with the number of incorrect answers (once, twice and three or more times).

Figure 4.4. The information of the learning logs of incorrect answers once

Figure 4.4. The information of the learning logs of incorrect answers once. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Figure 4.5. The information of the learning logs of incorrect answers twice

Figure 4.6. The information of the learning logs of incorrect answers three or more times

4.4. Workflow of L2D

Figure 4.7 shows a workflow of L2D. Detailed explanation about the workflow shown in Figure 4.7 is summarized as follows:

1. At first, learners have to create accounts by themselves. Then they can work on quizzes. All learning logs mean all learners' learning logs of SCROLL.
2. After finishing the quiz, the incorrect answers will be marked in green and stored in L2D whereas the correct answers will be saved in memorized logs.
3. At the next time if the learner answers incorrectly on the same quiz, the answered learning logs will be marked as yellow. If the learner makes mistake on the same word 3 or more times, that word will be marked in red color.

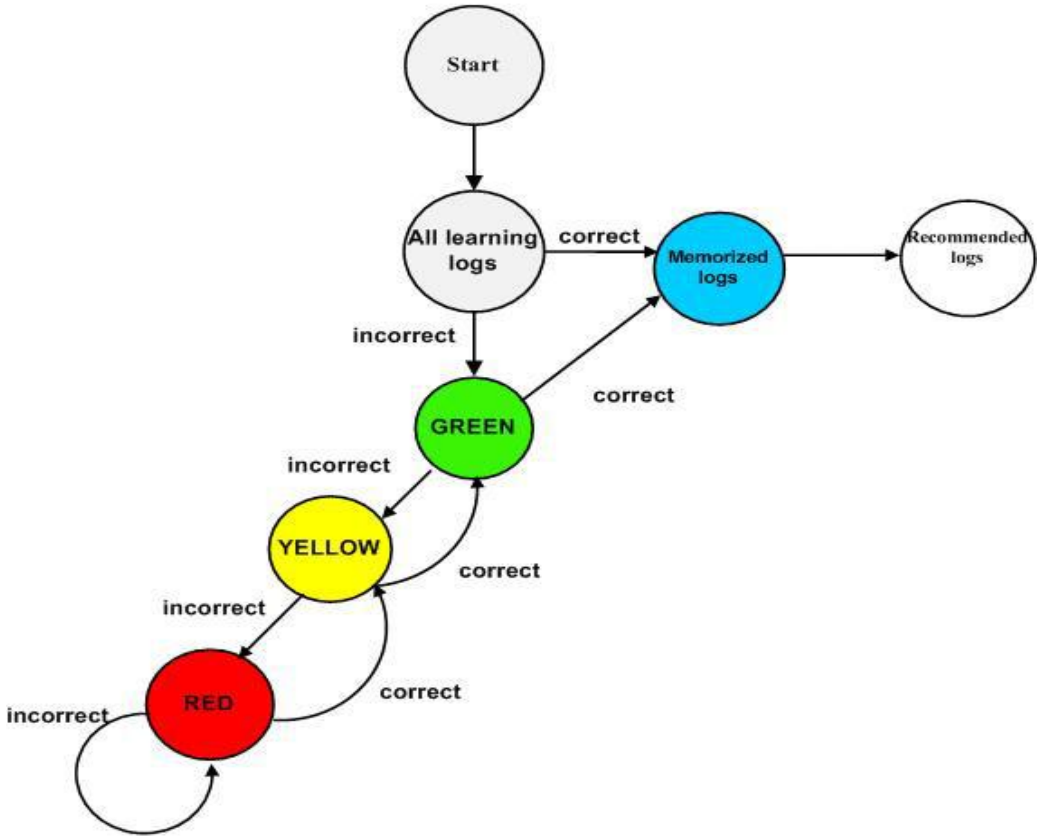

Figure 4.7. Workflow of L2D

Figure 4.7. Workflow of L2D. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

4. If the learner completes the quiz successfully without any mistake on the same word which s/he previously answered incorrectly, the color of the logs will be changed back. For example, if the learner correctly answers the same words 3 times, the color of the logs will be changed continuously until they move to memorize logs. After finishing a quiz L2D will automatically update the information.
5. Memorized learning logs consist of memory of learner's last quiz which the learner can see and work on.

The recommended learning logs (cf. Figure 4.8) are summarized on the display which shows the incorrect and correct answers of learner's past works. According to Pimsleur's proposal (1967) of memory schedule which defines the length of recall interval, it is 5 times of the previous interval's length. Pimsleur also discovers tenth recall of a word of second language that will not take place until 113 days or more than four months later. That one should hold the learner well over a year. According to the memory schedule after three months, learning logs will be reappearing previous learning logs to the learner for reinforcement in recommended logs.

Figure 4.8. Recommended learning logs

Learners also can examine themselves by practicing the quizzes in recommended learning logs. If a learner answers correctly to the quiz, the learning log disappears from the dashboard.

Basic research on human learning ability and memory has shown that practice of information retrieval has powerful effects on learning process and long term retention of information in human memory (Karpicke, Butler, & Roediger, 2009).

Moreover as mentioned in Atkinson–Shiffrin memory model (1968), firstly people save information in their short term memory then pass it to long term memory which enables them to remember information for long period. In order to store the information or knowledge in long term memory, people need to take effort such as repeating (Atkinson & Shiffrin, 1968).

The quiz function of SCROLL is based on the following two theories: the theory of encoding specificity (Tulving & Thomson, 1973) and the theory of test-enhanced learning (Karpicke, Butler, & Roediger, 2009; Roediger, & Karpicke, 2006). According to the former theory, a number of factors including the place where we obtained knowledge or we took photos can be encoded as initial retrieval cues. The initial retrieval cues are very effective for activation of stored memory (Tulving &Thomson, 1973). Regular testing enhances learning process more than repeated reading. Because repeated reading often has limited benefit than initial reading of the material (Karpicke, Butler, & Roediger, 2009). With the learning of a new word, the process of forgetting begins at the same time once and proceeds very rapidly. If a learner remembers the word until s/he completely forgets it, her/his memory potential shall be increased.

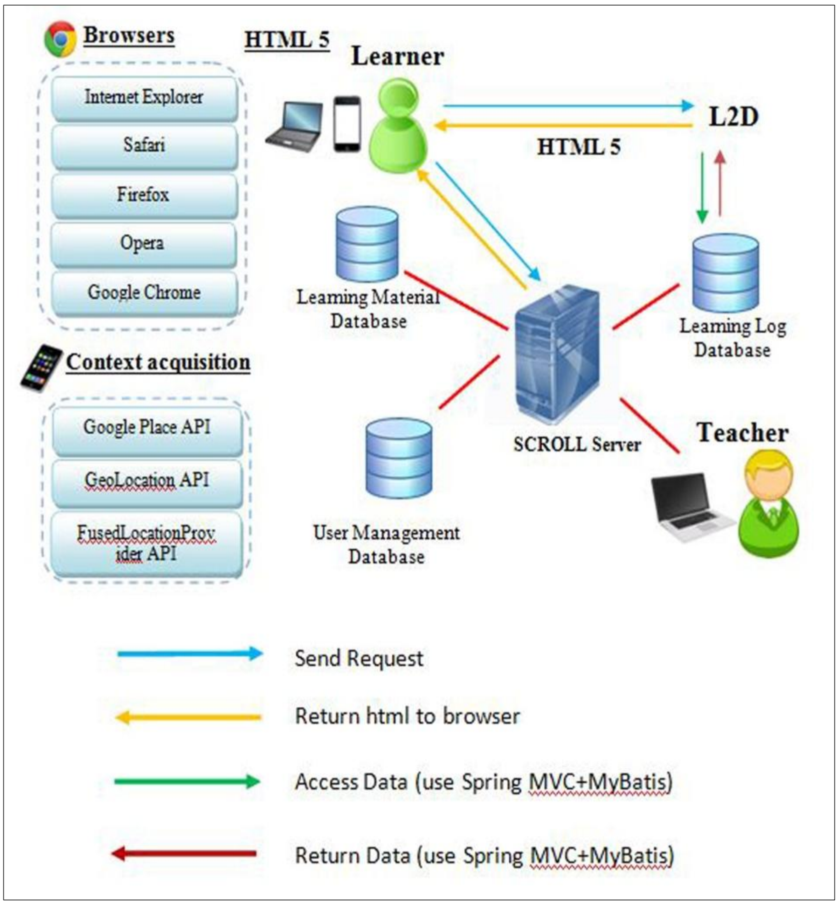

Figure 4.9. Architecture of L2D

L2D system is a type of client-server application (cf. Figure 4.9). The client side works on a PC web browser. The database on the server side consists of three main parts:

(1) User Management Database: It stores all learners' personal information such as their nationality, age, gender, mother language, JLPT (JLPT: Japanese Language Proficiency Test) level information, and email address.

(2) Learning Log Database: It contains information what, how, where and when they learn in every day. For example, they learn what kind of word, where they learn that word and when they learn. The creation of learning logs is done using photo, audio, video and tags.

(3) Learners can study by using SCROLL and L2D. Teachers can upload learning materials to Learning Materials Database.

4.5. Scenario of using L2D

As mentioned in Chapter 1, L2D's concrete targeting domain is a language learning. One typical scenario of L2D use is to help international students to learn Japanese in Japan. Foreign students face many unknown learning contexts in their daily life. For instance, they learn new words (phrases and sentences) when having a haircut in a barber, visiting an art gallery, doing shopping and so on.

In these cases, students can capture and record what they have learned by using ubiquitous technologies. As mentioned before, many students do not look back the ULL and the words are forgotten quickly. Ebbinghaus's (2013) most significant achievement was proof that within 1-2 days, people forget about 80% of what people have learnt. In this case, L2D system helps learners to recall and review their learning logs. Figure 4.10 illustrates the workflow of L2D usage.

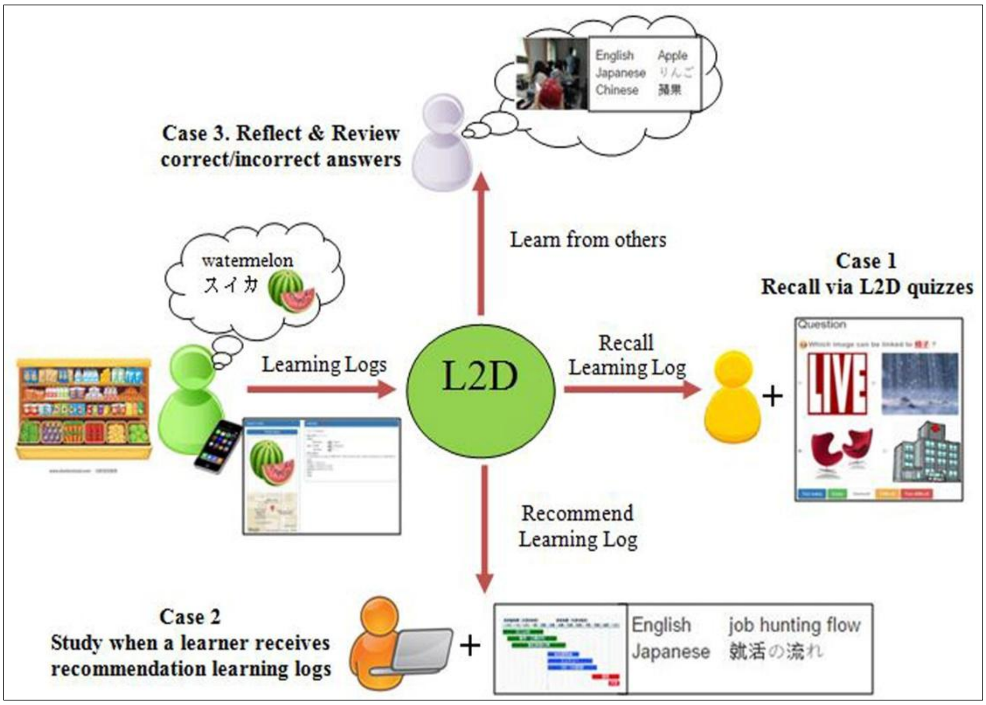

Figure 4.10. The scenario of using L2D

(1) Recall via L2D quizzes: learners can recall their ULL using L2D system. For instance, a learner can work on his/her previous incorrectly answered words.

(2) Recommended learning logs: previous learning logs are reappeared to the learner for reinforcing from recommended logs. Learners can work on and practice these learning logs offered from recommended learning logs.

(3) Reflect and review correct/incorrect answers: L2D system enables learners to self-reflect on their own activity. Reflection is important in learning and it increases learners' study motivation (Zimmerman, 2002). Moreover, L2D system visualizes the learners' activities to increase their awareness and to support their self-reflection.

Chapter 5

Evaluation

5.1. Method

The goal of the experiment is to compare the effect on learning by SCROLL with the use of L2D and without the use of L2D. In other words, this experiment tries to check whether students can get more benefit from SCROLL with L2D than normal SCROLL or not. To achieve the goal, an experiment was conducted from October 03 to November 19 in 2014. During this period, students used the systems to support their learning in daily lives.

The subjects consisted of 14 (10 females, 4 males) international students who have studied at Tokushima University. The students participating in the experiment were 1 from China, 2 from Malaysia, and 11 from Mongolia respectively. They were all aged between 24 and 38. Their length of stay in Japan was varied from 3 months to 5 years. The detailed information of students is shown in Table 5.1. The majors of the students were engineering and medical. They had internet connected PCs at home and smart phones.

Before the evaluation started, usage of SCROLL with L2D was explained. All the students were asked to record the Japanese words they have learned in a daily life. They took quizzes and reviewed contents with SCROLL and L2D by using PCs and smart phones. They've never used SCROLL before. Therefore, they had tried SCROLL for two days before the evaluation started in order to be accustomed.

Table 5.1. Details of students

Student	**Age**	**Gender**	**Length of stay in Japan (total)**
A	25	Male	1 year
B	30	Male	3 years
C	30	Female	5 years
D	24	Female	2 years
E	30	Female	1 year
F	27	Female	1 year 6 months
G	26	Female	1 year 6 months
H	28	Female	2 years
I	31	Male	2 years
J	28	Female	2 years
K	38	Female	3 months
L	38	Male	3 years
M	29	Female	2 years
N	26	Female	2 years

Table 5.1. Details of students. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET),*14(3), (2016, in press). Copyright 2016 by IGI Global.

A crossover research design was established involving two groups, with 7 students in each group. 14 students were divided into two groups according to pre-test result in order to make both groups homogeneous. Pre-test was a web based vocabulary test with multiple-choice questions. It was designed to translate the target Japanese words into English. The pre-test was based on the JLPT N3 level (Japanese Language Proficiency Test). Because JLPT is an official test which is organized by the Japan Foundation and Japan Educational Exchanges and Services, the students' ability level were referred to this JLPT level. Besides, the subjects of this experiment were oversea students who were learning Japanese in Japan. Hence it was necessary to know the students' ability level. Each group of students was engaged in following two conditions:

1) Students study Japanese language with SCROLL. They use SCROLL to evaluate and to review their learning activities by viewing, uploading contents, using knowledge map, time map, taking quizzes (for reinforcing memories).
2) Students study Japanese language with SCROLL and L2D. They use SCROLL with L2D by seeing their progress (achievements and learning information statistics), concentrating and working on the words answered incorrectly before, repeatedly practicing words by the quizzes and seeing their progress.

The order of the conditions rotates, so that each group had a different start conditions. The evaluation was carried out over 6 weeks. The aim of conducting a long term experiment was to accumulate students' history data to make an accurate prediction. Each group had an experience of both two learning modes for 3 weeks respectively, as indicated in the table below:

Table 5.2. The evaluation design

<table>
<tr><td rowspan="3">Pre-test</td><td colspan="3">Phase 1 (3 weeks)</td><td colspan="2">Phase 2 (3 weeks)</td><td rowspan="3">Questionnaire and open ended questions</td></tr>
<tr><td>Group A</td><td>SCROLL with Dashboard</td><td rowspan="2">Post test 1</td><td>SCROLL</td><td rowspan="2">Post test 2</td></tr>
<tr><td>Group B</td><td>SCROLL</td><td>SCROLL with Dashboard</td></tr>
</table>

Table 5.2. The evaluation design. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

During the experiment the students used the systems to get support for their learning activity in daily lives. After each phase, a post-test would occur. The test consisted of the Japanese words that each student learned in those weeks. It means that each student takes different test. The full mark for pre- and post-tests were 30. The students' learning activities were investigated. After the experiment, the students were asked to answer the questionnaire.

5.2. Results

After the experiment, the results were analyzed from students' post-tests, the log data stored in the server and the questionnaires. During the whole experiment, all the students uploaded 1,339 learning logs (mean=47.82, SD=46.99) and did 4,439 quizzes (mean=158.53, SD=81.09).

Table 5.3. The number of words uploaded and the number of quizzes took

phase 1 + phase 2	**Number of words uploaded**	**Number of quizzes**
Phase 1	785	1628
Phase 2	554	2811
Total	1,339 (96/each)	4,439 (317/each)

Table 5.3. The number of words uploaded and the number of quizzes took. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

As shown in Table 5.3, a student recorded 96 learning logs and worked on 317 quizzes averagely. It means that they adapted to the system well. Figure 5.1 shows some examples of the list linked to learning logs uploaded in this experiment.

Moreover, during the experiment the students have received the quizzes as shown in Figure 5.2. In the quiz, the student should select the correct image corresponding to the food-market.

The results of the five-point-scale survey is shown in Table 5.4 (a five-point Likert scale is used, the responses to which are coded as 1 = strongly disagree through to 5 = strongly agree).

Q6 (mean=4.64, SD=0.49) and Q7 (mean=4.5, SD=0.51) results were most highly rated. It means that students have a favorable impression on the main purpose of this system. This result indicates that the system influenced student's learning process efficiently by offering necessary and useful knowledge. Moreover the improvement from pre-test to post test (1) (2) endorsed this fact. Therefore these results show that L2D system worked as effectively. From Q1, the results show that the students are satisfied (mean=4.14; SD=0.77) with using L2D. Q2 asked them about influence on motivation. This result (mean=4.21; SD=0.69) indicates that the students could keep motivation.

Q3 and Q4 were about usefulness for vocabulary learning of L2D system. Q3 (mean=4.07, SD=0.73), in other words, it indicated that the students were able to retain their long-term memory using L2D system. Q4 results (mean=4.35, SD=0.74) show the students impression on how effectively the system navigated them to the vocabulary learning.

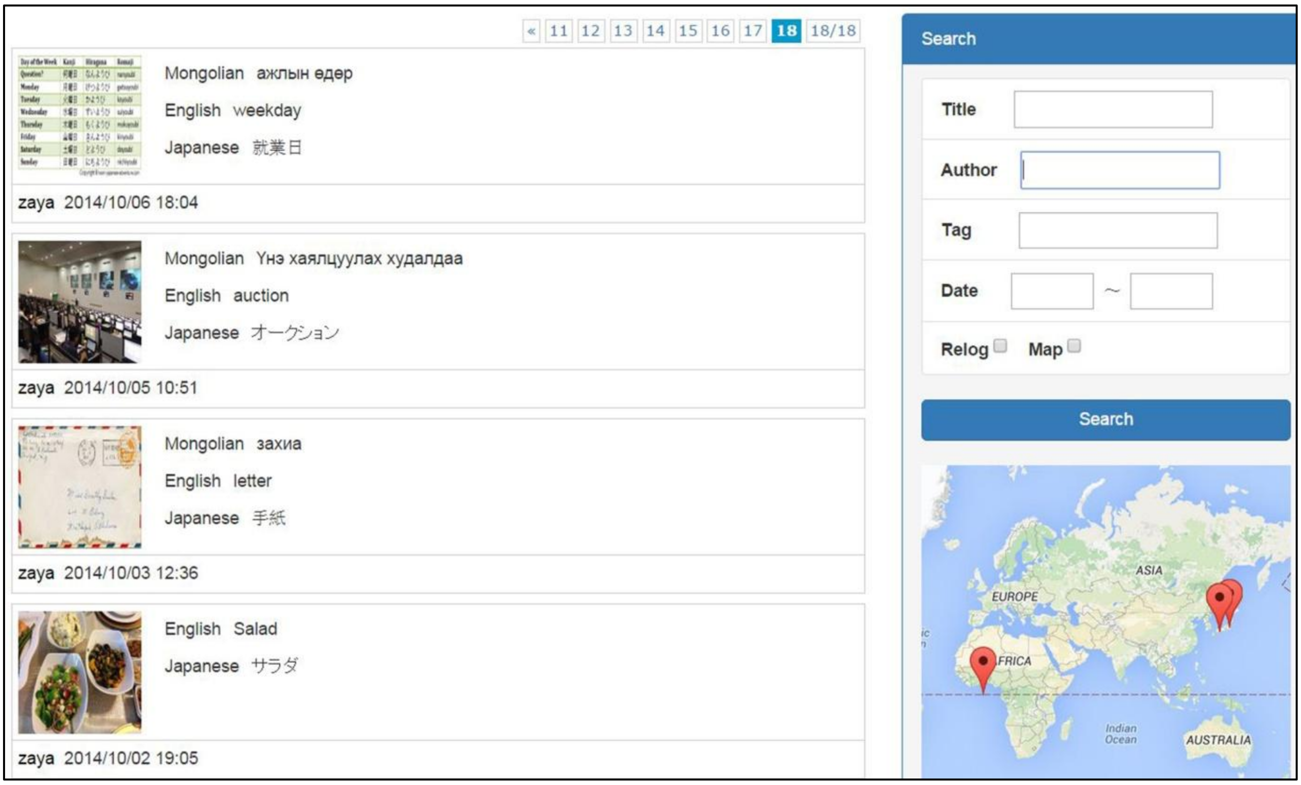

Figure 5.1. Learning logs uploaded in the experiment

Figure 5.2. Text based multiple-choice quiz

Figure 5.2. An example of quiz. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Q5, the students satisfied the quiz overview (mean=4.35, SD=0.49). Differently represented quizzes helped them to evaluate and to recall their knowledge. Also from open ended comments, one student wrote "Answering quizzes reminds me of the words forgotten. Especially colored buttons were interesting". The result indicates that students were able to retrieve the knowledge using the quiz overview.

Table 5.5 presents comparison between experimental and control settings of number of uploaded words and quizzes.

Table 5.4. Result of the five-point-scale questionnaire

Question	**Mean**	**SD**
Q1. Was L2D system interface easy to use?	4.14	0.77
Q2. Is it help your language learning motivation?	4.21	0.69
Q3. Was using L2D system impressive enough to retain in your long-term memory?	4.07	0.73
Q4. Was Dashboard with SCROLL useful for vocabulary learning?	4.35	0.74
Q5. How do you evaluate the quiz overview ? (differently represented in several colors)	4.35	0.49
Q6. Was this repeated quiz based on your previous mistakes efficient?	4.64	0.49
Q7. Was this system enjoyable?	4.5	0.51

Table 5.4. Result of the five-point-scale questionnaire. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Table 5.5. The number of uploaded logs and the number of quizzes

	Number of words uploaded	**Number of quizzes**
Experiment setting	**556 (Mean=37.71) (SD=17.93)**	**2,479 (Mean=177.07) (SD=83.63)**
Control setting	783 (mean=55.92) (SD=64.21)	1,960 (Mean=140) (SD=79.97)

Table 5.5. The number of uploaded logs and the number of quizzes. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

The students' frequency of activity information for experimental and control settings are shown in Figure 5.3 and Figure 5.4. Figure 5.3 illustrates that students were less active when they used L2D than the normal SCROLL from uploading activity viewpoint.

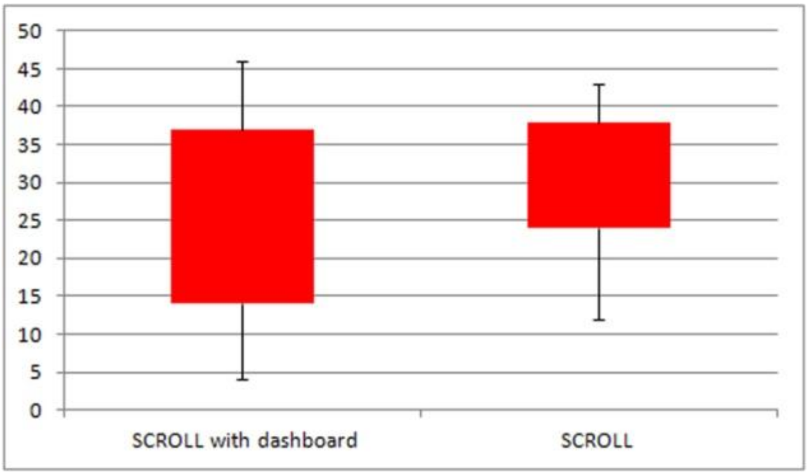

Figure 5.3. Frequency of learning log uploaded activity

Figure 5.3. Frequency of learning log uploaded activity. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

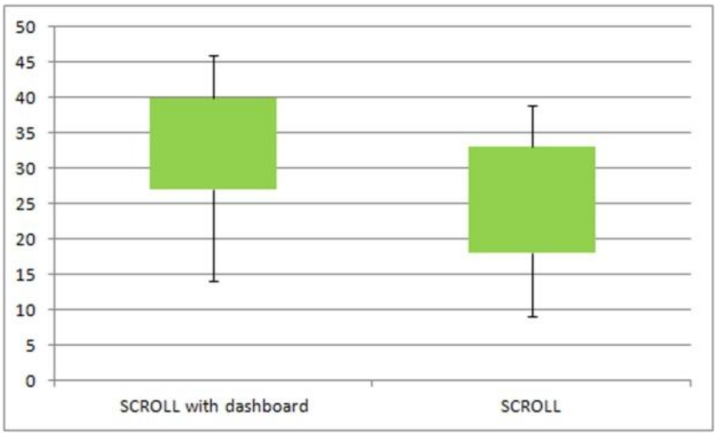

Figure 5.4. Frequency of quiz activity

Figure 5.4. Frequency of quiz activity. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Nevertheless Figure 5.4 presents that when students use SCROLL with learning log dashboard, quiz activity is higher than using normal SCROLL.

Table 5.6. Pre-test and Post-test results (Full mark: 30)

Groups	Pre-test	Phase 1 Post test (1)		Phase 2 Post test (2)		ANOVA
Group A	Mean=20.86 SD=4.7	**With L2D**	**Mean=24.57 SD=4.07**	Without L2D	Mean=25.14 SD=1.77	p>0.05
Group B	Mean=20.71 SD=5.76	Without L2D	Mean=22.28 SD=5.37	**With L2D**	**Mean=27.42 SD=1.71**	**p<0.05**

Table 5.6. Pre-test and Post-test results (Full mark: 30). Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Pre-and post-test (1) (2) results of Group A and Group B are presented in Table 5.6. There is a statistically significant difference between pre-test, post test (1), (2) for Group B as determined by one-way ANOVA ($p<0.05$). It means Group B shows improvement. Moreover, experimental and control settings are compared to pre-test by one-way ANOVA ($p<0.05$). There is a statistically significance. Then, further analysis (multiple comparison) is made according to Bonferroni method. The author found a pair (pre-test and experimental setting ($p<0.05$)). It means that L2D system is more useful in vocabulary learning.

Table 5.7 shows open-ended comments from the students. Most part of their comments are positive ones. Especially contents with dashboard gained good reputation (students C, E, G, H, J, K, L). L2D system seemed to enhance students' motivation of learning Japanese.

Table 5.7. Comments from students

Student	Comments
A	It was very good because I could learn words from other students' uploaded words. The words, which I uploaded, are appeared as a quiz. I think it is good way to memorize words.
B	It is very convenient to record what I have learned when I travel or shopping. Also, it is easy to review what I have learned.
C	The dashboard system was completely useful to study foreign languages, especially to confirm the new vocabulary we added. We can write down forgettable words or phrases and they are kept all through the time. Therefore, we can get a more effective feedback. Even we had fun and have increased our languages. We want to continue using this program in our free or studying hours.. Thank you very much.
D	It was easy to remember by answering quizzes. Also it was fun to answer quizzes.
E	I forget new vocabulary easily, but it was a good way to review by answering quizzes. Dashboard system is very good and interesting.
F	The advantage of the SCROLL system for me is that it gave me the motivation to study Japanese. And I can easily retain what I have learned, because the pictures I took usually help me to recall them.
G	Answering quizzes reminds me of the words forgotten. Especially colored buttons were interesting.
H	When I talk in Japanese, sometimes I forget the word I learned. But with this system, it is easier to recall them. Dashboard was very useful. (plurality opinion)
I	As I had to take a JLPT (Japanese Language Proficiency Test), it helped a lot to prepare for the examination. I felt like I wanted to learn more vocabulary when using the system.
J	This system is can be used to learn many languages. Dashboard menu suggested to do quizzes. The result of one user after doing the test is quiet interesting and attractive, making the learning is really done.
K	Dashboard was very good and fun. I think It’s very useful program for people who are learning foreign language. Also it's interesting and effective method for researcher of foreign languages.
L	The dashboard was useful to study foreign languages, but sometimes the system was very slow and crashing. It was difficult for me.
M	There came out a quiz of a word which I did not upload and I did not like it.
N	Sometimes, some weird translation came out. So, a dictionary function as a translator of a uploaded English word was not good enough.

Table 5.7. Comments from students. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

On the other hand, some weak points were found (student L, M and N). One of the negative opinion was about availability of L2D. The improvement of L2D stability will be included in the future work. Student M opinion was about the quiz function. Therefore, the quiz function of SCROLL was improved. As for the last comment, SCROLL integrates a function of automatic translator (Google translator). That is why some translation came out incorrect.

5.3. Discussion

The experimental setting showed a larger improvement for both tests than the control setting as given in Table 5.8 and Figure 5.5. The increasing difference of pre-test and post-test (1) (2) for experimental setting in phase 1 and phase 2 were 2 points larger than control setting in phase 1, 2. It means that experimental setting students uploaded fewer words, but learned more words than control setting students. In this sense, L2D system was more effective and supportive for usage of stored contents than normal SCROLL though paired t-test did not show that it was statistically significant.

Table 5.8. Increasing difference between pre-test, post test (1)(2) results

	Phase 1	**Phase 2**
	Pre & Post-Test 1 Increase mean (SD)	Pre & Post-Test 2 Increase mean (SD)
Experimental setting	**3.72 (1.97) (with L2D)**	**6.56 (5.37) (with L2D)**
Control Setting	1.57 (3.10) (without L2D)	4.43 (4.23) (without L2D)

Table 5.8. Increasing difference between pre-test, post test (1)(2) results. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Figure 5.6 shows the increasing difference between pre-test, post test (1) (2) for Group A and Group B. The author can say that the students are satisfied with the L2D system and it helps them to study Japanese language.

Table 5.9 shows each student's total numbers of uploaded words and times of quiz taking. Moreover, the correlation between the number of uploaded logs and each student's times of quiz taking were examined.

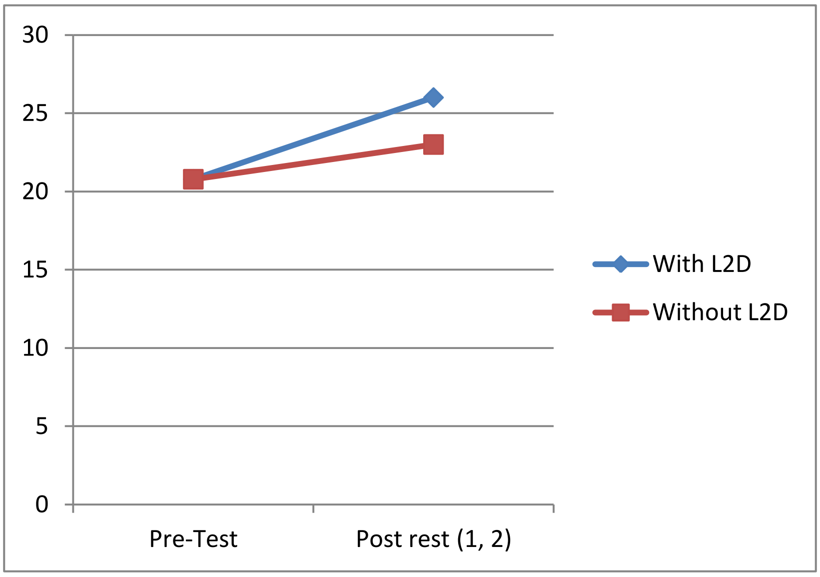

Figure 5.5. Pre-test and Post test (1) (2) results
(Experimental and Control setting)

Figure 5.5. Pre-test and Post test (1) (2) results (Experimental and Control setting). Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

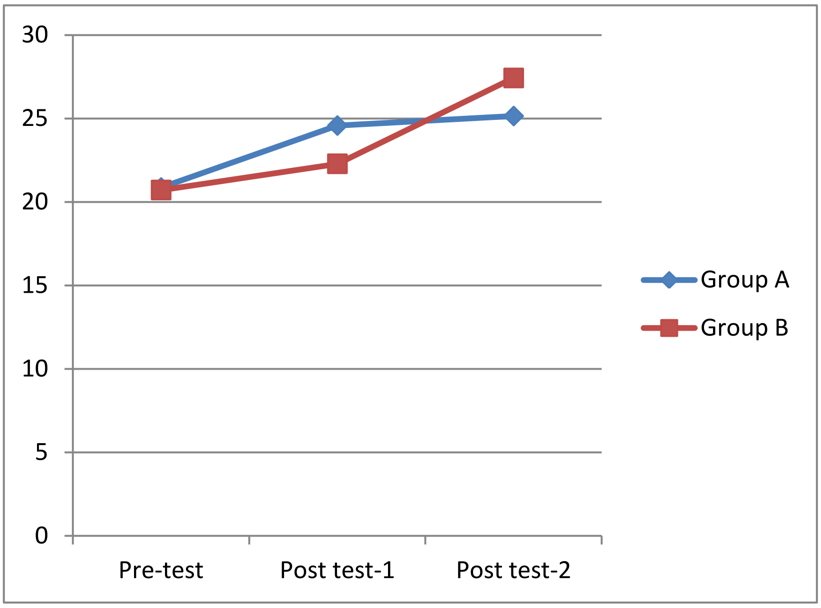

Figure 5.6. Pre-test, Post test (1) (2) results

Figure 5.6. Pre-test, Post test (1) (2) results. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

The coefficient of correlation between two factors was 0.3184. It means that the result was detected statistically significance correlation between the number of uploaded words and times of quiz taking.

Table 5.9. The number of uploaded logs and times of quiz-taking

Student	**Number of uploaded logs**	**Times of quiz-taking**
A	76	251
B	357	355
C	81	291
D	37	88
E	114	580
F	52	262
G	120	467
H	70	226
I	102	319
J	67	227
K	69	351
L	65	373
M	58	328
N	71	321
Mean SD	95.64 (78.62)	317.07 (115.83)

Figure 5.9. The number of uploaded logs and times of quiz-taking. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Table 5.10. The number of uploaded logs and the number of quizzes

	Phase 1 Uploaded logs		Completed quizzes		Phase 2 Uploaded logs		Completed quizzes
Group A	With L2D	Sum=265 Mean=37.85 SD=14.11 Min=14 Max=61	Sum=860 Mean=122 SD=68.05 Min=0 Max=204	**Group B**	With L2D	SUM=291 Mean=41.57 SD=22.13 Min=24 Max=88	Sum=1619 Mean=231.28 SD=60.54 Min=135 Max=324
Group B	Without L2D	sum=520 mean=74.28 SD=88.24 Min=5 Max=269	Sum=768 Mean=109.71 SD=79.92 Min=14 Max=256	**Group A**	Without L2D	SUM=263 Mean=37.57 SD=18.98 Min=22 Max=70	Sum=1192 Mean=170.28 SD=65.64 Min=88 Max=263

Figure 5.10. The number of uploaded logs and the number of quizzes. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

During the experiment, 1,339 learning logs (mean=47.82, SD=46.99) were uploaded and 4,439 quizzes (mean = 158.53, SD=81.09) were done in total. For a student in average, his or her records were 2.27 learning logs and 7.54 quizzes every day. It means that they engaged in the system well. Besides high standard deviations reveal that each student's involvement differs greatly. Hence, this research work focuses on statistics on every student's usage of the system. Specially, in phase 1 of Group B (mean=74.28, SD=88.24, min=5, max=269), each student's involvement differs greatly for uploaded logs as shown in Table 5.10. Table 5.10 also shows student B uploaded 269 learning logs. Therefore, from Figure 5.7 and Figure 5.8, the results show Group A with L2D learn actively more than Group B. Moreover, in phase 1, high standard deviations reveal for Group A (mean=122, SD=68.05) while Group B (mean=520; SD=88.24) did quizzes.

Seeing from Figure 5.9 and Figure 5.10, the students of Group A did quizzes more than Group B. Moreover Group A, student D didn't do quiz as shown in Table 5.10. High standard deviations also reveal for Group B (Mean=109.71, SD=79.92) that each student's involvement differs greatly. Group B, student E did 256 quizzes as shown in Table 5.10. Therefore, these results show that activity of Group A with L2D are higher than Group B. If student D of Group A worked on quiz, the activity of Group A would be more high. A total of 14 students attended the experiment. 11 of all the students are in the school of medicine, and they all have their own periodic tasks more than others. Probably this is one of the reasons why less activities is shown by using the systems.

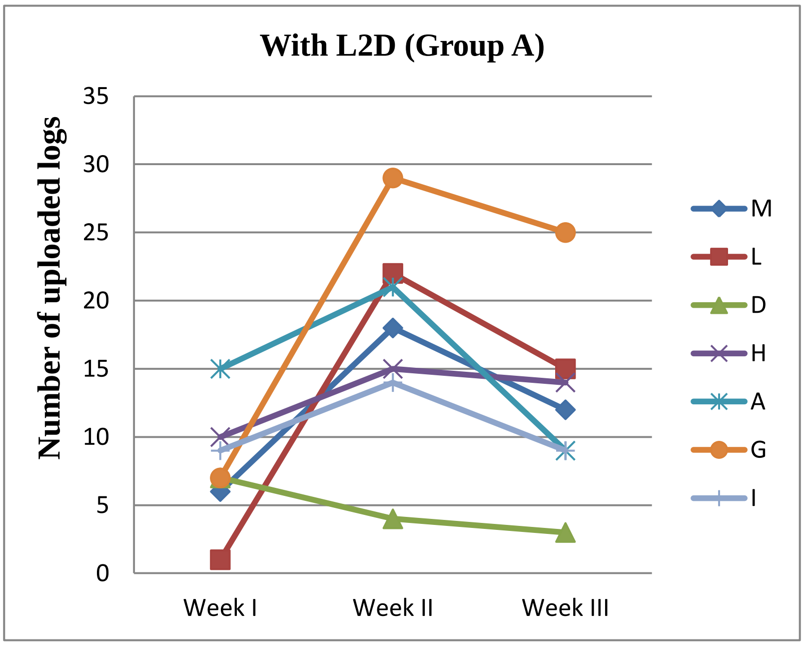

Figure 5.7. Number of uploaded logs of Group A

Figure 5.7. Number of uploaded logs of Group A. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

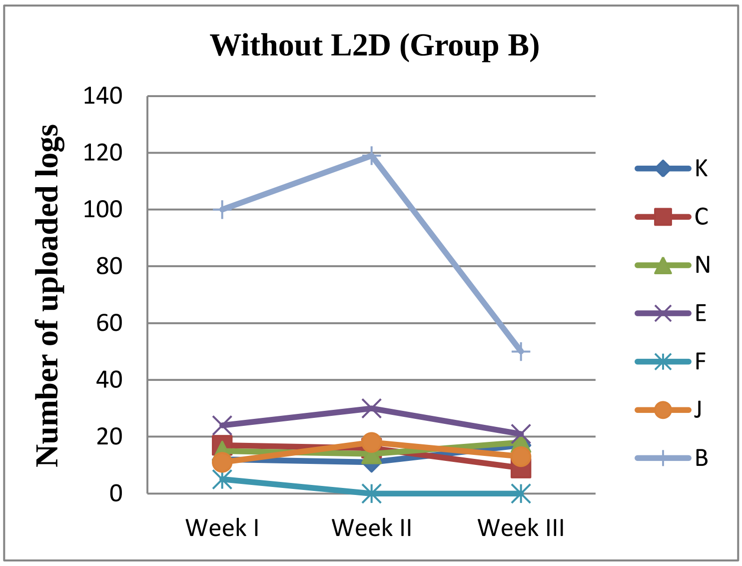

Figure 5.8. Number of uploaded logs of Group B

Figure 5.8. Number of uploaded logs of Group B. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

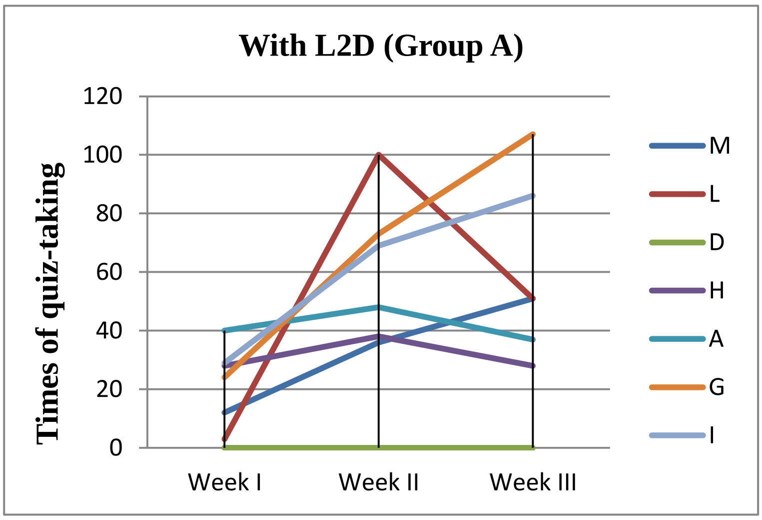

Figure 5.9. Times of quiz-taking with L2D of Group A

Figure 5.9. Times of quiz-taking with L2D of Group A. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

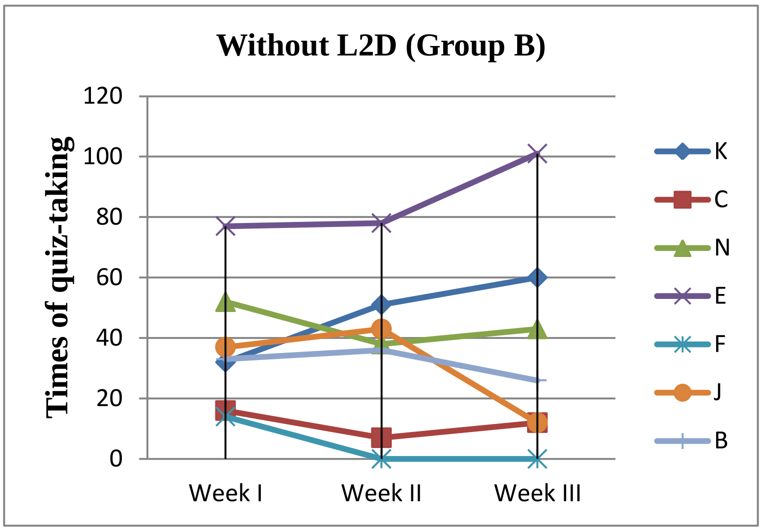

Figure 5.10. Times of quiz-taking without L2D of Group B

Figure 5.10. Times of quiz-taking without L2D of Group B. Adapted from "Dashboard For Analyzing Ubiquitous Learning Log" by Erdenesaikhan Lkhagvasuren, Kenji Matsuura, Kousuke Mouri, Hiroaki Ogata. *International Journal of Distance Education Technologies (IJDET)*,14(3), (2016, in press). Copyright 2016 by IGI Global.

Chapter 6

Conclusion

This paper is a contribution to the solution of the major problems faced in the ubiquitous learning environment. Specially, studies in the ULA haven't been realized yet to display, analyze and trace self-reflection of their own learning activities with their contexts in accordance with their learning situations in the real world.

In order to solve the problems, learning log dashboard (L2D) is developed. The main objective is to provide learners with the L2D system which reuses, analyzes and visualizes traces of learning activities in order to promote awareness and enables learners to reflect on their own activity and helps to recall what they have learned.

An evaluation was conducted to evaluate the usability of L2D system in the ubiquitous learning environment. In the evaluation, the following points were found out: 1) The experimental setting showed a larger improvement for both tests than the control setting. It means that experimental setting students uploaded fewer words, but learned more words than control setting students. 2) Therefore, it can safely be said that L2D system was more effective and supportive than normal SCROLL. According to the questionnaire result, it was find out that the system added some efficient way in vocabulary learning. 3) During the experiment, 1,339 learning logs (mean=47.82, SD=46.99) were uploaded and 4,439 quizzes (mean = 158.53, SD=81.09) were done. For a student, his or her records are 2.27 learning logs and 7.54 quizzes every day. It means that they engaged in the system well.

Moreover, the correlation between the number of uploaded logs and each student's times of quiz taking was examined. The coefficient of correlation between the two factors was 0.3184.

4) Besides open-ended comments from students, most part of their comments were positive. Especially contents with dashboard gained good reputation (students C, E, G, H, J, K, L). L2D seemed to enhance students' motivation of learning Japanese.

In terms of future works, it is necessary to recommend and present past learning logs on the system in accordance with each learner's condition. In addition, it is also necessary to prepare a guideline for effective use of SCROLL with L2D based on long-term evaluation.

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