SUPPORTING SELF-REGULATED LEARNING IN WEB 2.0 CONTEXTS

Yong-Ming Huang
Department of Engineering Science, National Cheng Kung University,
No. 1, University Road, Tainan 701, Taiwan, R.O.C.

Yueh-Min Huang
Department of Engineering Science, National Cheng Kung University,
No. 1, University Road, Tainan 701, Taiwan, R.O.C.
Department of Applied Geoinformatics, Chia Nan University of Pharmacy & Science
No. 60, Erh-Jen RD., Sec.1, Jen-Te, Tainan, 717, Taiwan

Chia-Sui Wang
[3]Department of General Education, Chia Nan University of Pharmacy & Science
No. 60, Erh-Jen RD., Sec.1, Jen-Te, Tainan, 717, Taiwan

Chien-Hung Liu
[4]Department of Network Multimedia Design, Hsing Kuo University of Management,
No. 600, Sec. 3, Taijiang Boulevard, Tainan 709, Taiwan, R.O.C.

Frode Eika Sandnes
Faculty of Engineering, Oslo University College, Oslo, Norway

*Corresponding Author: Yueh-Min Huang
Email: huang@mail.ncku.edu.tw

ABSTRACT
Web-based self-learning (WBSL) provides learners with a powerful means of acquiring knowledge. However, WBSL may disorient learners, especially when their skills are inadequate for regulating their learning. In this paper, a Web 2.0 self-regulated learning (Web2SRL) system based on the theory of self-regulated learning is proposed. Learners use the Web2SRL system to read articles in RSS feeds from blogs of interest. The Web2SRL system provides learners with mechanisms for regulating their learning, including planning, practice, and reflection. The results of pre- and post-tests show that the Web2SRL system supports knowledge acquisition in WBSL contexts, especially for low-achieving learners. The results of a questionnaire indicate that learners perceive the Web2SRL system to be useful in supporting WBSL. The proposed system can thus play an important role in supporting WBSL.

INTRODUCTION

Web-based learning contexts have received a lot of attention in recent years due to the popularity of Web 2.0 technologies (Kiyici, 2010; Lin, Huang, & Cheng, 2010; Tilfarlioğlu, 2011). They can be used to realize web-based self-learning (WBSL) contexts by providing individuals with an efficient means of sharing and acquiring knowledge. Blogs and RSS feeds are popular Web 2.0 technologies. Blogs are publishing platforms that enable individuals to share their knowledge (Kalelioglu & Gulbahar, 2010); they can be viewed as online learning material (Huang, Huang, Liu, Tsai, in press). RSS is an XML (extensible markup language) format that is used to deliver frequently updated content such as blogs (Lan & Sie, 2010). An RSS document is called an RSS feed, which contains a list of recently posted articles in a blog. Individuals can use an RSS reader to subscribe to RSS feeds and read articles from blogs of interest (Huang, Huang, & Fu, 2011).

However, WBSL may disorient learners, particularly those who are insufficiently skilled in regulating their learning (Azevedo, Cromley, Winters, Moos, & Greene, 2005). In WBSL contexts, learners may need to make decisions about how to plan their learning, how to practice what they have learned, and how to examine their process. Few learners are sufficiently skilled in regulating their learning (Azevedo & Cromley, 2004; Kramarski & Gutman, 2006; Kramarski & Mizrachi, 2007). Thus, mechanisms for supporting learners in undertaking WBSL are desirable.

This paper applies the theory of self-regulated learning (SRL) (Zimmerman, 2002) to design a Web 2.0 self-regulated learning (Web2SRL) system. The Web2SRL system is designed to support learners in regulating their self-learning in Web 2.0 contexts. The main idea behind SRL is to enable learners to constantly regulate their learning in order to gradually learn how to manage their learning (Zimmerman, 2000; 2002). SRL refers to self-generated thoughts and actions that are systematically and cyclically oriented towards the achievement of

personal goals (Zimmerman, 2000; 2002). SRL is a goal-oriented learning strategy that is very suitable for self-managed learning for promoting learning effectiveness in a web-based learning environment (Chen, Huang, Li, & Huang, 2007). Accordingly, SRL theory was adopted here to assist learners in undertaking WBSL in Web 2.0 contexts. To fully exploit the benefits of SRL, the Web2SRL system contains planning, practice, and reflection subsystems. The planning subsystem allows learners to plan their learning, the practice subsystem allows learners to practice what they have learned, and the reflection subsystem allows learners to examine their progress. If the reflection subsystem indicates poor progress, the planning subsystem is used to regulate learning in order to ensure that subsequent learning can be improved. Accordingly, learners gradually learn how to regulate their learning in WBSL contexts and further realize meaningful learning (Huang, Chiu, Liu, & Chen, 2011).

An experiment was conducted to evaluate the Web2SRL system. The Web2SRL system was implemented and deployed at a university. Pre- and post-tests were used to investigate the effect of the Web2SRL system on WBSL and a questionnaire was developed to obtain learners' perceptions of the system. Finally, analyses were carried out to examine the applicability of the Web2SRL system.

THEORETICAL BACKGROUND AND RELATED STUDIES

SELF-REGULATED LEARNING THEORY

SRL refers to self-generated thoughts, feelings, and actions that are systematically and cyclically oriented towards the achievement of personal goals (Zimmerman, 2000; 2002). It is a cyclical learning activity that involves three phases, namely forethought, performance, and self-reflection (Zimmerman, 1986; 1989; 2002). In the forethought phase, learners arrange their learning scheme through goal setting and strategic planning. In the performance phase, learners put their learning scheme into action. In the self-reflection phase, learners reflect on their learning process. The SRL process makes learners aware of their strengths and weaknesses and helps them regulate their goals and strategies (Zimmerman, 2002; 2008). The planning, practice, and reflection subsystems in the Web2SRL system correspond to the forethought, performance, and self-reflection phases of SRL, respectively. The Web2SRL system can thus be used to realize the SRL process.

RELATED STUDIES

SRL in web-based environments has received increasing attention (Zimmerman, 2008). Related studies can be roughly divided into three classes: (i) the analysis of online SRL behavior, (ii) the application of the SRL strategy, and (iii) the development of SRL-based systems.

The analysis of online SRL behavior is focused primarily on the behavior of learners. Azevedo and Cromley (2004) used the think aloud method to analyze learners' SRL process in a hypermedia learning environment. The think aloud method is used to understand learners' reports about their thoughts and cognitive processes when performing an action. In their work, learners were asked to think aloud while performing an action. Perry and Winne (2006) argued that self-reported data are not reliable for investigating learners' SRL process, especially when learners are young children. Hence, they designed a log analyzer to unobtrusively record how and when learners performed an action. The trace data provided fine-grained, detailed, time-referenced logs, which were used to investigate young children's SRL process. However, the analysis of such trace data is insufficient for interpreting the thoughts of learners, since it is based on quantitative analysis such as the frequencies of events or the properties of event sequences. Hence, such analysis is only used to explore learners' SRL process rather than learners' thoughts on SRL. Recently, Dettori and Persico (2008) utilized qualitative analysis and interaction analysis to investigate SRL in virtual learning communities. The interaction analysis was based on the detection of phrases and expressions to analyze the messages exchanged by learners. In their study, a set of indicators was designed to spot clues of self-regulated events within the messages. The clues were then used to explore the application of SRL by learners and to understand the thoughts of learners. In general, the interaction analysis is labor-intensive since researchers need to spend a lot of time spotting the clues from the learners' messages. Nevertheless, it provides researchers with an opportunity to observe the evolution of learners' SRL process over time.

The SRL strategy has been applied to online learning activities to determine its impact. Lee et al. (2008) combined problem-based learning (PBL) and SRL to enhance online learning. In their research, a series of quasi-experiments was conducted to examine the effects of PBL and SRL on web-based learning. Their results showed that the implementation of pedagogy was important for online learning, particularly for students with low academic achievement. One explanation is that the SRL strategy is useful in assisting low-achieving students, who are often easily distracted, in concentrating on online learning. Vighnarajah et al. (2009) applied the SRL strategy to an online community discussion platform. In their study, semi-structured interviews were

used to examine the relationship between the SRL strategy and the platform. Their results showed that participation in the online discussion was effective in improving the practice of the SRL strategy. Students can use the online discussion to seek help in practicing SRL. Fox example, students can read forum discussion threads to set their goals and then encourage each other to achieve them.

Assisting learners with monitoring self-learning is the main issue in the development of SRL-based systems. Chen et al. (2007) argued that SRL is very suitable for self-managed learning for promoting learning effectiveness in a web-based learning environment. They proposed a personalized e-learning system with self-regulated learning-assisted mechanisms to help learners improve their self-regulated learning ability. Chen (2009) developed a personalized e-learning system with an SRL indicator to assist learners. The SRL indicator is composed of several indices, including learning time and effort level. By using these indices, learners can monitor their learning performance and reflect on their learning process. However, these studies focused on only the reflection phase of SRL. The present study applies SRL theory to design a Web2SRL system for assisting students in performing systematic SRL.

Although SRL in web-based learning contexts has attracted a lot of attention, SRL in WBSL contexts has not been extensively studied, especially in Web 2.0 contexts. SRL theory has been found to be beneficial in web-based learning contexts, especially for low-achieving learners. However, whether SRL theory has the same benefits in Web 2.0 contexts is still unknown. The Web2SRL system used in this study was developed to investigate this issue. Details of the proposed system are described in the next section.

THE WEB2SRL SYSTEM

The Web2SRL system is designed to support learners when they undertake self-learning in Web 2.0 contexts. Specifically, learners can use the Web2SRL system to read articles in RSS feeds from blogs of interest. Unlike general RSS readers, the Web2SRL system provides learners with a cyclical mechanism for achieving SRL, as shown in Figure 1.

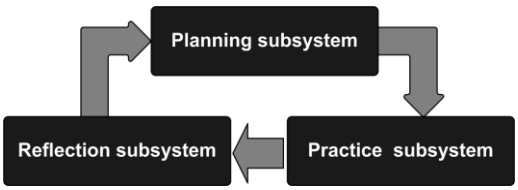

Figure 1. Cyclical mechanism for achieving SRL.

The planning subsystem is designed to enable learners to arrange a learning scheme that involves goal setting and strategic planning. For goal setting, learners decide the number of articles they wish to read during a certain period. For strategic planning, learners select a reading strategy such as SQ3R (survey, question, read, recite, review) (Robinson, 1961).

The practice subsystem allows learners to practice the learning scheme. Here, a subscribing function is designed to assist learners in subscribing to RSS feeds and reading the articles in RSS feeds. A note-taking function is designed to assist learners in writing down any ideas they have when reading the articles.

The reflection subsystem is designed to enable learners to examine their progress. A reading test function is designed to assist learners with examining their acquired knowledge. In the tests, learners select the appropriate keyword from a given article. A previously developed information retrieval technique, the term frequency-inverse document frequency (TF-IDF) technique (Salton & McGill, 1983), is adopted to select the keywords of an article, which are then used as the answers to the quiz. Learners can use the quizzes to assess their progress. Learners can increase or decrease the number of articles in the next learning scheme based on their quiz results.

RESEARCH DESIGN

A one-group pretest-posttest design was used to examine the effect of the Web2SRL system on WBSL. The design is a pre-experimental design in which one group is subjected to a treatment and observed before and after the treatment (Campbell & Stanley, 1963). In this study, students were observed before and after using the Web2SRL system to undertake a WBSL activity. The observations were used to explore the effect of the Web2SRL system on WBSL.

Research Questions

A previous study indicated that the implementation of SRL theory should be considered for online learning (Lee

et al., 2008). This study investigated the following research questions: (1) what is the effect of the Web2SRL system on high- and low-achieving students and (2) what are students' perceptions of the Web2SRL system?

Participants

A total of 39 undergraduate students from a university in Tainan, Taiwan, participated in the study. The average age of the participants was 20.5 years (standard deviation (sd) = 2.0 years). Their prior experience of Internet usage ranged from 4 to 12 years, with a mean of 8.1 years (sd = 2.2 years), and the amount of time spent on the Internet per day ranged from 1 to 10 hours, with a mean of 5.2 hours (sd = 2.6 hours). The participants were thus experienced and interested in using both computers and the Internet.

System and materials

The ASP.NET (C#) programming language and an SQL Server 2005 database were used to implement the system prototype used in this study. The materials used in the experiment were mainly from the Engadget blog (http://www.engadget.com/), which frequently publishes articles about new computer and Internet technologies. Figure 2 shows the participants performing a WBSL activity using the Web2SRL system.

Figure 2. Participants performing a WBSL activity using the Web2SRL system.

Questionnaire

To determine the students' perceptions of the Web2SRL system, the perceived ease of use (PEU) and perceived usefulness (PUF) constructs were used. These constructs are considered important in determining acceptance and use of information technology (Davis, 1989; Huang, Huang, Huang, & Lin, 2012; Lin, Lin, & Huang, 2011). The perceived WBSL effectiveness (PWE) and perceived WBSL satisfaction (PWS) constructs were used to investigate the students' perceptions of using the Web2SRL system to perform WBSL (Chou & Liu, 2005; Huang & Liu, 2009). Accordingly, a structured questionnaire was developed based on a review of prior studies (Chou & Liu, 2005; Davis, 1989; Huang & Liu, 2009) as well as feedback from two experts. The questionnaire includes PEU, PUF, PWE, and PWS, as shown in Table 1. The questionnaire was distributed to the participants, who were asked to complete it by indicating their level of agreement with a number of statements on a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5).

Table 1. Questionnaire

Construct	Items	Reference
PEU	(PEU1) I feel that this system was easy to use.	Davis, 1989;
	(PEU2) I feel that learning to use this system was easy.	Huang et al.,
	(PEU3) I feel that operating this system does not require too much time.	2012
PUF	(PUF1) I feel that this system was a useful learning tool.	Davis, 1989;
	(PUF2) I feel that using this system can promote the efficacy of learning.	Huang et al.,
	(PUF3) I feel that using this system can increase the motivation of learning.	2012;
		Lin et al., 2011
PWE	(PWE1) I can use this system to obtain new knowledge.	Self-developed
	(PWE2) I can use this system to constantly update my knowledge.	
	(PWE3) I can use this system to obtain new knowledge beyond that contained in	

	the textbook.	
PWS	(PWS1) I am satisfied with this way to learn. (PWS2) I am satisfied with using this system as a learning tool. (PWS3) I am satisfied with using this system to learn knowledge.	Chou & Liu, 2005; Huang & Liu, 2009

Procedure

The experiment was conducted in a course to introduce computer science, in which the Web2SRL system was used to increase the students' knowledge of new computer and the Internet technology. In this experiment, the learning topic was computer science and the learning objective was to learn about new computer and the Internet technology. At the start of the experiment, all the participants were asked to take a pre-test to evaluate their knowledge about new computer and Internet technologies before using the Web2SRL system. After the pre-test, all the participants performed a WBSL activity using the Web2SRL system. In the WBSL activity, the participants used the system to plan, practice, and reflect on their learning scheme. During the period of the WBSL activity, the participants could use the system to constantly regulate their learning in order to concentrate on WBSL. The WBSL activity was not only performed in the regular curriculum, but also in extracurricular time. When the WBSL activity was completed (one month), the participants were asked to take a post-test to evaluate their knowledge about new computer and Internet technologies after using the Web2SRL system. The pre- and post-tests both consisted of 15 multiple-choice questions designed by two experts (i.e., a total of 30 items). The two tests had the same level of difficulty in order to examine the difference in the participants' knowledge between before and after using the Web2SRL system. Finally, the participants were asked to fill out a questionnaire that explored their perceptions of the Web2SRL system.

RESULTS AND DISCUSSION

Analysis of the effect of the Web2SRL system on WBSL

This analysis examines the effect of the Web2SRL system on all students (AS), low-achieving students (LS), and high-achieving students (HS). The students were classified into LS and HS based on their pre-test scores. Students with pre-test scores lower and higher than the mean score were designated as LS and HS, respectively.

A paired-sample t-test was used to assess the difference in the knowledge of AS, LS, and HS between pre-test and post-test. The results of AS show that there was a significant difference ($t = 7.25$, $df = 38$, $p < 0.001$) between pre-test (mean = 8.89, sd = 1.51) and post-test (mean = 11.07, sd = 1.78) performance. The results of LS show that there was a significant difference ($t = 7.00$, $df = 15$, $p < 0.001$) between pre-test (mean = 7.43, sd = 0.81) and post-test (mean = 10.43, sd = 1.36) performance. The results of HS show that there was a significant difference ($t = 4.28$, $df = 22$, $p < 0.001$) between pre-test (mean = 9.91, sd = 0.94) and post-test (mean = 11.52, sd = 1.92) performance. The students could thus successfully acquire knowledge by using the Web2SRL system regardless of their pre-test achievement level.

An independent sample test was used to compare the difference in pre-test and post-test performance between LS and HS. The results of the pre-test show that there was a significant difference ($t = 8.47$, $df = 37$, $p < 0.001$) between LS (mean = 7.43, sd = 0.81) and HS (mean = 9.91, sd = 0.94). That is, LS and HS did not have equivalent levels of knowledge before using the Web2SRL system. The results of the post-test show that there was no significant difference ($t = 1.93$, $df = 37$, $p > 0.05$) between LS (mean = 10.43, sd = 1.36) and HS (mean = 11.52, sd = 1.92), though this was a relatively small effect size (eta-squared = 0.09). That is, LS and HS had equivalent levels of knowledge after using the Web2SRL system. The level of knowledge of LS improved by an average score of 3 and that of HS improved by an average score of 1.61. The level of knowledge of LS was thus greatly enhanced (to almost the level of HS) by using the Web2SRL system.

The analysis results indicate that the Web2SRL system supports the acquisition of knowledge in WBSL contexts, especially for LS. The Web2SRL system helps LS manage their WBSL. In general, LS are likely to become disoriented in web-based learning contexts since they are easily addicted to the Internet (Lee et al., 2008). The Web2SRL system enables LS to take responsibility for their learning. The Web2SRL system logs show that LS' average number of using planning subsystem was 2.00 (sd = 1.26) and HS' average number of using planning subsystem was 1.82 (sd = 1.02). This indicates that LS concentrated more on their learning than did HS, and were thus able to keep up with HS. Overall, the findings of this analysis confirm those obtained by Chang (2005) and Lee et al. (2008). Chang (2005) revealed that the SRL strategy enables students to concentrate more on web-based learning. Lee et al. (2008) indicated that the SRL strategy was useful for web-based learning, particularly for students with low academic achievement.

Analysis of students' perceptions of the Web2SRL system

This analysis examines the perceptions of the Web2SRL system of AS, LS, and HS through the questionnaire.

The questionnaire was assessed before the analysis in order to determine its reliability and validity. Cronbach's α was used to assess the reliability and expert validity as well as construct validity were used to examine the validity.

Assessment of questionnaire

The results of the reliability analysis are summarized in Table 2. The table shows that the Cronbach α values for the four constructs are higher than 0.70 (total Cronbach α value in four dimensions=0.97; PEU=0.95, PUF=0.90, PWE=0.95, and PWS=0.90). This implies that the reliability was sufficiently high (Hair, Black, Babin, Anderson, & Tatham, 2006). Furthermore, the minimum value of each corrected item-to-total correlation was above 0.5 (minimum = 0.68), which shows that the questionnaire had strong reliability (Doll & Torkzadeh, 1988).

Table 2. Results of reliability analysis

Construct	Item	Reliability analysis results	
		Corrected item-total correlation	Cronbach's α
PEU	PEU1	0.88	0.95
	PEU2	0.89	
	PEU3	0.88	
PUF	PUF1	0.89	0.90
	PUF2	0.68	
	PUF3	0.91	
PWE	PWE1	0.88	0.95
	PWE2	0.87	
	PWE3	0.85	
PWS	PWS1	0.80	0.90
	PWS2	0.76	
	PWS3	0.84	

Two domain experts examined the domain validity. Some ambiguous or unsuitable items were modified, removed, altered, or arranged in the proper order according to the expert feedback. This rigorous process implies that the questionnaire had good validity.

Construct validity is used to validate that a questionnaire is actually a measure of what it is intended to measure (i.e., the construct) and not a measurement of other variables. It is evaluated by using convergent and discriminant validity (Ong, Day, & Hsu, 2009). The convergent validity is assessed by examining the average variance extracted (AVE), which must exceed the standard minimum level of 0.5 (Hair et al., 2006). The discriminant validity is assessed using the square root of the AVE and the correlation matrix of the construct (Fornell & Larcker, 1981), in which the square root of the AVE of each construct should exceed the correlation shared between one construct and other constructs. The results of the construct validity analysis are summarized in Table 3. The table shows that most criteria exceeded the threshold suggested in previous research and thus indicates that a satisfactory construct validity was obtained. The reliability and validity results prove the adequacy of the questionnaire used in this study.

Table 3. Results of construct validity analysis

Construct	Convergent validity	Discriminant validity			
	AVE	Correlation matrix of constructs			
		PEU	PUF	PWE	PWS
PEU	0.96	0.98			
PUF	0.92	0.87	0.96		
PWE	0.95	0.82	0.80	0.98	
PWS	0.92	0.78	0.77	0.81	0.96

Results of questionnaire

The responses of AS to the questionnaire are summarized in Table 4. The table shows that AS gave positive feedback for all dimensions. The three major results are:

(1) 74% of the students indicated that they could use the Web2SRL system to obtain new knowledge beyond that contained in the textbook.
(2) 69% of the students indicated that their motivation of learning was increased by using the Web2SRL system.

(3) 62% of the students indicated that they were satisfied with this way of learning.

These results show that students thought that they could use the Web2SRL system to acquire knowledge and that the system was useful in promoting their motivation of learning. This finding is similar to those obtained in the studies of Chang (2005), Lee et al. (2008), and responds to the study of Usta (2011). Chang and Lee et al. found that web-based learning with the SRL strategy increases both the learning and motivation of students. Usta showed that the SRL strategy influences the attitude of students towards the Internet.

Table 4. Responses to the questionnaire

Construct	Item	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean
PEU	PEU1	33% (13)	41% (16)	13% (5)	8% (3)	5% (2)	3.9
	PEU2	31% (12)	41% (16)	15% (6)	8% (3)	5% (2)	3.8
	PEU3	36% (14)	33% (13)	23% (9)	5% (2)	3% (1)	3.9
PUF	PUF1	31% (12)	33% (13)	26% (10)	8% (3)	3% (1)	3.8
	PUF2	23% (9)	26% (10)	36% (14)	10% (4)	5% (2)	3.5
	PUF3	33% (13)	36% (14)	15% (6)	13% (5)	3% (1)	3.8
PWE	PWE1	33% (13)	36% (14)	26% (10)	5% (2)	0% (0)	4.0
	PWE2	31% (12)	38% (15)	18% (7)	10% (4)	3% (1)	3.8
	PWE3	31% (12)	44% (17)	15% (6)	8% (3)	3% (1)	3.9
PWS	PWS1	26% (10)	36% (14)	28% (11)	8% (3)	3% (1)	3.7
	PWS2	18% (7)	41% (16)	31% (12)	8% (3)	3% (1)	3.6
	PWS3	21% (8)	38% (15)	33% (13)	5% (2)	3% (1)	3.7

Pearson correlation analysis was used to examine the correlations between constructs and to determine significant intercorrelations between constructs (Huang, Yang, & Liaw, in press). Table 5 shows various highly significant intercorrelations between constructs. The three most significant intercorrelations are between PEU and PUF (0.87), PEU and PWE (0.82), and PWE and PWS (0.81).

The above results show that PEU is highly positively correlated to PUF and PWE, and that PWE is highly positively correlated to PWS. This indicates that when students can easily use the Web2SRL system to acquire knowledge, they find the system useful for learning and are satisfied with using the system to learn. The results are are similar to those obtained in the studies of Davis (1989) and Huang et al. (in press).

Table 5. Results of correlation analysis

Construct	PEU	PUF	PWE	PWS
PEU	1			
PUF	0.87*	1		
PWE	0.82*	0.80*	1	
PWS	0.78*	0.77*	0.81*	1

*$p < 0.01$

An independent sample t-test was used to compare the difference in the perceptions of the Web2SRL system between LS and HS. The results are summarized in Table 6. The table shows that there was no significant difference in the perceptions of the Web2SRL system between LS and HS ($p > 0.05$). Therefore, LS and HS had similar perceptions of the Web2SRL system. Students thought that the Web2SRL system was useful in WBSL, regardless of their pre-test achievement level.

Table 6. Comparison of the perceptions of the Web2SRL system by LS and HS

Construct	Level of knowledge	Mean	Standard deviation	t-value	p-value
PEU	LS	3.66	0.94	1.16	0.25
	HS	4.05	1.09		
PUF	LS	3.47	0.87	1.29	0.20
	HS	3.89	1.06		
PWE	LS	3.66	0.78	1.37	0.17
	HS	4.08	1.02		
PWS	LS	3.52	0.75	0.99	0.32
	HS	3.81	0.98		

CONCLUSION

Web 2.0 technologies have considerable potential for WBSL. This study developed the Web2SRL system, which assists students in engaging in self-learning environments. With the Web2SRL system, students can subscribe to RSS feeds of blogs of interest and read the articles in the feeds. The Web2SRL system is based on SRL theory, and thus has planning, practice, and reflection subsystems. These subsystems enable students to regulate their learning in WBSL contexts. A one-group pretest-posttest design was used to investigate the effect of the Web2SRL system on WBSL, and a questionnaire was used to determine students' perceptions of the Web2SRL system. The experimental results show that all students could successfully acquire knowledge by using the Web2SRL system, particularly the low-achieving students. Moreover, all students found the Web2SRL system useful, regardless of their pre-test achievement level.

Although the proposed system is useful, some problems should be addressed in future research. In this study, the reading goal was to read a set number of articles. However, a more practical goal is not only to read a certain number of articles, but to actually retain a certain amount of knowledge. For example, if students are able to read ten articles in the first week, this does not mean they will be able to read another ten articles in the second week. Various parameters of articles should be considered, such as length and difficulty. A better reading test would be one that assesses whether the students actually comprehend the content of an article, rather than simply asking them to select the correct keywords. In future work, a better way of setting reading goals will be developed. In addition, an automatic method for measuring learning throughout the WBSL process will be explored. Finally, the system logs will be used to analyze the relationship between the students' SRL and their learning effectiveness.

The limitations of this study include the type of experimental design and the relatively small sample size. Specifically, the experimental design of this study is a pre-experimental design rather than a quasi-experimental designs or a true experimental design. Therefore, the improvement in the level of knowledge of students may be affected by some factors rather than the use of the Web2SRL system. Increasing the sample size will provide a stronger evidence of the benefits of the proposed Web2SRL system. Nevertheless, the proposed system was shown to play an important role in supporting WBSL.

ACKNOWLEDGEMENTS

The authors would like to thank the National Science Council of the Republic of China for financially supporting this research under Contract No. NSC 100-2511-S-006-014-MY3, NSC 100-2511-S-006-015-MY3, NSC 100-2218-E-006-017, NSC 100-2631-S-006 -002, NSC 100-2631-S-006 -002, and NCS 100-2511-S-432 -001.

REFERENCES

Azevedo, R., & Cromley, J. G. (2004). Does training on self-regulated learning facilitate students' learning with hypermedia? *Journal of Educational Psychology, 96*(3), 523-535.

Azevedo, R., Cromley, J. G., Winters, F. I., Moos, D. C., & Greene, J. A. (2005). Adaptive human scaffolding facilitates adolescents' self-regulated learning with hypermedia. *Instructional Science, 33*(5-6), 381-412.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Boston: Houghton Mifflin Company.

Chang, M. M. (2005). Applying self-regulated learning strategies in a web-based instruction: an investigation of motivation perception. *Computer Assisted Language Learning, 18*(3), 217-230.

Chen, C. M. (2009). Personalized e-learning system with self-regulated learning assisted mechanisms for promoting learning performance. *Expert Systems with Applications, 36*(5), 8816-8829.

Chen, C. M., Huang, T. C., Li, T. H., & Huang, C. M. (2007). Personalized e-learning system with self-regulated learning assisted mechanisms for promoting learning performance. In *Proceedings of the 7th IEEE International Conference on Advanced Learning Technologies* (pp. 637-638). Niigata, Japan.

Chou, C. M. (2011). Student teachers socialization development by teaching blog: reflections and socialization strategies. *The Turkish Online Journal of Educational Technology, 10*(2), 190-201.

Chou, S. W., & Liu, C. H. (2005). Learning effectiveness in a web-based virtual learning environment: a learner control perspective. *Journal of Computer Assisted Learning, 21*(1), 65-76.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Dettori, G. & Persico, D. (2008). Detecting self-regulated learning in online communities by means of interaction analysis. *IEEE Transactions on Learning Technologies, 1*(1), 11-19.

Doll, W. J., & Torkzadeh, G. (1988). The measurement of end-user computing satisfaction. *MIS Quarterly, 12*(2), 259-74.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate Data Analysis*. New Jersey: Prentice-Hall Press.

Huang, A. F. M., Yang, S. J. H., & Liaw, S. S. (in press). A study of user's acceptance on situational mashups in situational language teaching. *British Journal of Educational Technology*, DOI: 10.1111/j.1467-8535.2010.01152.x.

Huang, T. C., Huang, Y. M., & Fu, F. Y. (2011). Cooperative weblog learning in higher education: its facilitating effects on social interaction, time lag, and cognitive load. *Educational Technology & Society, 14*(1), 95-106.

Huang, Y. M., & Liu, C. H. (2009). Applying adaptive swarm intelligence technology with structuration in web-based collaborative learning, *Computers & Education, 52*(4), 789-799.

Huang, Y. M., Chiu, P. S., Liu, T. C., & Chen, T. S. (2011). The design and implementation of a meaningful learning-based evaluation method for ubiquitous learning. *Computers & Education, 57*(4), 2291-2302.

Huang, Y. M., Huang, Y. M., Huang, S. H., & Lin, Y. T. (2012). A ubiquitous English vocabulary learning system: evidence of active/passive attitudes vs. usefulness/ease-of-use. *Computers & Education, 58*(1), 273-282.

Huang, Y. M., Huang, Y. M., Liu, C. H., & Tsai, C. C. (in press). Applying social tagging to manage cognitive load in a Web 2.0 self-learning environment. *Interactive Learning Environments*, DOI:10.1080/10494820.2011.555839.

Kalelioglu, Filiz, & Gulbahar, Y. (2010). Investigating the usage of blogs in educational settings from multiple intelligences perspective. *The Turkish Online Journal of Educational Technology, 9*(2), 132-144.

Kiyici, F. B. (2010). The definitions and preferences of science teacher candidates concerning Web 2.0 tools: a phenomenological research study. *The Turkish Online Journal of Educational Technology, 9*(2), 185-195.

Kramarski, B., & Gutman, M. (2006). How can self-regulated learning be supported in mathematical E-learning environments? *Journal of Computer Assisted Learning, 22*(1), 24-33.

Kramarski, B., & Mizrachi, N. (2007). Online discussion and self-regulated learning: effects of instructional methods on mathematical literacy. *The Journal of Educational Research, 99*(4), 218-231.

Lan, Y. F., & Sie, Y. S. (2010). Using RSS to support mobile learning based on media richness theory. *Computers & Education, 55*(2), 723-732.

Lee, T. H., Shen, P. D., & Tsai, C. W. (2008). Applying web-enabled problem-based learning and self-regulated learning to add value to computing education in Taiwan's vocational schools. *Educational Technology & Society, 11*(3), 13-25.

Lin, Y. C., Lin, Y. T., & Huang, Y. M. (2011). Development of a diagnostic system using a testing-based approach for strengthening student prior knowledge. *Computers & Education, 57*(2), 1557-1570.

Lin, Y. T., Huang, Y. M., & Cheng, S. C. (2010). An automatic group composition system for composing collaborative learning groups using enhanced particle swarm optimization. *Computers & Education, 55*(4), 1483-1493.

Ong, C. S., Day, M. Y., & Hsu, W. L. (2009). The measurement of user satisfaction with question answering systems. *Information & Management, 46*(7), 397-403

Perry, N. E. & Winne, P. H. (2006). Learning from learning kits: gStudy traces of students' self-regulated engagements using software. *Educational Psychology Review, 18*(3), 211-228.

Robinson, F. (1961) *Effective study*. New York: Harper and Row Press.

Salton, G., & McGill, M. J. (1983). *Introduction to modern information retrieval*. New York: McGraw Hill Book Co. Press.

Tilfarlioğlu, F. Y. (2011). An international dimension of the student's attitudes towards the use of English in Web 2.0 technology. *The Turkish Online Journal of Educational Technology, 10*(3), 63-68.

Usta, E. (2011). The examination of online self-regulated learning skills in web-based learning environments in terms of different variables. *The Turkish Online Journal of Educational Technology, 10*(3), 278-286.

Vighnarajah, Wong, S. L., & Bakar, K. A. (2009). Qualitative findings of students' perception on practice of self-regulated strategies in online community discussion. *Computers & Education, 53*(1), 94-103.

Zimmerman, B. J. (1986). Becoming a self-regulated learner: which are the key subprocesses? *Contemporary Educational Psychology, 11*(4), 307-313.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81*(3), 329-339.

Zimmerman, B. J. (2000). Attainment of self-regulation: a social cognitive perspective. In M. Boekaerts, P.R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-regulation* (pp. 13-39). San Diego, CA: Academic Press.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: an overview. *Theory into Practice, 41*(2), 64-70.

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: historical background, methodological developments, and future prospects. *American Educational Research Journal, 45*(1), 166-183.

