A Social Learning Management System Supporting Feedback for Incorrect Answers based on Social Network Services

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ABSTRACT
In this research, we propose a Social Learning Management System (SLMS) enabling real-time and reliable feedback for incorrect answers by learners using a social network service (SNS). The proposed system increases the accuracy of learners' assessment results by using a confidence scale and a variety of social feedback that is created and shared through learners' personal SNS connections. The system measures the intimacy between learners and their SNS friends, as well as the registered feedback time for reliable social feedback. We examined the performance of the proposed SLMS in relation to collaborative learning through the measurement of learners' level of satisfaction.

Keywords
Collaborative learning, Learning management system, Social learning, Social network services, Social feedback

Introduction

With the development of the Internet, a considerable amount of research has been carried out on Web-based e-learning, which enables learners to study anytime and anywhere without traditional limitations of place and time (Horton, 2000). In addition, a variety of learning management systems (LMSs) has been developed for the systematic management of courses, grades, progress, and attendance of the students. Representative examples of LMSs include Moodle (Cole & Foster, 2007; Kumar, Gankotiya, & Dutta, 2011), Desire2Learn (D2L) (Wang, & Shao, 2008), and Blackboard (Martin, 2008; Pishva, Nishantha, & Dang, 2010). LMSs support and manage learning content allowing various file formats and media. One of the various features of LMSs is the ability to conduct assessment by providing learners with a quiz (or tests) to evaluate their ability, analyze their correct or incorrect answers, and provide feedback on their incorrect answers. The quiz helps learners recognize the information they did not understand during the learning period. An educator can evaluate a learner’s grade by using learners’ quiz results. In particular, feedback, including an explanation of incorrect answers, helps learners improve their understanding of the learning contents and relearn why their answers were incorrect (Thoms, 2011).

However, the quiz and feedback of existing LMSs has the following limitations: a lack of analysis of whether the learners understand the content; static explanations despite the different learning abilities of the respective learners; and restricted interaction and collaboration feedback among learners. First, existing LMSs lack the ability to analyze whether learners understand the precise meaning of a question. Such systems simply measure the level of understanding and insight of learners by depending on the outcome of analyzing their correct or incorrect quiz answers. Some correct answers may have been given by chance, but the learners are not provided with an explanation and feedback for such answers. To improve the learner’s understanding of the subject material and evaluate their level of understanding and insight, an LMS system needs to be able to analyze whether the learner correctly understands the questions and answers of a quiz. In addition, existing LMSs only provide a previously defined static explanation of an incorrect answer without analyzing the various reasons why the learners may have answered a question incorrectly. Analyzing the various causes for incorrect answers and providing a corresponding explanation require considerable time and cost. To solve incorrect answers, the learners study and acquire additional information from the internet or the course lectures, or ask the educator or someone despite providing basic static explanation. This additional inconvenient process is frequently repeated. As a result, refinement and further development of LMSs is required for efficiently supporting and managing various analyses based upon the causes of incorrect answers and the different levels of learner achievement. Finally, as a general course-based approach to e-learning, such systems have restricted interaction and collaboration feedback among learners (Dalsgaard, 2007).
When a learner has a question related to a course lecture, the learner may ask the educator during the course. The educator can provide feedback to the learners through different questions and lead the students through the course. On the other hand, the relationship among learners is temporary and restricted to the duration of the course. After the end of the course period, the learners may not have the opportunity to ask questions related to their learning. As a result, these limitations make an LMS inappropriate for supporting collaborative learning.

Various researches in education investigating interaction, participation, and sharing among learners have been recently conducted with the evolution of Web 2.0 and the advent of e-learning 2.0 (Yang & Chen, 2008; Chen, Kinshuk, Wei, & Yang, 2008; Huang, Jeng, & Huang 2009). Social media, i.e., Web 2.0 tools (e.g., blogs, wikis, social bookmarking sites, social networking services, and etc.), help users create content that can be shared with other users. When social media is applied to e-learning, the key feature of social software supports the learner in creating and sharing their learning content (Mcloughlin & Lee, 2010; Ford, Bowden & Beard, 2011). The learner therefore becomes an active participant in the LMS course. The relationships among learners support interactive and collaborative feedback. Among the different types of social media, video, pod-casts, wikis, and so on are valuable tools for teaching, and SNS can be valuable tools for collaborative learning (Mcloughlin & Lee, 2010; Ford, Bowden & Beard, 2011). The learner therefore becomes an active participant in the LMS course. The relationships among learners support interactive and collaborative feedback. Among the different types of social media, video, pod-casts, wikis, and so on are valuable tools for teaching, and SNS can be valuable tools for collaborative learning (Mcloughlin & Lee, 2010; Ford, Bowden & Beard, 2011). According to a Pearson’s survey, more than 90% of the faculty members in US universities employ social media for personal purpose or professional education, and among them, visits and postings to SNS make up the highest of such usage (Moran, Seaman & Tinti-kane, 2011). SNS-based learning enables the learners to carry out collaborative learning by forming close personal connections on the basis of social learning theory and Connectivism (Siemens, 2005) using their real-world personal connections and SNS based on online social networking (Huang, Yang, Huang, & Hsiao, 2010; Haythornthwaite, & de Laat, 2010). SNS can help learners share information and their opinions for learning with their friends in real time. Teaching and learning utilizing social media have increased continuously. Furthermore, SNS in the field of learning has become more important owing to the social interaction with learners. The use of SNS in learning involves the advantage of real-time, information sharing, simple posting and reliable feedback from friends (Du, Fu, Zhao, Liu & Liu, 2013; Yin, Tabata & Ogata, 2009; Popescu, 2014).

In order to benefit from social networks, we propose a Social Learning Management System (SLMS) that enables real-time and reliable feedback on incorrect answers by incorporating a SNS. The SLMS allows learners to share the necessary information for learning with each other and receive feedback from their personal connections through an SNS. Collaborative learning among learners using SNS minimizes the time and expense required for an analysis of their incorrect answers and provides various and abundant feedback by allowing questions to be shared and analyzed, as well as providing reasons for incorrect answers. In addition, to provide feedback based on a precise evaluation of the learner’s ability, for this study, we measure the learner’s confidence in their answers by expanding the Confidence-Based Marking (CBM) feature proposed in Moodle. This feature is used to evaluate the learner’s ability (Gardner-Medwin, & Curtin, 2007). When compared to existing LMSs, the SLMS can improve learners’ learning ability by supporting feedback on incorrect answers through collaborative learning by relying on the social connections among learners.

**Quiz and feedback process of existing representative online LMSs**

Moodle is an open source course management system (Cole & Foster, 2007; Kumar, Gankotiya, & Dutta, 2011) that provides an array of tools for educators to manage and promote teaching and learning. Among the various quiz options that Moodle provides, there is an option for offering CBM, analyzing whether the learners have filled out the correct answers with confidence, and feedback options providing an analysis and explanation of the incorrect answers by analyzing the learning results (Gardner-Medwin, & Curtin, 2007). CBM uses a 3-point scale. The level of the learner is determined by granting a credit or penalty based on the confidence level in their answers. In this way, Moodle identifies the exact ability of the learners. However, Moodle does not provide feedback on incorrect answers by utilizing CBM. Moodle provides learners with three types of feedback, namely, overall feedback, general feedback, and specific feedback. Overall feedback is provided to the learners after they submit a quiz; it is dependent on the grade that the learners achieve. General feedback includes some background knowledge about the questions; it too is provided after the quiz is completed; this feedback gets entered for each quiz item by the educator when the quiz is first created. Depending on the learner’s answers, preset specific feedback is also provided. Such feedback is provided by Moodle for learners focusing on preset feedback; the system provides only predetermined static
feedback information without any analysis of the cause of the incorrect answers. It does not provide collaborative feedback between the learners.

Blackboard is commercial LMS (Martin, 2008; Pishva, Nishantha, & Dang, 2010) that provides test and test feedback options for determining the ability of the learners. The test feedback option determines the type of feedback provided to the learners after the completion of the test. There are four types of feedback: score, submitted answers, correct answers, and feedback. The score option shows only the learner’s test score, and the submitted answers option shows the content of the questions of the test and the answers that the learners selected. The correct answers option shows only the content of the test questions and the correct answers. In addition, it distinguishes between the correct and incorrect answers and doesn’t display the answers chosen by the learners. The feedback option provides an explanation of the incorrect answers. However, the test feedback options don’t consider whether the learner has a good understanding of the questions, and provide only a brief preconfigured explanation.

D2L provides an online environment for creating and managing courses (Wang, & Shao, 2008). The evaluation method of D2L relies on quizzes, discussions, grades, surveys, and drop-boxes. Among them, the quizzes are used to assess the learners by offering various test formats. The difference between other LMSs and D2L is that D2L supports social networking among learners. Learners register and share their profiles through social media in order to connect their various SNS accounts to their educational, personal, and professional communities. However, social networking supported by the current version of D2L shares only the learner’s experiences, goals, and progress with their peripheral personal connections; it does not support any learning through these connections.

Social learning management system based on SNS

System architecture

As shown in Figure 1, the architecture of the proposed system is divided into the SLMS and Social Learning Learner Interface (SLLI). The SLMS consists of a quiz items management module, an incorrect answer management module, a learner management module, and a Social Feedback module.

The SLLI has a series of processes that provide learners with the requested quiz items and allows them to exchange feedback about their incorrect answers. It consists of 5 steps. In the first step, the learner sends a quiz request query to the system and receives the items. In step 2, the learner’s answers to the items and their confidence scale are
evaluated. The confidence scale classifies whether the learner knows the correct answer of an item based on the results analyzed on a 3-point scale that the learner choose when answering quiz items. If the confidence scale is “assurance” and the item is also the correct answer, the algorithm calculates the percentage of correct answers. On the other hand, if the confidence scale is “assurance” but the item is incorrectly answered, the algorithm provides an explanation for the incorrect answer and executes the social feedback module. Similarly, if the confidence scale is “uncertainty” or “unknowingness,” the learner does not clearly understand the item even though their answer might be correct. The SLLI generates the items given to the learners, their answers, and their confidence scale as a resource (R), and handles them by submitting them to the SLMS. In step 3, the results are sent to the learner after their correct and incorrect answers are classified by the incorrect answer management module along with an analysis of the confidence scale based on R. Step 4 provides an explanation for incorrect answers that is a predefined static explanation in the system. The last step provides social feedback based on the SNS through feedback sharing among the learners. R, i.e., the resources described above, can be defined as follows:

**Definition 1.** A resource that is given to the learner is defined as a triple (I, A, C), where I denotes the type of items and the set of questions, A denotes the learner’s results for a set of items, and C indicates their confidence scale.

**Resource R = (I, A, C)**

The quiz items management module consists of the quiz items manager and the items level manager. The quiz items manager contains the items and manages them based on the learning type; it retrieves the items from the item bank by analyzing the type of items that the learners requested or answered incorrectly. The items level manager manages the items by classifying items based on their level of difficulty and determines the level of difficulty of new items or modifies the level of difficulty of the existing items, based on the average rate of correct answers given by the learners. The item bank consists of a variety of item types, where each type of item has a subset of several different types of items. R, described in Definition 1, consists of pairs of items (I) and answers (A) because they share a mapping relationship. The following is a formal definition of item and answer.

**Definition 2.** I consists of an ItemPattern, which is the quiz type, and i, which is a subset of the quiz type. A denotes the answers corresponding to the items. An item and its answer are composed of the pair (I, A).

**ItemPattern = {ItemPattern1, ItemPattern2, ..., ItemPatternn}**

**ItemPattern = {i1, i2, i3, ..., in}**

In case of \( i_1 \in \text{ItemPattern1}, a_1 \in A_i, \text{ItemPattern1} \subseteq I \) and \( A_i \subseteq A \), it is defined as \((i_1, a_1), (\text{ItemPattern1}, A_i)\)**

The incorrect answer management module consists of the manager of explanation for incorrect answer, the analysis of confidence scale, and the evaluation engine. The explanation for incorrect answer manager manages basic static explanations based on the items, the learning type, and the level of difficulty of the items, and provides explanations to the learners. The analysis of confidence scale module classifies the items as either correct or incorrect through an analysis of the confidence scale. Based on the results of this analysis, the evaluation engine provides the social feedback manager with the results of the evaluation determining whether the items were answered incorrectly. The aforementioned confidence scale is an evaluation of the learner’s confidence in their answers and is defined as follows:

**Definition 3.** The confidence scale is an evaluation of the degree of confidence of the correct answers for the learner’s learning outcomes. Assurance indicates that the learner understands the correct answer exactly. Uncertainty indicates that the learner is uncertain of a correct answer. Unknowingness indicates that the learner does not know the correct answer.

**Confidence Scale C = {assurance, uncertainty, unknowingness}**

The learner management module consists of the learner profile manager and the learner social network manager. Through the learner profile manager, the system can analyze a learner’s profile and the learning information. Through this analysis, the level of the learner is determined and the generation of and change in the learning level are managed. Moreover, by managing the login information of the learners enrolled in the system, the system manages whether the learners receive training on a regular basis, the amount of their studying/learning during a certain period of time, and the degree of increase in their learning level. Through this feature, the learners can manage their own learning schedule and their amount of learning. The learner’s social networking manager manages the information of the personal connections among the learners. In particular, to provide feedback for incorrect answers based on SNS-
Based feedback through the sharing of incorrect answers, the system uses the information of the learner’s personal connections. The social feedback module consists of the social feedback engine, the intimacy measurement, and the social feedback manager. The social feedback engine shares quiz items, answers, and explanations for incorrect answers on the various SNS used by the learners. In addition, the social feedback engine ranks the social feedbacks by weighing the intimacy between a learner and their SNS friends as well as the registered time of social feedback. The social feedback is registered by the learner’s SNS friends in real time. When new social feedback is registered, the social feedback engine compares it with previous registered social feedback, and then provides a high ranking to social feedback having a higher value of intimacy and that is more recently registered. Therefore, the SLMS can avoid blind advertisements or spam from strangers.

The intimacy measurement measures the degree of closeness between learners and their SNS friends. Various researches on the measurement of intimacy between people have been conducted (Liang, Li & Turban, 2009; Seol, Kim, Shim & Baik, 2012; Seo, Kim & Baik, 2014). Among such various researches, we consider the ratio of sharing friends as a method for calculating the intimacy among users (Seol, Kim, Shim & Baik, 2012; Seo, Kim & Baik, 2014). The following is a definition of the relationship between learners and their SNS friends.

**Definition 4.** Intimacy $I_n$ is an affinity between learner and SNS friend. In consist of Learner $L$, SNS Friends $F$, and Edge of Relationship between learner and SNS friend $Ed$.

Intimacy $I_n = (L, F, Ed)$

$L = \{l_1, l_2, ..., l_n\}$ is a set of learners.

$F = \{F_{l_1}, F_{l_2}, ..., F_{l_n}\}$ is a set of SNS friends.

$F_{l_1} = \{f_{l_1,1}, f_{l_1,2}, ..., f_{l_1,x}\}$, $F_{l_2} = \{f_{l_2,1}, f_{l_2,2}, ..., f_{l_2,x}\}$, ..., $F_{l_n} = \{f_{l_n,1}, f_{l_n,2}, ..., f_{l_n,x}\}$ is a set of SNS friends of a learner.

$Ed< L, F >$, $ed< l_n, F_{l_n} >$ is the relationship between a learner and their SNS friends.

The social feedback manager manages the registered social feedbacks. The social feedback manager includes the following information for registered social feedback: 1) the type of item, 2) who provided the social feedback, and 3) when the social feedback was written. Based on this information, the social feedback engine measures the ranking of the registered social feedback in real-time, and the social feedback manager then reflects the ranking results. The definition and ingredients for social feedback are as follows.

**Definition 5.** Social Feedback $S$ is feedback for sharing an item written by SNS friends of the learner. $S$ consists of Resource $R$, Intimacy $I_n$ between the learner and their SNS friends, and the registered time $T$ of the social feedback.

Social Feedback $S = (R, In, T)$

**Algorithm for the social feedback**

In this section, we describe an algorithm for processing the social feedback. The algorithm processes to share the information related to an items on SNS and to provide the learners with feedback from their SNS friends. As shown in Algorithm 1, for information on an item, the input is $R$, $In$ is the intimacy between the learner and their SNS friends, and $T$ is the time the feedback is written. The output, $S$, is the registered social feedback by the learner’s SNS friends. In Lines 1 and 2, $l_i$ is the learner ($L$) using the SLMS, $F_{l_i}$ is the set of SNS friends of $l_i$. $i$ is the identification number of the learner. In Lines 4 and 5, if $l_i$ as a learner has SNS friends ($F_{l_i}$), $R$ is shared with every $F_{l_i}$. In lines 6 and 7, social feedback $S_{l_i}$ by written the learner’s jth SNS friend ($f_{l_j}$) consists of ($R_n$, $I_n$, $T$), such as described in Definition 5. The social feedback is affected by the intimacy between the learner and their SNS friends and the registered time of the social feedback. In other words, an SNS friend that has a higher value of intimacy can provide more reliable social feedback. Recent registered social feedback has more reliability than older feedback because a social network is a real-time system and recent registered social feedback refers to previous registered social feedback. As a result, line 8 measures the intimacy between the learner and their SNS friends, and then ranks $S_{l_i}$ by
reflecting the registered time of the social feedback. Finally, line 9 returns $S_{ij}$ reflecting the measured result of the ranking.

Algorithm 1. Algorithm for Social Feedback

INPUT:
- $R$, a set of resources $R = (I, A, C)$
- $In$, a set of Intimacy $In = (L, F, Ed)$
- $T$, time the feedback is written

OUTPUT: $S$, Social Feedback

METHOD:
1: $i, l \in L, l$ is a Learner($L$)
2: $F_{il} = \{ f_{il,1}, f_{il,2}, \ldots, f_{il,k} \}$, $F_{il}$ is a set of SNS friends of $l$
3: $i$ is the identification number of the learner
4: if $l$ has $F_{il}$ then
5:   Sharing $R_n$ with $\forall f_{il}$
6:   for $j = 1$ to $k$ do
7:     Social_Feedback $S_{ij} (R_n, In_{ij}, T)$
8:     ranking $S_{ij} \leftarrow (1 - \lambda) \cdot (l \leftrightarrow f_{il} / |F_{il}|) + (\lambda \cdot t_{ij})$
9:     return $S_{ij}$
10: endfor
11: endif

We propose an equation for measuring the ranking of social feedback, shown in (1). In social network, the intimacy is determined by ratio of sharing friends. That is, the greater the number of sharing friends, the higher the intimacy measured. The smaller the number of sharing friends, the lower the intimacy measured.

$$S_{ij} \leftarrow (1 - \lambda) \cdot (l \leftrightarrow f_{il} / |F_{il}|) + (\lambda \cdot t_{ij}) \quad (1)$$

In (1), $\lambda$ is a constant value. We decide a $\lambda$ value of 0.1 for weighting the direct friend relationship than the registered time of the social feedback because the quality of social feedback that helps the learner is more important than when the feedback is given. $l \leftrightarrow f_{il}$ is the number of sharing friends among the learner ($l$) and their SNS friends ($f_{il}$).

As the registered time of feedback, $t_{ij}$ is calculated based on the up-to-the-minute and oldest registered time of social feedback. Recent registered social feedback has higher reliability rather than older feedback because a social network is a real-time system and recent registered social feedback refers to previous registered social feedback. Therefore, $t_{ij}$ holds the weight of the recent registered social feedback. The registered time of the feedback is $t_{feedback}$, and the up-to-the-minute registered time is $t_{new}$. The previous registered time of the feedback is $t_{old Feedback}$. Therefore, we propose (2) for the registered time of social feedback ($t_{ij}$).

$$t_{ij} = 2^{t_{new - \text{feedback}}/t_{new - \text{old Feedback}}} - 2^{-1} \quad (2)$$

Implementation

We describe the implementation of the SLMS based on the SNS. A quiz that is sent to the learner’s mobile device consists of the items, a 3-point confidence scale, and answer checks, as shown in Figure 2. As shown in Figure 2-(A), the learner selects the answers to all items and submits them to the system along with their level of confidence in their answers. As shown in Figure 2-(B), the correct or incorrect answers are classified by analyzing the submitted answers and the level of confidence. As shown in Figure 2-(C), for items that the learners answer incorrectly, the proposed system provides a basic static explanation registered in the SLMS. The learners can go through the
explanation and correct answers provided by the SLMS. They can determine the reason for their incorrect answers based on the explanations given. However, there is a limit to such an analysis because an explanation provides the same information to all learners. As a result, the learners share their explanation and other details of an item through their SNS, as shown in Figure 3-(A). The learner’s peripheral personal connections on Facebook provide feedback to the learner. As shown in Figure 3-(B), the learner’s SNS friends write their feedback that enables them to verify the type of learning, as well as the items, annotations, answers, explanation, degree of difficulty, etc. A variety of social feedback provided by the learner’s SNS friends can be verified through the explanations of their incorrect answers in the SLMS (Figure 3-(C)).
Experiment and evaluation

Our experiment targeted a specific quiz (TOEIC) and can be categorized as a one-group post-test quasi-experimental design since no random assignments were performed. The purpose of this experiment was to evaluate the SLMS performance in relation to collaborative learning through the measurement of learner’s level of satisfaction. We examined the measurement of learner satisfaction to compare the two different types of systems. One system is SLMS without a confidence scale and social feedback similar to existing LMSs, and the other is SLMS with a confidence scale and social feedback. The experiment was conducted over a period of two months, i.e., April and May of 2013. For the experiment, 258 university students attending Korea University (130 students) and the University of Seoul (128 students) who were attending the same class during the same semester were chosen.

![Figure 4. Basic investigation of the experiment participants](image)

Basic experiment (Participants)

The participants were surveyed on their use of SNS and the registration of an online lecture, as shown below.

**Use of SNS**
- 4-(A) Do you use SNS?
- 4-(B) If you do, what SNS are you using now (multiple answers allowed)?
- 4-(C) How frequently do you use the SNS daily?
- 4-(D) How long do you use the SNS daily?

**Registration for online lecture**
- 4-(E) Have you ever taken an online lecture?
- 4-(F) How long did you take the online lecture?
- 4-(G) Were you satisfied with the explanation for incorrect answers provided in the online lecture you took?

As shown in Figure 4, among the 258 participants, 88% (228 persons) answered that they use an SNS (Figure 4-(A)), 53% (234 persons) reported that Facebook is their most-used and most-visited site. 34% (152 persons) reported that they use Cyworld (Figure 4-(B)). Regarding how many times they visit SNS daily, 43% (98 persons) said 1 to 5 times, 21% (49 persons) said 5 to 10 times, 28% (63 persons) said 10 to 30 times, and 8% (18 persons) answered that they visit an SNS more than 30 times (Figure 4-(C)). Regarding how many hours they use SNS daily, 35% (79 persons) said 10 to 30 minutes, which was the highest proportion, followed by 30 minutes to 1 hour at 28% (65 persons), and 5 to 10 minutes at 20% (45 persons) (Figure 4-(D)). Through the above results, the majority of the participants used an SNS each day. Regarding their experience with online lectures, 81% (208 persons) of the participants answered that they had taken an online lecture before (Figure 4-(E)); in addition, 49% (102 persons) of them took an online lecture for more than one year, whereas 26% (54 persons) and 19% (40 persons) took a lecture
for more than six and three months, respectively (Figure 4-(F)). Meanwhile, of the participants who responded to the question regarding their satisfaction of the explanations for incorrect answers provided during their online lecture, 32% (55 persons) answered that they Agree, 36% (61 persons) neither Agree nor Disagree, and 32% (55 persons) Disagree (Figure 4-(G)). Most of the participants responding to the basic experiment had experienced an online lecture (three months to more than one year) and received an explanation for their incorrect answers. They also stated that the explanation for their incorrect answers contributed greatly to their learning improvement, that is, the explanation for incorrect answers had a significant effect on their learning result (Figure 4-(H)).

Through the basic experiment, it was found that most of the participants experienced an online lecture in the past, the explanations for their incorrect answers provided by the online lecture had a significant effect on their learning, and the participants are users of an SNS. Therefore, as an experimental group for the performance experiment of the SLMS, another experiment evaluation was conducted on the 198 students who stated they have experienced an online lecture in the past and use Facebook.

**Experiment**

For the experiment evaluation, which aimed to determine the participants’ level of satisfaction, 198 participants were given TOEIC questions to study using the SLMS for a two-month period. The items used in the experiment were 10 practice tests excerpted from reading comprehension Part 5, 6, and 7 in TOEIC.

For the first month, the participants were instructed to learn the material using the SLMS in the same manner as a traditional online learning method with no confidence scale or social feedback. During the second month, the participants were asked to learn using the SLMS. This time their learning involved with a confidence scale and social feedback. The participants shared the information regarding the TOEIC questions and incorrect answers through their personal Facebook accounts linked with the SLMS. They could thus receive social feedbacks from their close friends. The learner’s SNS friends (i.e., how to solve a problem and knowledge regarding the solution) were registered and managed by the Social Feedback Manager of the SLMS. During the experiment period, the participants could log into their personal accounts registered in the SLMS system using their personal smartphones. This ensured anytime-anywhere learning. After the two-month learning experiment a survey was conducted to evaluate learners’ level of satisfaction with the SLMS system. Results are shown in Table 1.

<table>
<thead>
<tr>
<th>Survey item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. The explanation for incorrect answers reflect a level of learners</td>
<td>0%</td>
<td>8%</td>
<td>15%</td>
<td>57%</td>
<td>40%</td>
</tr>
<tr>
<td>II. The learners can find the reason for their incorrect answers through the provided explanation</td>
<td>0%</td>
<td>15%</td>
<td>26%</td>
<td>49%</td>
<td>35%</td>
</tr>
<tr>
<td>III. The learners can reflect the feedback with regard to their own incorrect answers</td>
<td>1%</td>
<td>13%</td>
<td>14%</td>
<td>59%</td>
<td>37%</td>
</tr>
<tr>
<td>IV. The explanations for incorrect answers can be shared (including previous used online lecture systems)</td>
<td>0%</td>
<td>17%</td>
<td>11%</td>
<td>49%</td>
<td>34%</td>
</tr>
<tr>
<td>V. The system provide sufficient explanations for incorrect answers</td>
<td>0%</td>
<td>15%</td>
<td>14%</td>
<td>45%</td>
<td>35%</td>
</tr>
<tr>
<td>VI. The system with providing explanations for incorrect answers is conducive to the learning effect</td>
<td>0%</td>
<td>16%</td>
<td>16%</td>
<td>50%</td>
<td>36%</td>
</tr>
</tbody>
</table>

*Note. A = SLMS without Confidence Scale & Social Feedback, B = SLMS (Proposed System). 1 = Strongly Agree, 2 = Agree, 3 = Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.*

**Experiment result and evaluation**

During the two-month period a total of 1,000 items were provided to the participants. On average, the participants had to learn the answers to 352 items. In addition, 942 items (including the duplicate items) were shared through the SNS, which indicates a sharing of 4.75 items per participant during the experiment. Furthermore, the total number of
social feedbacks received with regard to the shared items was 3,436. This represents 3.64 feedbacks per shared item on average. Table 2 shows the detailed statistics of the experiment results.

Table 2. SLMS usage statics

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td># Participants</td>
<td>198</td>
<td>-</td>
</tr>
<tr>
<td># Quiz (items)</td>
<td>1000</td>
<td>352</td>
</tr>
<tr>
<td># Sharing</td>
<td>942</td>
<td>4.75</td>
</tr>
<tr>
<td># Social Feedback</td>
<td>3436</td>
<td>3.64</td>
</tr>
</tbody>
</table>

Table 1 shows the survey result of the satisfaction level after using the two different types of systems. Table 1-A shows the satisfaction level with regard to the system in which no confidence scale and social feedback were provided. The response to the question of whether the explanation for an incorrect answer reflected the level of the learner revealed that 45% of the respondents believe it did not, whereas 15% believe it did. The response to the question of whether learners can find the reason for their incorrect answers through the provided explanation indicated that 39% said they cannot find the reason while 26% answered yes. Regarding the question of whether learners can reflect the feedback about their incorrect answers, 48% did not agree that they can reflect the feedback while 15% agreed that they can reflect the feedback. For the question of whether the explanations for incorrect answers can be shared, 55% of the respondents answered that they cannot, whereas only 11% answered that they can. In addition, 51% of the students answered they received insufficient explanations from the system, whereas 14% said they received sufficient explanations. Finally, 48% of the students answered that the system providing explanations for incorrect answers did not enhance the learning effect, whereas 16% of the students thought it was helpful.

On the other hand, Table 1-B shows the survey results on the satisfaction level for the system in which a confidence scale and social feedback were provided. The response to the question on whether the explanation for incorrect answers reflected the level of the learners revealed that 65% of the respondents said the explanations reflected a level of learners, while only 7% did not agree. In addition, the response to the question on whether learners can find the reason for their incorrect answers through the provided explanation indicated that 64% said they found the reason while 8% answered no. Regarding the question on whether a learner can reflect the feedback about their incorrect answers, 72% of the students agreed that it is possible, whereas 7% did not agree. Furthermore, 66% of the students agreed that the system allows them to share their explanations of incorrect answers, whereas only 2% did not. In addition, 60% of the students agreed that sufficient explanations can be provided through social feedback, whereas only 7% said they disagree. Finally, 76% of the students agreed that the system providing social feedback was
enhanced the learning effect, whereas only 4% did not agree. Based on the results in Table 1, the satisfaction level with regard to the learning effect for both systems can be found in Figure 5, in which the proposed SLMS had a higher overall satisfaction level of learning than SLMS without a confidence scale and social feedback with only explanations provided for incorrect answers.

Additionally, regarding the comparison survey question asking which system contributed more to their learning, 159 students indicated that the SLMS system which uses a confidence scale and social feedback was more helpful in increasing their learning, whereas only 39 students responded that the traditional LMS providing an explanation for incorrect answers only, but without a confidence scale and social feedback is more effective. An analysis of these 159 students’ survey results indicate five reasons why the SLMS system contributed more to a positive learning experience, as depicted in Figure 6. The most influential characteristic of the proposed system making a positive contribution to learning was providing various feedbacks through social network. In addition to the basic static explanations for their incorrect answers, students can obtain additional knowledge in relation to their learning because various opinions can be provided through an SNS. Similar to the first reason, the second most influential factor was about how to share information in relation to learning with close friends using an SNS. In addition, a real-time response, the use of a confidence scale, and active interaction with close friends were chosen as the remaining three advantages of the proposed system.

Figure 7 shows four representative factors influencing the learning effects of the system not providing confidence scale and social feedback. The biggest reason why 39 students selected this system was unreliable social feedback. Among them, 29 students pointed out that they cannot rely on the explanations provided through social feedback, which they saw as a drawback. On the other hand, the system without social feedback provided basic static explanations, which they viewed as reliable and satisfactory explanations that were more effective in increasing the learning effect. In addition, the students judged that the system without a confidence scale and social feedback was more effective because of its simple process and saving time.
As a result, more positive responses regarding the satisfaction level of the proposed system were received from the students when a confidence scale and social feedback were applied. Furthermore, the comparison survey also indicated that the proposed system had a higher learning effect than the other system. However, a small number of students who indicated that the system without a confidence scale and social feedback was better for the learning effect suggested that the quality and reliability of the explanations for incorrect answers provided through social feedback could not be guaranteed.

Conclusion

We proposed a SLMS based on SNS for providing learners with a variety of social feedback related to incorrect answers. In the SLMS, the accuracy of the learning results is increased by defining the confidence scale, and instead of providing a basic static explanation for incorrect answers to all learners, a variety of real-time social feedback is created and shared through the learner’s SNS friends based on Connectivism theory. For this purpose, we define the algorithm for processing the social feedback. For improving reliability of social feedback, the algorithm measures the intimacy between the learner and their SNS friends and the time of registered social feedback. Based on this, the algorithm ranks social feedbacks. Our experiment was to evaluate the SLMS performance in relation to collaborative learning through social feedback. The experiment participants were asked to study using the proposed SLMS method, both without and with a confidence scale and social feedback applied for two months. As a result, the evaluation result represents more positive responses regarding the satisfaction level from the experiment participants when a confidence scale and social feedback were applied. However, some participants were concerned regarding the reliability of the feedback.

As future work, we plan to extend the SLMS with added mechanisms regarding automatic filtering and management of unsuitable social feedbacks for improving reliability. Furthermore, we intend to apply the SLMS for other domains based on the positive responses received from the students.

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References


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