The Effect of Socially Shared Regulation Approach on Learning Performance in Computer-Supported Collaborative Learning

Lanqin Zheng[1*], Xin Li[1] and Ronghuai Huang[1,2]

[1]School of Educational Technology, Faculty of Education, Beijing Normal University, Beijing, China // [2]Smart Learning Institute, Beijing Normal University, Beijing, China // bnuzhenglq@bnu.edu.cn // lxbnu@mail.bnu.edu.cn // huangrh@bnu.edu.cn

[*]Corresponding author

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ABSTRACT

Students' abilities to socially shared regulation of their learning are crucial to productive and successful collaborative learning. However, how group members sustain and regulate collaborative processes is a neglected area in the field of collaborative learning. Furthermore, how group members engage in socially shared regulation still remains to be resolved in the collaborative learning context. In this study, a socially shared regulation-embedded collaborative learning tool was developed to enable learners to collectively regulate their learning. Our study evaluated the effect of the socially shared regulation approach on learning performance. In total, 66 undergraduates were randomly assigned to two groups: experimental (socially shared regulation approach) and control (non-socially shared regulation approach). The results indicated that the proposed approach significantly improved participants' learning achievements, group performance, and socially shared regulation frequency. Moreover, participants were satisfied with the proposed approach in terms of perceived usefulness, perceived ease of use, and cognitive load. The practical implications and future studies are also discussed based on the findings.

Keywords

Socially shared regulation, Computer-supported collaborative learning, Learning performance

Introduction

Over the past two decades, research on computer-supported collaborative learning (CSCL) have demonstrated positive learning outcomes. Most studies in this field centered on the quality of knowledge co-construction (Gan & Zhu, 2007; Kimmerle, Moskaliuk, & Cress, 2011). However, previous studies revealed that co-construction of knowledge was not easy to achieve (Kuhn, 2015) and true knowledge creation was rare (Siqin, van Aalst, & Chu, 2015). The major reason was that group members need to regulate their own and the whole groups' learning processes (Järvelä et al., 2016). As we know, collaborative learning emphasizes co-constructing shared goals, shared task representations, and shared strategies in a shared space, otherwise without these shared components, this approach may create a divergent or less effective and satisfying space for learners (Järvelä & Hadwin, 2013). In order to achieve common goals and shared understanding, a group need to coordinate group efforts in an effective and efficient manner (Kwon, Liu, & Johnson, 2014).

It has been recognized that regulatory processes played a very critical role in collaborative learning settings (Rogat & Linnenbrink-Garcia, 2011; Volet, Summers, & Thurman, 2009). In CSCL contexts, group members' engagement in interactions need to be facilitated by the group's regulatory processes in the shared task space (Roschelle & Teasley, 1995). Constructing shared goals and strategies needs to be coordinated by group members' motivations, cognitions, metacognitions, emotions, and behaviors. In addition, learning occurs in increasingly interactive manner (Isohätälä, Järvenoja, & Järvelä, 2017). Therefore, it was necessary to investigate regulatory processes beyond the individual (Hadwin, Järvelä, & Miller, 2011a). Socially shared regulation (SSR) emerged when group members worked together to regulate their cognitions, metacognitions, motivations, emotions, and behaviors in collaborative learning settings (Järvelä & Hadwin, 2013). Socially shared regulation was also transactive since it required individuals to collectively regulate collaborative learning processes (Hadwin, Järvelä, & Miller, 2011a). However, most learners were lack of joint regulatory skills when they completed collaborative learning tasks (Malmberg, Järvelä, Järvenoja, & Panadero, 2015). Furthermore, it was very difficult to collectively regulate cognitions, metacognitions, motivations, emotions, and behaviors because individuals were self-regulating agents (Järvelä, Volet, & Järvenoja, 2010). Thus, a large gap exists between the expectations and realities regarding socially shared regulation of learning in CSCL contexts.

CSCL technologies have been found to contribute to productive social interactions and construction of knowledge (Koschmann, 1996). However, most CSCL tools only support communication or sharing of information, rather than regulating collaborative learning processes (Gress & Hadwin, 2010). In this study, a

socially shared regulation-embedded CSCL tool was proposed and developed. To evaluate the effectiveness of the developed system, we examined the effects on learning achievements, group performance, socially shared regulation frequency, technology acceptance, and cognitive load. Students were divided into experimental and control groups. Those in the experimental group learned by using a socially shared regulation-embedded CSCL tool, while those in the control group learned by using a CSCL tool without a socially shared regulation mechanism. The following research questions were addressed to examine the effects of this new approach:

- Is there any significant difference in learning achievements between the experimental and control groups?
- Is there any significant difference in group performance between the experimental and control groups?
- Is there any significant difference in socially shared regulation frequency between the experimental and control groups?
- Is there any significant difference in perceived usefulness and perceived ease of use between the experimental and control groups?
- Is there any significant difference in cognitive load between the experimental and control groups?

Literature review

Regulation of collaboration

Regulation of collaboration is characterized as goal-directed metacognitive activities where group members take strategic control of their behavior, cognition, metacognition, motivation, and emotions through interactions (Hadwin et al., 2011a; Miller & Hadwin, 2015). Therefore, regulation differs from knowledge construction because the former focuses on constructing metacognition, meta-motivation, and meta-emotion, while the latter centers on constructing domain knowledge (Järvelä & Hadwin, 2013). Three types of regulation for successful collaboration exist: self-regulation, co-regulation, and socially shared regulation (Hadwin et al., 2011b; Järvelä & Hadwin, 2013).

Self-regulation of collaborative learning requires individuals to plan, monitor, evaluate, and adapt their motivations, cognitions, emotions, and behaviors during collaboration (Schunk & Zimmerman, 2008). Winne and Hadwin (1998; 2008) proposed four iterative and linked phases of self-regulated learning: defining the task, setting goals and planning how to reach them, enacting strategies, and adapting metacognition. Therefore, in the first phase, learners need to define the task as well as understand the task. Then the second phase sees them setting task goals and planning how to approach the task. In the third phase, learners apply tactics to achieve task goals as well as monitor and control the learning process. Finally, the fourth phase sees learners making adaptations to task perceptions, goals, plans, and strategies by self-evaluating their learning performance. During collaborative learning, self-regulating oneself is necessary and essential for successful collaboration. However, self-regulation alone is not enough because collaborating with others requires group members to be aware of one another's motivations, cognitions, metacognitions, emotions, and behaviors, as well as to regulate each other's goals, plans, and strategies.

Co-regulation of collaborative learning is also important for successful collaboration. In co-regulation, individuals socially regulate each other's learning through questioning, prompting, and restating (Volet, Summers, & Thurman, 2009), and occurs when one group member guides, supports, or shapes others' activities (Hadwin, Oshige, Gress, & Winne, 2010). Developing awareness of others' goals and progress as well as monitoring and regulating others' self-regulation are required (Miller & Hadwin, 2015). Therefore, each group member must keep track of one another's progress in order to coordinate collaborative activities. To summarize, the aim of co-regulation is regulating one another's self-regulation so as to provide services for the whole group.

Socially shared regulation in collaborative learning

Socially shared regulation refers to the process by which all group members regulate their motivations, cognitions, metacognitions, emotions, and behaviors to construct a shared outcome (Hadwin et al., 2011a). When all group members set goals, make plans, or monitor progress, they are engaged in socially shared regulation. Studies have found that students need to regulate motivations, cognitions, metacognitions, and emotions together during collaborative learning (Hurme, Merenluoto, & Järvelä, 2009; Järvelä & Järvenoja, 2011). Therefore, socially shared regulation centers on jointly coordinated activities working toward the same goal in collaborative learning.

Collaborative learning aims to co-construct shared task representations, shared goals, shared plans, and shared strategies. Therefore, these shared activities need to be leveraged through socially shared regulation in order to regulate everyone's motivation, cognition, metacognition, emotion, and behavior. Socially shared regulation is a complex process that plays a vital role in collaborative learning (Kempler Rogat & Linnenbrink-Garcia, 2011). Group members must use socially shared regulation to orientate their tasks, set task goals, make plans, enact tactics, monitor their learning process, and evaluate their performance in order to achieve productive collaborative learning.

Despite the evidence, studies have demonstrated that learners failed to achieve socially shared regulation during collaborative learning (Kirschner & Erkens, 2013; Zimmerman & Schunk, 2011). This occurred because it was more difficult and complex to regulate at the group level than at the individual level (Winne, Hadwin, & Perry, 2013). In addition, learners were not equipped to regulate the collective activities and share group work (Kempler Rogat & Linnenbrink-Garcia, 2011). Thus, external support was essential for facilitating socially shared regulation during collaborative learning. Furthermore, Järvelä et al. (2015) posited that socially shared regulation can be leveraged and facilitated by technology-based tools. Winne (2015) also recommended software systems as a medium for regulating group work. However, some studies also revealed that use of technology-based tools in promoting socially shared regulation remained scarce (Järvelä & Hadwin, 2013; Järvelä et al., 2015). In addition, many efforts have been made to support cognitive activities in CSCL (Hmelo-Silver & Barrows, 2008; Saab, Joolingen, & Hout-Wolters, 2012; Zhang, Scardamalia, Reeve, & Messina, 2009). Therefore, research is limited regarding enhancing socially shared regulation in CSCL. The present study aims to bridge these identified gaps and develop the CSCL tool to support socially shared regulation in collaborative learning.

Development of a socially shared regulation-embedded collaborative learning tool

In order to promote socially shared regulation, a CSCL tool with a socially shared regulation approach was developed. This socially shared regulation-embedded CSCL tool facilitated socially shared regulation by group members jointly setting goals, making plans, selecting strategies, discussing online, monitoring learning processes, evaluating, and reflecting in a CSCL environment. In addition, some pop-up hints and prompts were incorporated to remind learners to collectively regulate during collaborative learning processes.

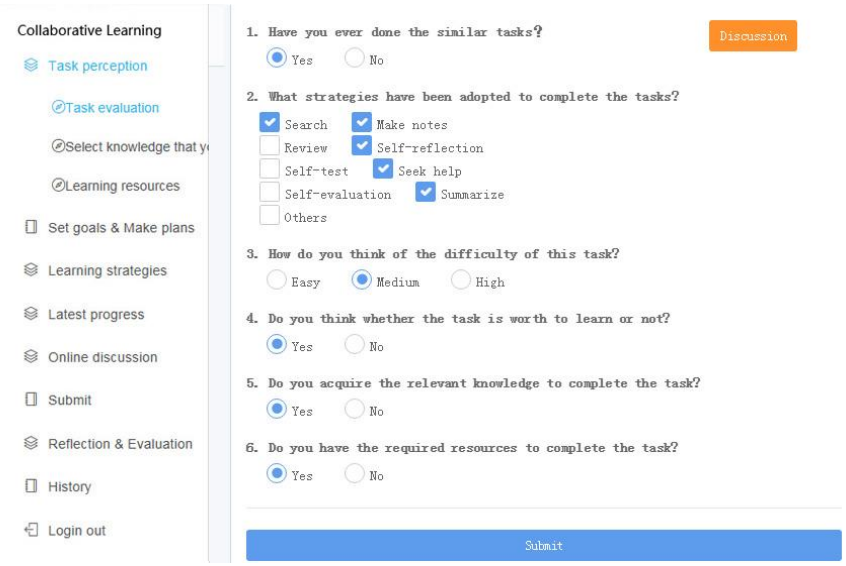

Figure 1. Task evaluation

This socially shared regulation-embedded CSCL tool includes seven modules. The first module addresses task perception, enabling learners to evaluate a task in terms of difficulty, value, and similarity with previous tasks (See Figure 1). Learners can input their prior knowledge so that other group members can be aware of peers' prior knowledge. Learners can also download the task resources and check the task description. In the second module, each group member can set goals and make plans, whereas other group members can revise these goals and plans. However, learners usually need to jointly set goals, preset learning achievements, timelines, steps, and strategies after discussion (See Figure 2). Thus, when all group members agree upon the goals and plans, they can proceed onto the next steps. The third module supports learners in enacting strategies, including searching

for information, making notes, and summarizing. The fourth module demonstrates the latest progress, including the amount of prior knowledge, number of postings, goals and plans, emotional status, current learning performance, and the number of enacting strategies (See Figure 3). Group members can monitor collaborative learning processes based on the latest progress to collectively regulate goals, plans, strategies, emotions, and behaviors. The fifth module supports group members in discussions online (See Figure 4). Here, when learners input negative emotion symbols, automatic pop-up system prompts encourage learners to be more positive. For example, if learners input a symbol indicating a sad emotion, the following pop-up appeared: “Don’t be too sad. Kindly discuss with your group members and you can find a solution. Be optimistic.” Eight kinds of emotions can be selected, including enjoyment, hope, pride, shame, anxiety, anger, hopelessness, and tiredness. The system prompts can facilitate regulation of emotions. The sixth module supports learners in submitting their group products online. As the submission date approaches, which was predetermined by each group, an automatic pop-up system prompt reminds learners of the deadline. Thus, learners can finish the collaborative learning task on time. The seventh module supports group members in reflecting and evaluating what they have learned as well as the whole collaborative learning process. If one group member believes they have not achieved a goal, our system will guide them to reset goals, revise plans, and study again. All of these modules were designed as technological interventions to facilitate socially shared regulation. Furthermore, Figure 5 demonstrates the associations between the technological interventions and SSR processes.

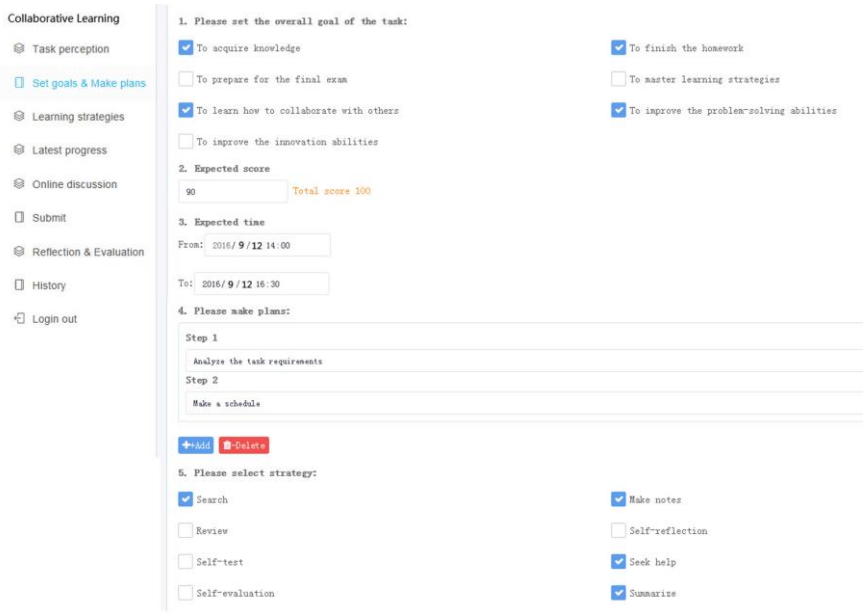

Figure 2. Setting goals and making plans

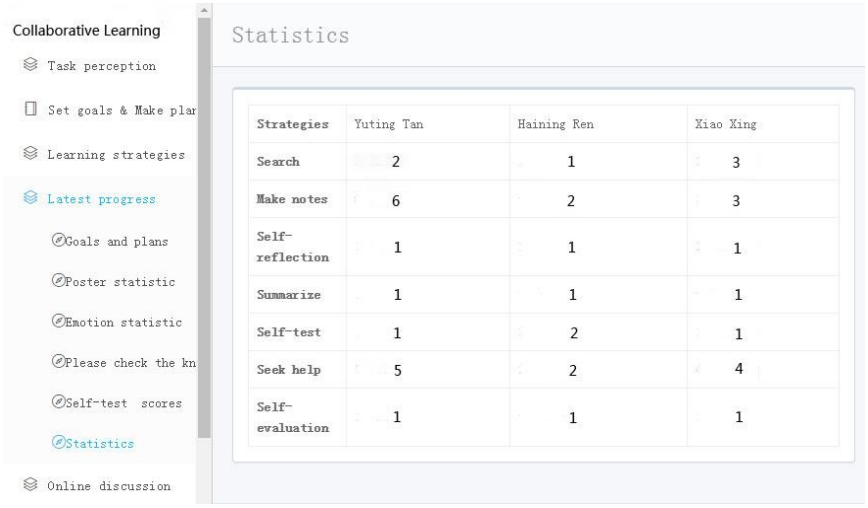

Figure 3. The statistics of strategies

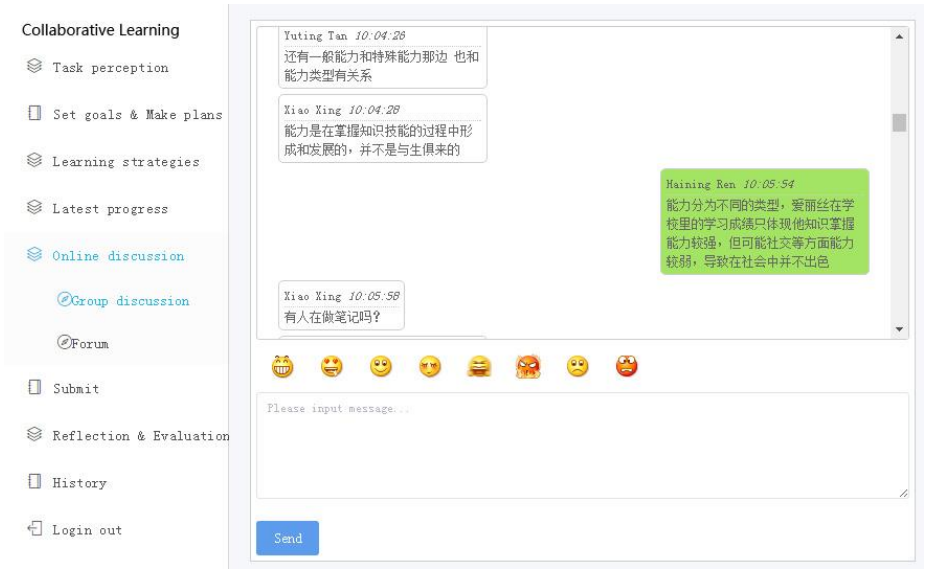

Figure 4. Online discussion

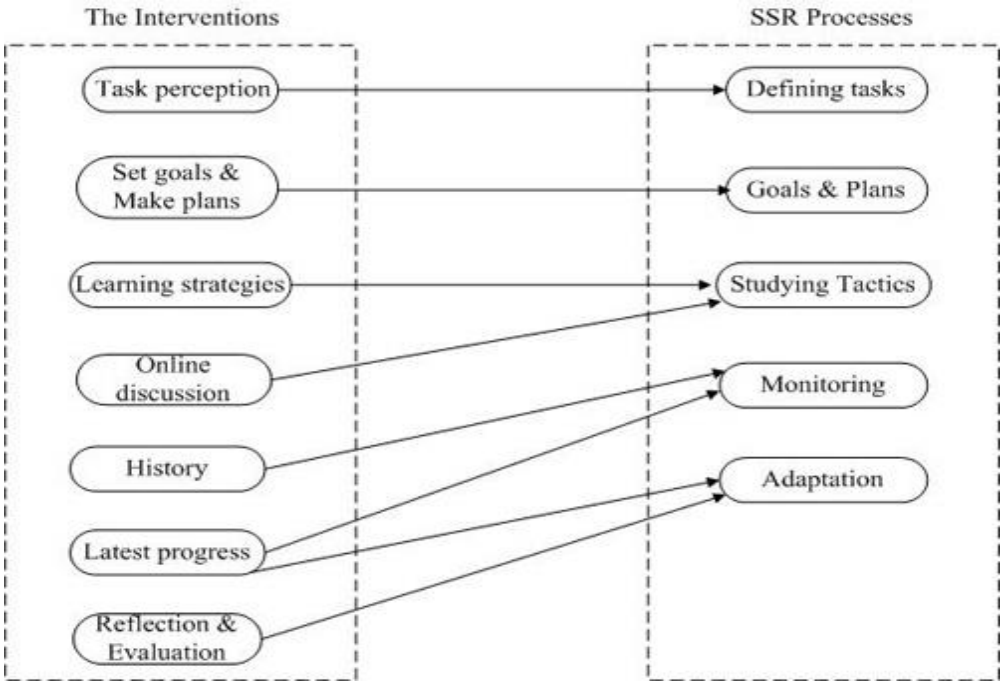

Figure 5. The associations between the technological interventions and SSR processes

Method

Participants

In total, 66 undergraduate students who responded to study recruitment posters displayed at a university participated. They ranged in age from 19 to 21 years, with only three being male. They majored in psychology, educational science, or educational technology. All participants were randomly assigned into experimental and control groups. Each group included three undergraduates. Thus, 11 experimental groups conducted collaborative learning using a socially shared regulation-embedded CSCL tool, while 11 control groups learned using a CSCL tool without socially shared regulation. All participants had experienced collaborative learning in previous courses. However, three members of each group had never experienced collaborative learning together and only participated in this study once. Therefore, this was new experience for all participants.

Collaborative learning tasks

All groups completed a collaborative learning task closely related to the cultivation of abilities that was taught in their psychology course. The collaborative learning tasks of the experimental and control groups were identical. The group product was a Word document that indicated each group's opinions and solutions to these problems. They collaboratively solved the following problems online:

- *Alice is a good student with a remarkable academic record. Her teacher also believes that she is the best student in her class. But after graduation, Alice performs at only an average level in her career. In addition, her classmates who are not good at studies show better career performances than her. Please explain the phenomenon and analyze the reasons by using online discussion with your group members.*

- *"There are three-hundred and sixty trades, and every trade has its grand master". This is an old Chinese saying. These grand masters can acquit themselves of various duties splendidly. Please analyze what kinds of abilities are crucial for these grand masters. Are these abilities inherent?*

- *Many people can win gold medals in the Olympic Games, but only a few people can win a Nobel Prize in China. Qian Xuesen, a famous scientist, once questioned, "Why innovative talents can't be fostered in China?" Please analyze and explain the phenomena as well as propose your solutions.*

Data collection and analysis

Data included a pre-test, a post-test, and questionnaires for measuring participants' learning achievements, technology acceptance, and cognitive load. The present study assumed that socially shared regulation approach can improve learning achievements and group performance. The learning achievement was measured by the tests. The pre-test aimed to examine prior knowledge regarding collaborative learning tasks. It consisted of 10 single-choice items and five multiple-choice items, with a perfect score of 100. All of these items were associated with the concepts, characteristics, and the measurement of abilities. The post-test comprised five short answer questions and two open-ended questions, also with a perfect score of 100. These questions were related to the definitions, characteristics, individual differences of abilities as well as the methods to cultivation of abilities. The pre-test and post-test were developed by the experienced teachers. In addition, group performance was measured using the scores of group products. Moreover, the pre-test and post-test were independently assessed by the two raters. Cohen's kappa was adopted to determine the inter-rater reliability coefficient. The kappa value for the pre-test and post-test were 0.91 and 0.86, respectively. Two raters also independently evaluated the group products. The Cohen's kappa value achieved 0.89, indicating good reliability.

The technology acceptance questionnaire aimed to examine the perceived usefulness and perceived ease of use of our tool, which was adapted from the one developed by Chu, Hwang, Tsai, and Tseng (2010). It included seven items for "perceived ease of use", and six items for "perceived usefulness." The Cronbach's alpha values were 0.75 and 0.92, respectively. The cognitive load questionnaire adapted from Lai and Hwang (2015) included eight items with a seven-point rating scheme. These items aimed to evaluate whether our tool increased the cognitive load of leaners. The Cronbach's alpha value was 0.80.

A content analysis method was also adopted to analyze the frequency of socially shared regulation behaviors. The socially shared regulation episode was analyzed. The episode comprised pieces of dialogue with a shared focus and collective regulation of the activity (Grau & Whitebread, 2012). The socially shared regulation episode was identified and coded based on several criteria. First, the initiative dialogues that started the collective discussion were coded as one socially shared regulation episode. For example, group member A said: "Hello, everyone! Let's start." group member B said, "OK. Let's begin discussing the first task." Second, the dialogues that achieved the shared regulation of learning among all group members were also coded as one socially shared regulation episode. For example, group member A said: "Can we make a detailed plan first?" group member B said: "Yes, we should make a plan to specify how to achieve the goal." group member C said: "OK, let's make a plan now." Third, only dialogues that reflected task perception, setting goals, making plans, enacting strategies, monitoring and controlling, reflecting and evaluating, and making adaptation were coded as socially shared regulation episodes. All discussion transcripts were independently coded by two raters so as to identify the socially shared regulation episodes. The Cohens' kappa value achieved 0.81. All discrepancies were discussed and solved.

Experimental procedure

The experimental procedure is shown in Figure 6. Experimental and control groups completed a pre-test about prior knowledge. Then, during the collaborative learning activity, experimental group participants learned using a socially shared regulation-embedded CSCL tool and those in the control group learned using a CSCL tool without socially shared regulation. To conduct online collaboration using our tool, members of the same group were located in different laboratories. The experimental and control groups completed the same collaborative learning task for 2 hours. Next, all participants completed the post-test and the questionnaires to compare learning achievements, technology acceptance, and cognitive load. Finally, eight participants were randomly selected from the experimental group to conduct the interview so as to investigate their perceptions of learning using the new approach. The interviewees addressed the following questions:

- What are the advantages of this new approach (i.e., using a socially shared regulation-embedded CSCL tool to learn)? Why?
- Do you think this new approach (i.e., using a socially shared regulation-embedded CSCL tool to learn) is helpful for you in collaborative learning? Why?
- Would you recommend this new approach to your peers?

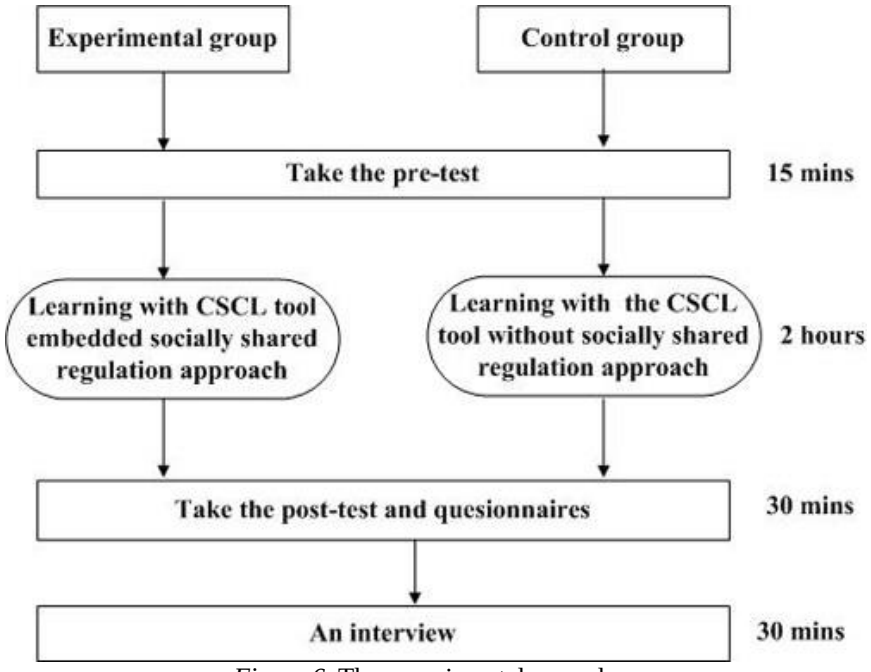

Figure 6. The experimental procedure

Results

Analysis of learning achievements

Before the experiment, all participants from the experimental and control groups took a pre-test to evaluate their prior knowledge. The respective mean values and standard deviations of the pre-test were 56.06 and 15.45 for the control group, and 51.97 and 13.40 for the experimental group. The *t*-test result demonstrated no significant differences between the two groups ($t = 1.149$, $p > .05$), indicating that the two groups had equivalent prior knowledge before the collaborative learning activity.

Table 1. ANCOVA result of learning achievements on the post-test

Group	*N*	Mean	*SD*	*F*
Experimental group	33	71.52	8.56	4.101*
Control group	33	66.33	10.03	

Note. $^{*}p < .05$.

After the collaborative learning activity, experimental and control group post-test results were compared. Table 1 shows the analysis of covariance (ANCOVA) result of learning achievements. A positively significant difference was found between the experimental and control groups ($F = 4.101$, $p < .05$), implying that the socially shared

regulation approach helped improve students' learning achievements. In addition, the mean of the experimental group was higher than that for the control group. Therefore, the socially shared regulation approach positively impacted on improving learning achievements.

Analysis of group performance

The group products of the experimental and control groups were analyzed to compare differences. As shown in Table 2, a significant difference in group performance existed between the experimental and control groups. This finding indicated that the socially shared regulation approach had a significant impact on group performance.

Table 2. The *t*-test result of group performance for the experimental and control groups

Group	*N*	Mean	*SD*	*t*
Experimental group	33	89.27	2.78	3.35**
Control group	33	86.58	3.69	

Note. $^{**}p < .01$.

Analysis of socially shared regulation frequency

Online collaborative learning was a new experience for all group members. We were particularly interested in whether this new approach can promote socially shared regulation among group members. The frequencies of socially shared regulation between the experimental and control groups were analyzed and compared. As shown in Table 3, it was obvious that there were significant differences in socially shared regulation frequency between the experimental and control groups ($t = 7.962$, $p < .05$). Furthermore, compared with the control group, the experimental group had higher socially shared regulation frequency. This finding indicated that the socially shared regulation approach had a significant impact on promoting socially shared regulation in collaborative learning.

Table 3. The *t*-test result of socially shared regulation frequency for the experimental and control groups

Group	*N*	Mean	*SD*	*t*
Experimental group	33	20.73	4.60	7.962***
Control group	33	7.90	2.70	

Note. $^{***}p < .001$.

Analysis of perceived usefulness and perceived ease of use

The technology acceptance included the perceived usefulness and perceived ease of use. As shown in Table 4, no difference was found regarding perceived usefulness between the experimental and control groups ($t = 0.247$, $p > .05$). No significant difference was also found with regard to perceived ease of use between the experimental and control groups ($t = -0.125$, $p > .05$). These findings implied that learners' perceptions were not affected by the treatments.

Table 4. The *t*-test result of technology acceptance of the experimental and control groups

	Group	*N*	Mean	*SD*	*t*
Perceived usefulness	Experimental group	33	3.45	1.15	0.247
	Control group	33	3.38	1.00	
Perceived ease of use	Experimental group	33	4.41	0.77	-0.125
	Control group	33	4.43	0.63	

Analysis of cognitive load

Because learning to use the socially shared regulation approach was a new experience for all participants, we also examined whether this new approach increased cognitive load during collaborative learning. Table 5 shows the t-test result of the cognitive load. No significant difference was found for cognitive load between the experimental and control groups ($t = -.773$, $p > .05$). Therefore, the proposed socially shared regulation approach did not increase learners' cognitive load.

Table 5. *t*-test result of cognitive load for experimental and control groups

Group	*N*	Mean	*SD*	*t*
Experimental group	33	3.02	0.81	-0.773
Control group	33	3.18	0.93	

Interview results

To obtain a better understanding of learners' perceptions of the collaborative learning activities, eight students from the experimental group were randomly selected for interviews. All interviewees reported one main difference between the collaborative learning activity and previous learning activity. That is, the socially shared regulation approach can promote awareness of collective regulation and facilitate knowledge building during collaborative learning. For example, student A indicated, "This tool can indeed improve the awareness of socially shared regulation. Consequently, our group performance was also improved."

The results of interviews also revealed that learners believed that the socially shared regulation approach was helpful in facilitating setting of goals, making plans, monitoring the collaborative learning processes, and reflecting and evaluating learning outcomes and processes. For example, student B indicated, "This tool can facilitate setting goals and making plans. Usually, we are not aware of setting goals and making plans." Student C stated, "This friendly tool reminds us to submit group products based on our schedule." Student D said, "This tool can help us to reflect on the collaborative learning process and group products. This is very necessary for improving learning performance."

All eight students reported that they would be willing to adopt our system using the socially shared regulation approach to conduct collaborative learning in the future. They also indicated that they would recommend the socially shared regulation approach to their peers.

Discussion and conclusions

We proposed a socially shared regulation approach for supporting collaborative learning activities by examining the learning achievements, group performance, socially shared regulation frequency, technology acceptance, and cognitive load between students situated in two different groups. One group worked in a socially shared regulation-embedded collaborative learning environment and the other in a conventional collaborative learning environment. We found that the socially shared regulation approach can significantly improve students' learning achievements and group performance. This was consistent with Järvelä and Hadwin's (2013) results, which demonstrated that socially shared regulation can promote collaborative knowledge building. This finding was also in line with Panadero and Järvelä (2015) who found that socially shared regulation improved learning outcomes. Our findings were also consistent with those of Mayordomo and Onrubia (2015), which revealed that there was an increase in collaborative knowledge construction when work group coordination was applied. Researchers have reported that the groups with the higher level of socially shared regulation achieved the higher group performance and learning achievements (Grau & Whitebread, 2012; Janssen, Erkens, Kirschner, & Kanselaar, 2012; Volet, Summers, & Thurman, 2009).

Furthermore, it was found that the proposed socially shared regulation approach can promote awareness and frequency of collective regulation. Figure 5 clearly demonstrated the relationships between the proposed interventions and socially shared regulatory processes. It was found that the functionalities provided by task perceptions informed users about other group members' status, the availability of resources, and the difficulty of tasks so as to define tasks. The module of setting goals and making plans was effective for users to set learning goals and performance goals as well as make proper plans. Furthermore, Järvelä et al. (2015) also indicated that socially shared regulated learning environment should be designed to promote the activation of regulatory processes. Our tool provided the recommendation about learning strategies, which can help group members to select and enact strategies. In addition, online group discussion promoted the externalization of learning processes, which can facilitate the activation of joint regulation. Moreover, the usage information provided by the modules of history and the latest progress facilitated users to monitor the learning processes as well as increase the awareness of both self- and group members' learning processes. The module of reflection and evaluation reminded learners to reflect whether they achieved the goals. If learners did not achieve the goals, our tool guide learners to iteratively regulatory of the learning processes. Previous studies also revealed that regulated learning can be supported when the learning environment provided scaffolds (Van Merrienboer & Kirschner, 2013). Our socially shared regulation-embedded CSCL tool provided scaffold in the key regulatory

processes such as setting goals, making plans, enacting strategies, monitoring, and reflection to achieve a shared outcome. Consequently, the socially shared regulation can be achieved by increasing metacognitive awareness and regulatory at the group level.

In addition, this new approach did not negatively affect learners' perceptions regarding usefulness and ease of use. Feedback from the experimental group revealed that they believed the socially shared regulation approach was useful and easy to use. In addition, the socially shared regulation approach did not increase learners' cognitive load. Although there was no significant difference in cognitive load, the experimental group appeared lower than the control group. The major reason was that our system was friendly and not complex, thereby motivating students' willingness to use it for an extended period. As Mayer and Moreno (2003) indicated that system designers should aim to reduce cognitive load and increase users' pleasure by proper design as well as allocating cognitive resources.

In the field of CSCL, most studies focused on collaborative knowledge building among group members. Little attention was paid to socially shared regulation of task perceptions, goals, plans, and strategy use. In addition, Hadwin and Oshige (2011b) revealed that learners often experience problems in jointly regulating their learning. Therefore, the present study sought to improve group members' socially shared regulatory skills during collaborative learning. The main contribution of this study lie in proposing and developing a collaborative learning tool using a socially shared regulation approach. The results of the empirical study validated the effectiveness of the proposed socially shared regulation approach.

The current study presents several implications for teachers and practitioners. First, socially shared regulation was a very important aspect for productive collaborative learning. Collaboration required all group members to successfully regulate their own learning and help other members to collectively regulate learning (Winne et al., 2013). Hence, teachers and practitioners should pay greater attention to socially shared regulation during collaborative learning. Teachers and practitioners were required to guide learners in collectively regulating beliefs, motivations, cognitions, metacognitions, emotions, and behaviors in order to achieve collaborative learning, rather than cooperative learning. For example, teachers encouraged group members to share responsibility before collaborative learning. Second, development or use of a technological tool can facilitate socially shared regulation during collaborative learning. Järvelä et al. (2015) reported on how these tools should increase group members' awareness, promote activation of joint regulation of learning as well as support sharing and interactions with each other. Third, teachers should engage in collaborative learning to monitor learning processes and provide real-time feedback and intervention for learners.

This study has several limitations. First, the sample size was small, thereby making it difficult to generalize the results to other conditions. In future studies, we will enlarge the sample size and validate the approach in other contexts. Second, the collaborative learning tasks only focused on how to cultivate abilities in the field of psychology. Examining learners' perceptions in other task contexts would be of value. Third, this study was conducted in a laboratory over a short period. Future studies should conduct a longitudinal study to examine the socially shared regulation approach in classrooms.

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