

Socially Shared Regulation and Performance in Group Work on Creativity Tasks: Analyzing Regulation Utterances

Takamichi Ito¹ & Takatoyo Umemoto²

¹ Faculty of Human-Environment Studies, Kyushu University, Fukuoka, Japan

² Faculty of Foreign Studies, Kyoto University of Foreign Studies, Kyoto, Japan

Correspondence: Takamichi Ito, Faculty of Human-Environment Studies, Kyushu University, 744 Motoooka, Nishi-ku, Fukuoka 819-0395, Japan.

Received: March 22, 2022

Accepted: May 25, 2022

Online Published: June 4, 2022

doi:10.5539/jel.v11n4p74

URL: <https://doi.org/10.5539/jel.v11n4p74>

Abstract

This study examined socially shared regulation of learning (SSRL) and motivation processes in a collaborative learning task that required creativity using the ICT tool of mind mapping. Thirty university students formed three groups, collaborating face-to-face to generate creative ideas. The following results were obtained from qualitative and quantitative data using psychological scales and utterance analysis. In the middle phase of the collaborative activity, there was a significant weak-to-moderate positive correlation between socially shared regulation of cognition, self-regulation, co-regulation, and socially shared regulation of intrinsic motivation and a deep level of regulation utterances. Moreover, there were significant weak-to-moderate correlations between behavioral and cognitive engagement, SSRL of monitoring and cognition, and the three modes of motivational regulation. Creative performance was significantly and moderately positively associated with socially shared regulation of cognition and total frequency of utterances in the group. Based on these findings, the implications for practice in university education are discussed from the perspective of socially shared regulation in collaborative learning.

Keywords: collaborative learning, co-regulation, motivation, self-regulation, socially shared regulation

1. Introduction

Comprehending the regulatory process of cognitions, emotions, and behaviors in collaborative learning is critical for productive participation in real-life learning environments and social learning contexts (Järvenoja, Järvelä, & Malmberg, 2020; Volet & Summers, 2013). In recent years, research on learning and instruction has focused on socially shared regulation of learning (SSRL) (Grau et al., 2018; Hadwin, Järvelä, & Miller, 2011, 2018; Järvelä & Hadwin, 2013; Li, Lin, & Shadiev, 2020; Li, Li, Su, Peng, & Hu, 2020; Lin, 2018; Tsai, Shen, Chiang, Chen, & Chen, 2018). The SSRL is a psychological and theoretical framework that explains the regulatory process of collaboration with others. Research on collaborative learning has shifted its focus from self-regulated learning (SRL) to SSRL (Panadero & Järvelä, 2015; Järvelä, Järvenoja, & Malmberg, 2019), as it is an activity in which various types of involvement with others are essential. This theory assumes three modes of regulation. In the first mode, self-regulation indicates that one's cognitions, emotions, and behaviors are effectively regulated by the learner to achieve desired goals (cf. Zimmerman, 1989, 2000; Zimmerman & Schunk, 2001, 2011). In the second mode, co-regulation of learning (CoRL) is the temporary coordination of self-regulation between the self and others, and then the learner needs to share to engage in co-regulated behavior (Hadwin et al., 2011). CoRL is a phenomenon that occurs between the self and the other, where either the learner guides another peer learner, or vice versa. In the third mode, multiple learners jointly regulate their cognition, behavior, and emotion through social interaction. "Socially shared regulation" refers to groups taking metacognitive control of the task together through negotiated, iterative, fine-tuning of cognitive, behavioral, motivational, and emotional conditions/states, as needed (Hadwin, Järvelä, & Miller, 2018). This is considered an important mode of social regulation in collaborative learning (Hadwin et al., 2011, 2018; Järvelä & Hadwin, 2013; Järvenoja et al., 2019). In the SSRL process, all group members share the same goals, implement strategies to achieve them together, and jointly reflect on the learning results. Joint beliefs, outcomes, strategies, and awareness intentionally co-emerge in group activities, rather than being guided or directed by any one person (i.e., co-regulation). SSRL implies jointly evoked regulative acts and emerging perceptions in the collaborative learning process (Hadwin et al., 2018).

1.1 Socially Shared Regulation of Motivation and Research Methods

Research on SSRL is still in its early stages, but most studies have examined how learners regulate their cognition and behavior in collaborative learning (Hadwin et al., 2011, 2018; Järvelä & Hadwin, 2013; Järvelä et al., 2019). Although motivation is an important factor for success in academic learning and performance (Usher & Schunk, 2018), few studies have focused on its social regulation of motivation (Järvenoja et al., 2020). In clarifying the regulatory processes of both cognitive and motivational aspects, a deeper and more sophisticated theoretical explanation of SSRL will be possible.

Utterance and log file data analyses were used to examine the processes of co-regulation and SSRL. These methods are well-suited for the qualitative and in-depth examination of the learning process. However, the regulatory process in collaborative learning is a complex phenomenon that requires clarification through qualitative and quantitative research methods (e.g., Zimmerman & Schunk, 2011). The triangulation of various qualitative and quantitative research methods is required, and evidence based on multimodal data is necessary (Järvelä et al., 2019; Järvenoja et al., 2020; Ochoa, 2017; Zimmerman & Schunk, 2011). Currently, attempts to measure co-regulation and SSRL using questionnaires have just begun (e.g., Ito & Umemoto, 2017, 2021), and necessitate the comprehensive investigation of the relationship between self-report measures and utterance analysis. The first SSRL scale (Ito & Umemoto, 2017) consists of subscales that capture the social regulation of monitoring, cognition, and effort, and the second SSRL scale (Ito & Umemoto, 2021) consists of subscales that capture the self-regulation, co-regulation, and SSRL of “intrinsic motivation.” The former focuses on the social regulation of cognition and behavior within the SSRL process, while the latter differs in that it focuses specifically on the social regulation of motivation. Both studies were conducted with college students and attempted to measure the extent to which they performed socially shared regulations in their daily group activities.

In previous studies (Järvenoja et al., 2020) on the socially shared regulation of motivation, four-year teacher education students were examined while working on collaborative learning tasks related to educational practices. The students collaborated to create a mid-term plan for primary school mathematics. Group work was supported by a mobile application tool that promoted group members’ awareness of the motivational, emotional, and cognitive states of collaborative learning. Likert-type scales measuring the SSRL were not used in this study. The results of this study indicated that the ICT tool prompted the groups to regulate their motivation and emotions at the beginning of motivationally and emotionally challenging learning sessions.

Similarly, most studies on SSRL, although not involving “motivational regulation,” are validated using ICT tools in collaborative learning tasks in university classes. For instance, Splichal, Oshima, and Oshima (2018) examined students’ regulation scripts as a repertoire of regulatory processes in SRL, CoRL, and SSRL, and clarified whether the repertoire increased after the project-based learning course using the Knowledge Forum (KF; Scardamalia & Bereiter, 2014). KF is a digital portfolio and public note in which students collaboratively reflect on their learning. Malmberg, Järvelä, Järvenoja, and Panadero (2015) explored how groups progress in their SSRL in the context of computer-supported collaborative learning. The teacher education students collaborated in groups through a multimedia course. The groups used the Virtual Collaborative Research Institute (VCRI) learning environment along with regulation tools. Volet, Summers, and Thurman (2009) examined the process of collaborative learning in veterinary science students’ group activities at a university. Based on the video data of students working on a case-based project, regularities in the emergence of high-level co-regulation were identified. As few studies have focused on the socially shared regulation of “motivation,” researchers should verify the social regulation process qualitatively and quantitatively by using various collaborative learning tasks and ICT tools in the future.

1.2 The Present Study

This study aimed to examine how university students collaboratively engage in creative learning tasks and socially share the regulations of learning and motivation. The research method adopted was a combination of utterance analysis and a questionnaire survey from the viewpoint of triangulation. It aims to elucidate the collaborative learning process, both qualitatively and quantitatively. We used a mind-mapping support tool on a laptop computer as an ICT tool to support collaborative learning. University students worked face-to-face in groups on issues that exercise their creativity and brainstorming abilities by using ICT tools. Mind mapping can stimulate creative thinking by connecting diverse ideas and spreading activation through drawing maps (Buzan & Buzan, 2010; Malycha & Maier, 2017). Previous research (e.g., Sun, Wang, Wegerif, & Peng, 2022) has indicated that a computer-based mind map promotes and improves group thinking and creativity.

Presumably, SSRL in collaborative learning has both superficial and deep levels of regulation (Chin & Brown,

2000; De Backer, Van Keer, & Valcke, 2012, 2015a, 2015b; Malmberg et al., 2015; Veenman, Elshout, & Meijer, 1997). Two levels of regulation are manifested in in-group utterances, according to the three phases of the self-regulation cycle: forethought, performance/volitional control, and self-reflection. A deep level of regulation, as opposed to a superficial level of regulation, generates richer ideas and divergent thinking. Moreover, it also leads to more creative performance. By conducting an utterance analysis according to the phases of the activities, such as the initial, middle, and final phases, the functions of the SSRL can be examined in more detail.

In summary, this study is exploratory in form and investigates the SSRL and motivation processes in a collaborative learning task that requires creativity using the ICT tool of mind mapping. First, we examined the relationship between self-report measures and utterance analysis results to gain a deeper understanding of the SSRL phenomenon in collaborative learning. A psychological scale (Ito & Umemoto, 2017, 2021) was used to measure both cognitive and motivational aspects of SSRL. Then, utterance analysis of SSRL was conducted according to the three phases of the self-regulation cycle and the timing of regulation activities, and an episode of deep-level regulation utterance was analyzed. From a triangulation perspective based on qualitative and quantitative research methods, significant positive relationships between the results of the analysis of self-report measures and superficial/deep-level regulation utterances were clarified. Second, to confirm the validity of the scale, we examined the relationship between the SSRL scale, motivational factors, and creative performance. The motivational factors focused on academic engagement and creative performance were evaluated based on the content of the mind map created. Academic engagement has recently been considered an important motivational factor (Christenson, Reschly, & Wylie, 2012; Skinner, Furrer, Marchand, & Kindermann, 2008; Skinner, Kindermann, Connell, & Wellborn, 2009; Reeve, 2012, 2013). It consists of behavioral, emotional, and cognitive aspects (Moreira et al., 2018). A significant positive association was predicted between SSRL measures and all three aspects of engagement and creative performance.

2. Method

2.1 Participants

Thirty university students (15 males and 15 females) agreed to participate in the study. The average age of the participants was 20.53, and the *SD* was 1.86. The study was approved by the institutional review board and conducted in accordance with the guidelines for human participants.

2.2 Survey Contents

2.2.1 Socially Shared Regulation

Before carrying out group work, we distributed a questionnaire to the participants and measured three modes of socially shared regulation of cognition and behavior. Participants were asked to answer based on a scale (Ito & Umemoto, 2017) that captures socially shared regulation in daily group and pair work at the university. This scale consists of three subscales on socially shared regulation: monitoring (e.g., working while confirming each other's thoughts and ideas, four items), cognition (e.g., working on issues by utilizing each other's knowledge and information, four items), and effort (e.g., working while encouraging each other, five items). Participants answered using a six-point scale of "I don't agree at all (1)" to "I agree very much (6)." Based on the participants' answers, the numerical values shown in parentheses were used for scoring, and these scores were used in subsequent analyses. The answering and scoring methods for the six-point scale in the questionnaire were the same for all the scales.

2.2.2 Three Modes of Motivational Regulation

Three modes of motivational regulation, following the scale of socially shared regulation and regulation of intrinsic motivation in daily group activities, were also measured. Using a scale that captures three modes of motivational regulation (Ito & Umemoto, 2021), we measured the self-regulation of intrinsic motivation (e.g., "I try to increase my motivation by making the contents of group activities as enjoyable as possible," five items), co-regulation (e.g., "I try to support the motivation of the group members by devising ways to make the members find the contents of group activities interesting, five items), and socially shared regulation (e.g., "I try to support the motivation of the entire group by devising ways to make them find the contents of group activities interesting," five items). For this scale, participants answered using a six-point scale.

2.2.3 Engagement

Engagement in group work was measured immediately after completion of group work. We distributed a questionnaire to the participants; behavioral engagement (I was able to pay attention to group work), emotional engagement (I felt interested), and cognitive engagement (I was able to connect with my own experience) were

measured with one item each. These items were developed with reference to Reeve and Tseng (2011), and Skinner, Kindermann, and Furrer (2009). For this scale, participants answered using a six-point scale.

2.2.4 Performance

The creativity of the ideas in group work was evaluated on a three-point scale based on the contents of the mind map. Based on the expansion of ideas on the map and categorization, we comprehensively evaluated whether concepts were uniquely expressed. Grades were assigned on a scale of A, B, and C depending on the level of creativity. A score of 3 to 1 was assigned to the corresponding symbols (A–C). The inter-rater agreement rate between the two independent raters was 80.00%. Inconsistent scores between the two rates were all within the range of one point, and the scores were finalized after discussion.

2.3 Procedure

Participants worked in groups, three people in each group, freely coming up with ideas and demonstrating creativity to each other. As a specific theme, we stated to participants, “We would like to show the charm of Japan to as many foreigners as possible. What do you think would be appealing?” We also instructed participants to create as many ideas as possible while creating a mind map and engaging in group work. The group members sat around the table, while we prepared a laptop with writing equipment and a questionnaire. A mind map creation tool was installed on the laptop, and participants were instructed on how to use it. No specific instructions were provided regarding the division of roles, such as laptop operators and leaders in the group work. The time limit for the session was 15 min, and with the participants’ permission, their utterances during group work were recorded using an IC recorder.

2.4 Utterance Coding

First, we created a transcript based on voice data. While referring to sentence-ending expressions and connecting particles, the utterances were coded after they had been separated according to breaks in meaning. The total number of segments obtained from all the utterance data was 2,762.

As coding criteria, we set two levels, surface and deep, of regulation utterance, according to the three phases of the self-regulation cycle: forethought, performance/volitional control, and self-reflection. Utterances unrelated to group work, computer operation, and those that expressed emotions were not analyzed in this study.

The foresight phase of the self-regulation cycle involves creating a prospect to come up with ideas. During this phase, participants decide on the overall policy and plan, which leads to the generation of the next idea. The surface level of regulation utterances in foresight is merely confirmation of information; for example, utterances that confirm SW1H (what, who, when, where, why, and how) about what to engage with from now on. The deep level of regulation utterances provides directions that can lead to deepening of thought. These utterances concretely propose how to proceed to the next step.

Ideas are constantly generated during the performance and volitional control phases. Surface-level regulation utterances contain ideas and propose them accordingly. Deep levels of regulation utterances include content that develops ideas; for example, utterances that expand upon or derive ideas beyond merely suggesting them.

The self-reflection phase reflects whether the ideas created in the group work are valid and appropriate. Surface-level regulation utterances merely respond to the preceding utterances spoken by group members. For example, these include utterances that only answer yes or no or those that accept the utterances of other members as they are and do not involve deep thinking. A deep level of regulation utterances encourages deep reflection on members’ utterances. The utterances included raising a question and assessing an idea’s validity. They also included utterances that gave reasons for ideas and stopped thinking by questioning.

Based on the above criteria, two independent raters coded the protocols for all groups. The inter-rater agreement rate between the two independent raters was 77.37%. Considering the inconsistent utterances between the two raters, the code was finalized after the discussion.

3. Results

3.1 Composition of Subscales

According to previous research, the average value of the items was calculated for each subscale and used as the scale score. Table 1 shows the means and *SDs* of each scale score. For regulation utterances, 15 min of one session was divided into three phases (initial, middle, and final), and the frequency was counted every five minutes.

Table 1. Means and standard deviations of the SSRL scale, engagement, and performance

	Mean	SD
SSRL (Monitoring)	4.83	0.59
SSRL (Cognition)	5.60	0.86
SSRL (Effort)	4.53	0.63
Self-regulation	4.05	0.85
Co-regulation	4.01	0.72
Socially shared regulation	3.91	0.85
Behavioral engagement	5.13	0.88
Emotional engagement	5.20	0.87
Cognitive engagement	4.87	0.96
Creativity	2.00	0.63

3.2 Relationship Between the SSRL Scale and Regulation Utterances

Regarding the relationship between socially shared regulation in group work, the correlation coefficients were calculated for the three regulation modes of intrinsic motivation in group activities, and the surface/deep-level regulation utterances in the self-regulation cycle (forethought, performance/volitional control, and self-reflection phases). Table 2 presents the results of the correlation analysis.

In the initial phase, significant moderate positive correlations were observed between the co-regulation and socially shared regulation of intrinsic motivation and surface-level regulation utterances. The positive correlation between the socially shared regulation of effort and surface-level regulation utterances was marginally significant and weak.

In the middle phase, a significantly weak positive correlation was observed between the socially shared regulation of cognition and the deep level of regulation utterances. Moreover, significant moderate positive correlations were present between self-regulation, co-regulation, and socially shared regulation of intrinsic motivation, and deep levels of regulatory utterances.

In the final phase, a significantly weak positive correlation was observed between the co-regulation of intrinsic motivation and surface-level regulation utterances. Moreover, there was a significant moderate positive correlation between socially shared regulation of intrinsic motivation and surface-level regulation utterances.

Table 2. Results of correlation analysis between the SSRL scale, and surface/deep level of regulation utterance in three phases

	Initial phase		Initial phase		Middle phase		Middle phase		Final phase		Final phase	
	Surface level	(6.98)	Deep level	(4.25)	Surface level	(5.91)	Deep level	(3.58)	Surface level	(6.79)	Deep level	(3.95)
Average of the total number of utterances (SD)	19.33		6.43		19.87		6.90		19.97		6.70	
SSRL (Monitoring)	.15		.10		-.09		.27		.10		.05	
SSRL (Cognition)	.16		.11		-.20		.36 *		.16		.01	
SSRL (Effort)	.34 †		-.14		-.19		.22		.13		.11	
Self-regulation	.29		-.06		-.25		.41 **		.18		.08	
Co-regulation	.40 *		.07		.10		.48 **		.39 *		.08	
Socially shared regulation	.42 *		.06		.04		.48 **		.50 **		.12	

Note. † $p < .10$. * $p < .05$. ** $p < .01$.

3.3 Relationships Between the SSRL Scale, Engagement, and Creativity

Behavioral engagement had significant positive moderate correlations with socially shared regulation of monitoring and cognition, self-regulation, and socially shared regulation of intrinsic motivation. Behavioral engagement has a significantly weak positive correlation with co-regulation. Table 3 presents the results.

Emotional engagement had significant positive moderate correlations with socially shared regulation of monitoring and cognition. Moreover, emotional engagement was positively correlated with self-regulation, co-regulation, and socially shared regulation of intrinsic motivation, and these correlations were marginally significant and weak.

Cognitive engagement had significantly positive moderate correlations with socially shared regulation of monitoring and cognition, self-regulation, co-regulation, and socially shared regulation of intrinsic motivation.

A significant positive moderate correlation was observed between creativity and the socially shared regulation of cognition. Moreover, creativity had weak positive correlations with socially shared regulation of monitoring, co-regulation, and socially shared regulation of intrinsic motivation, and these correlations were marginally significant.

There was a significant positive correlation between the total frequency of utterances and creativity ($r = .41, p < .05$).

Table 3. Results of correlation analysis between the SSRL scale, engagement, and performance

	Behavioral engagement	Emotional engagement	Cognitive engagement	Creativity
SSRL (Monitoring)	.62 **	.44 *	.40 *	.31 †
SSRL (Cognition)	.62 **	.53 **	.48 **	.41 *
SSRL (Effort)	.07	.29	.16	.04
Self-regulation	.41 *	.36 †	.48 **	.27
Co-regulation	.37 *	.31 †	.51 **	.34 †
Socially shared regulation	.54 **	.36 †	.49 **	.32 †

Note. † $p < .10$. * $p < .05$. ** $p < .01$.

3.4 Examining an Episode with a Deep Level of Regulation

One episode in which a deep level of regulation manifested was taken as an example and the process of socially shared regulation was examined from an interpretive perspective. As shown in Table 4, this utterance episode was found in two phases of the self-regulation cycle: performance/volitional control and self-reflection. The utterance occurred shortly after the final phase. While brainstorming about Japan’s attractiveness using a mind map, C mentions “architecture,” which is simply an idea. It can be said that this is the surface level of regulation utterances in the performance/volitional control phase. However, B continued, “Is there anything else?” In response, A said, “Temples and shrines,” which is derived from “architecture.” This could be interpreted as a deep level of regulation utterances that expanded or derived ideas beyond merely suggesting them. Then, A suggested, “Can we just say ‘Buddhism’?” This can be interpreted as the surface level of regulation utterance to which B responds, “Yeah. Oh, wait. If you put Buddhism in there, you can put the names of temples there, can you not?” In response to the group members’ statements, B’s utterance raises questions and evaluates the validity of the idea. This can be interpreted as a deep level of regulatory utterances in the self-reflection phase. The subsequent utterance of A is, “That is certain. Do you want to include temples in detail? Do you want me to?” This utterance causes group members to stop thinking by questioning, which can also be interpreted as a deep level of regulation utterance in the self-reflection phase. As the regulation process unfolded, this group engaged in deep collaborative thinking, creative problem-solving, and generating various ideas.

Table 4. An example of an episode with surface/deep level of regulation utterance

Speaker	Verbal protocol excerpt	Level
C	Architecture	3
A	Oh, sorry (while typing)	
B	Is there anything else besides “architecture,” in the way of groupings?	4
A	I don’t know. What do you mean, there’s something else?	4
C	It’s not “architecture”?	3
A	“Temples and shrines” derived from “architecture”? “Temples and shrines” derived from “dwellings”?	4
C	Derived from “architecture”	4
B	“Temples”	3
A	Temples, shrines...	3
B	Why don’t you put the building together into something big? “Shrines and temples” are right?	4
A	Can we just say “Buddhism”?	3
C	Hmm...	
B	Yeah. Oh, wait. If you put Buddhism in there, you can put the names of temples in there, can’t you?	6
A	That’s for sure. Do you want to include the temples in the details? Do you want me to?	6
B	Let’s put in a little bit.	5
A	Kiyomizu (Temple)?	3
B	Yes, Kiyomizu (Temple)	5

Note. As levels of regulation utterances, 3 represents “surface performance/volitional control,” 4 represents “deep surface performance/volitional control,” 5 represents “surface self-reflection,” and 6 represents “deep self-reflection.”

4. Discussion

4.1 Relationship Between SSRL Scale and Utterance Analysis Results

This study examined the SSRL process in collaborative learning using ICT tools and employing qualitative and quantitative research methods. The SSRL scale is used to measure social regulation. The regulation utterances were then analyzed in terms of surface and deep levels during the cycle of self-regulation. In the initial, middle, and final phases of the group activity, the average total number of utterances was calculated, and the correlation between the scale scores and the frequency of utterances was analyzed. The analysis revealed significant weak-to-moderate positive relationships between co-regulation and socially shared regulation of intrinsic motivation and the surface level of regulation at the initial and final phases. In particular, it is conceivable that co-regulation or socially shared regulation of intrinsic motivation is important at these two points in time and serves as a booster for initial motivation. Observations of the collaborative activity showed that immediately after the start, the students tried to generate as many ideas as possible while making regulatory utterances. As the end of the activity time approached, the participants drew as many ideas as possible on a mind map and communicated with each other. Students focused on the number of ideas, instead of quality, in the early and late stages of the activity.

In the middle phase, there was a significantly weak positive relationship between socially shared regulation of cognition and the deep level of regulation utterances. Moreover, there were significant moderate positive relationships between self-regulation, co-regulation, and socially shared regulation of intrinsic motivation, and deep levels of regulatory utterances. As collaborative learning approached its midpoint, activities begin to take courses and deepen. Evidently, the members who regulated cognition and intrinsic motivation produced higher levels of utterances. Triangulation of the self-report measure and utterance analysis may have increased the possibility of an intricate understanding of the SSRL process in collaborative learning.

4.2 Relationships Between the SSRL Scale, Motivational Factor, and Creative Performance

The results of the correlation analysis showed significant weak-to-moderate relationships between behavioral and cognitive engagement, SSRL of monitoring and cognition, and the three modes of motivational regulation. These results can be interpreted as evidence confirming the validity of these scales. When exercising creativity, socially shared effort regulation may be required to engage in high-level cognitive activities. However, the validity of this scale requires further investigation.

Emotional engagement was significantly and positively associated with SSRL for monitoring and cognition. However, there was a marginally significant, weak, and positive association between the three modes of motivational regulation. Emotional engagement consists of interest in and enjoyment of learning. Intrinsic motivation also comes from curiosity about learning and interest in learning. As the relationship between emotional engagement and intrinsic motivation is conceptually close, clearer results could have been obtained. The sample size may have affected the results of this analysis and further studies are required.

Creative performance was moderately positively associated with socially shared regulation of cognition. The socially shared regulation of cognition, which deepens the understanding and thinking of all members, is extremely important and, as a result, may be more likely to lead to creative performance. Additionally, creative performance had a weak positive relationship with socially shared regulation of monitoring, co-regulation, and socially shared regulation of intrinsic motivation; however, these correlations were marginally significant. Future research should examine how different types of SSRL processes determine creative performance in collaborative learning situations using ICT.

A significant moderate positive association was found between total number of utterances and creativity. It was confirmed that SSRL utterances may lead to an overall creative performance. The examination of episodes also shows how deep levels of regulation utterances expand thinking and creativity.

5. Implications and Limitations

The implication for higher education is that university instructors should support students based on their tendency to perform SSRL and their deep level of regulatory utterances during collaborative learning. This will help students demonstrate creative performance by using ICT tools. For example, it is necessary to emphasize that motivation regulation is needed when a group's learning motivation decreases. It is important to teach and develop students' strategies and skills that not only enhance intrinsic motivation of the self or a specific member but also support the motivation of the entire group by devising ways to make them find the learning content interesting and sharing the importance of the learning content. These efforts will encourage active engagement in collaborative learning in universities and lead to the creation of highly creative products. The SSRL scales

validated in this study may be useful for assessing students' degree of regulation before classroom practice. Cultivating both the cognitive and motivational aspects of socially shared regulation will lead to active engagement in collaborative learning and encourage students to think deeply and create ideas with classmates. Instructors must observe whether students engage in a deep level of regulation utterances in the self-regulation cycle during the lesson. In the middle phase of a collaborative activity, it may be necessary to assess and promote a deep level of regulation through utterances.

The limitations of this study are as follows: first, in conducting utterance analysis, regulation utterances of emotion and motivation were not included because of the difficulty of observation and the low frequency of occurrence. As recent studies on socially shared regulation have focused on emotions and motivation, future research is needed to examine the differences between the cognitive, emotional, and motivational functions of the social regulation process. In contrast, the analysis of the SSRL scale allowed for a multidimensional and detailed examination of the regulatory process, including cognitive and motivational aspects. Second, only one item was used as a measure of engagement, considering the burden on participants. Future studies should include more items to improve reliability and validity. Third, interventional studies should be conducted in college classrooms. Practical interventions for regulatory utterances should be implemented to demonstrate the effects of SSRL on creativity and academic achievement in higher education.

In summary, this study used qualitative and quantitative research methods to identify the socially shared regulation processes of college students' learning and motivation in a collaborative learning task that requires creativity using the ICT mind-mapping tool. The relationships between the psychological scales and utterance analysis were analyzed from a triangulation viewpoint. These findings provide theoretical and practical contributions to the SSRL and offer potential for future research.

Acknowledgments

We would like to express our gratitude to all of the university students and graduate students who cooperated in our research.

Declarations

Funding: This work was supported by JSPS KAKENHI Grant Numbers JP17K04352 and JP20K03337.

Conflicts of interest: The authors declare no conflicts of interest associated with this manuscript.

References

- Buzan, T., & Buzan, B. (2010). *The mind map book: Unlock your creativity, boost your memory, change your life*. Harlow, Essex: Pearson Education Limited.
- Chin, C., & Brown, D. E. (2000). Learning in science: A comparison of deep and surface approaches. *Journal of Research in Science Teaching*, 37(2), 109–138. [https://doi.org/10.1002/\(SICI\)1098-2736\(200002\)37:2<109::AID-TEA3>3.0.CO;2-7](https://doi.org/10.1002/(SICI)1098-2736(200002)37:2<109::AID-TEA3>3.0.CO;2-7)
- Christenson, S. L., Reschly, A. L., & Wylie, C. (2012). *Handbook of research on student engagement*. New York, NY: Springer. <https://doi.org/10.1007/978-1-4614-2018-7>
- De Backer, L., Van Keer, H., & Valcke, M. (2012). Fostering university students' metacognitive regulation through peer tutoring. *Procedia – Social and Behavioral Sciences*, 69, 1594–1600. <https://doi.org/10.1016/j.sbspro.2012.12.104>
- De Backer, L., Van Keer, H., & Valcke, M. (2015a). Promoting university students' metacognitive regulation through peer tutoring: The potential of reciprocal peer tutoring. *Higher Education*, 70(3), 469–486. <https://doi.org/10.1007/s10734-014-9849-3>
- De Backer, L., Van Keer, H., & Valcke, M. (2015b). Exploring evolutions in reciprocal peer tutoring groups' socially shared metacognitive regulation and identifying its metacognitive correlates. *Learning and Instruction*, 38, 63–78. <https://doi.org/10.1016/j.learninstruc.2015.04.001>
- Grau, V., Lorca, A., Araya, C., Urrutia, S., Ríos, D., Montagna, P., & Ibaceta, M. (2018). Socially shared regulation of learning and quality of talk: Age differences in collaborative group work in classroom contexts. In V. Grau & D. Whitebread (Eds.), *Relationships between Classroom Dialogue and Support for Metacognitive, Self-Regulatory Development in Educational Contexts. New Directions for Child and Adolescent Development*, 162, 11–39. <https://doi.org/10.1002/cad.20261>
- Hadwin, A. F., Järvelä, S., & Miller, M. (2011). Self-regulated, co-regulated, and socially shared regulation of learning. In B. J. Zimmerman & D. H. Schunk (Eds.), *Handbook of self-regulation of learning and*

- performance* (pp. 65–84). New York, NY: Routledge.
- Hadwin, A. F., Järvelä, S., & Miller, M. (2018). Self-regulation, co-regulation, and shared regulation in collaborative learning environments. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 83–106). New York, NY: Routledge. <https://doi.org/10.4324/9781315697048-6>
- Ito, T., & Umemoto, T. (2017). Exploring socially shared regulation of learning during creative problem-solving. *Bulletin of Kyoto University of Education*, *131*, 61–68.
- Ito, T., & Umemoto, T. (2021). *Self-regulation, co-regulation, and socially shared regulation of motivation for collaborative activity: Comparison between university students and working adults*. Japanese Psychological Research. Advance online publication. <https://doi.org/10.1111/jpr.12337>
- Järvelä, S., & Hadwin, A. F. (2013). New frontiers: Regulating learning in CSCL. *Educational Psychologist*, *48*(1), 25–39. <https://doi.org/10.1080/00461520.2012.748006>
- Järvelä, S., Järvenoja, H., & Malmberg, J. (2019). Capturing the dynamic and cyclical nature of regulation: Methodological progress in understanding socially shared regulation in learning. *International Journal of Computer-Supported Collaborative Learning*, *14*(4), 425–441. <https://doi.org/10.1007/s11412-019-09313-2>
- Järvenoja, H., Järvelä, S., & Malmberg, J. (2020). Supporting groups' emotion and motivation regulation during collaborative learning. *Learning and Instruction*, *70*, 101090. <https://doi.org/10.1016/j.learninstruc.2017.11.004>
- Li, J., Lin, Y., Sun, M., & Shadiev, R. (2020). *Socially shared regulation of learning in game-based collaborative learning environments promotes algorithmic thinking, learning participation and positive learning attitudes*. Interactive Learning Environments. Advance online publication. <https://doi.org/10.1080/10494820.2020.1857783>
- Li, Y., Li, X., Su, Y., Peng, Y., & Hu, H. (2020). Exploring the role of EFL learners' online self-regulation profiles in their social regulation of learning in wiki-supported collaborative reading activities. *Journal of Computers in Education*, *7*, 575–595. <https://doi.org/10.1007/s40692-020-00168-3>
- Lin, J. W. (2018). Effects of an online team project-based learning environment with group awareness and peer evaluation on socially shared regulation of learning and self-regulated learning. *Behaviour & Information Technology*, *37*(5), 445–461. <https://doi.org/10.1080/0144929X.2018.1451558>
- Malmberg, J., Järvelä, S., Järvenoja, H., & Panadero, E. (2015). Promoting socially shared regulation of learning in CSCL: Progress of socially shared regulation among high- and low-performing groups. *Computers and Human Behavior*, *52*, 562–572. <https://doi.org/10.1016/j.chb.2015.03.082>
- Malycha, C. P., & Maier, G. W. (2017). The random-map technique: Enhancing mind-mapping with a conceptual combination technique to foster creative potential. *Creativity Research Journal*, *29*(2), 114–124. <https://doi.org/10.1080/10400419.2017.1302763>
- Moreira, P. A. S., Dias, A., Matias, C., Castro, J., Gaspar, T., & Oliveira, J. (2018). School effects on students' engagement with school: Academic performance moderates the effect of school support for learning on students' engagement. *Learning and Individual Differences*, *67*, 67–77. <https://doi.org/10.1016/j.lindif.2018.07.007>
- Ochoa, X. (2017). Multimodal learning analytics. In C. Lang, G. Siemens, A. Wise & D. Gašević (Eds.), *Handbook of learning analytics* (pp. 129–141). NY: Society for Learning Analytics Research (SoLAR). <https://doi.org/10.18608/hla17>
- Panadero, E., & Järvelä, S. (2015). Socially shared regulation of learning: A review. *European Psychologist*, *20*(3), 190–203. <https://doi.org/10.1027/1016-9040/a000226>
- Reeve, J. (2012). A self-determination theory perspective on student engagement. In S. L. Christenson, A. L. Reschly & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 149–172). New York, NY: Springer. https://doi.org/10.1007/978-1-4614-2018-7_7
- Reeve, J. (2013). How students create motivationally supportive learning environments for themselves: The concept of agentic engagement. *Journal of Educational Psychology*, *105*(3), 579–595. <https://doi.org/10.1037/a0032690>
- Reeve, J., & Tseng, C.-M. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology*, *36*(4), 257–267. <https://doi.org/10.1016/j.cedpsych.2011.05.002>

- Scardamalia, M., & Bereiter, C. (2014). Knowledge building and knowledge creation: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (2nd ed., pp. 397–417). New York, NY: Cambridge University Press. <https://doi.org/10.1017/CBO9781139519526.025>
- Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology, 100*(4), 765–781. <https://doi.org/10.1037/a0012840>
- Skinner, E. A., Kindermann, T. A., Connell, J. P., & Wellborn, J. G. (2009). Engagement and disaffection as organizational constructs in the dynamics of motivational development. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 223–245). New York, NY: Routledge.
- Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational and Psychological Measurement, 69*(3), 493–525. <https://doi.org/10.1177/0013164408323233>
- Splichal, J. M., Oshima, J., & Oshima, R. (2018). Regulation of collaboration in project-based learning mediated by CSCL scripting reflection. *Computers & Education, 125*, 132–145. <https://doi.org/10.1016/j.compedu.2018.06.003>
- Sun, M., Wang, M., Wegerif, R., & Peng, J. (2022). How do students generate ideas together in scientific creativity tasks through computer-based mind mapping? *Computers & Education, 176*, 104359. <https://doi.org/10.1016/j.compedu.2021.104359>
- Tsai, C. W., Shen, P. D., Chiang, I. C., Chen, W. Y., & Chen, Y. F. (2018). Exploring the effects of web-mediated socially-shared regulation of learning and experience-based learning on improving students' learning. *Interactive Learning Environments, 26*(6), 815–826. <https://doi.org/10.1080/10494820.2017.1415940>
- Usher, E. L., & Schunk, D. H. (2018). Social cognitive theoretical perspective of self-regulation. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 19–35). New York, NY: Routledge. <https://doi.org/10.4324/9781315697048-6>
- Veenman, M. V. J., Elshout, J. J., & Meijer, J. (1997). The generality vs domain-specificity of metacognitive skills in novice learning across domains. *Learning and Instruction, 7*(2), 187–209. [https://doi.org/10.1016/S0959-4752\(96\)00025-4](https://doi.org/10.1016/S0959-4752(96)00025-4)
- Volet, S., & Summers, M. (2013). Interpersonal regulation in collaborative learning activities: Reflections on emerging research methodologies. In S. Volet & M. Vauras (Eds.), *Interpersonal regulation of learning and motivation: Methodological advances* (pp. 204–220). Abingdon, Oxon: Routledge. <https://doi.org/10.4324/9780203117736>
- Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction, 19*(2), 128–143. <https://doi.org/10.1016/j.learninstruc.2008.03.001>
- Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81*(3), 329–339. <https://doi.org/10.1037/0022-0663.81.3.329>
- Zimmerman, B. J. (2000). Attaining 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. <https://doi.org/10.1016/B978-012109890-2/50031-7>
- Zimmerman, B. J., & Schunk, D. H. (Eds.). (2001). *Self-regulated learning and academic achievement: Theoretical perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Zimmerman, B. J., & Schunk, D. H. (Eds.). (2011). *Handbook of self-regulation of learning and performance*. New York, NY: Routledge.

Copyrights

Copyright for this article is retained by the author, with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).