Chapter 5
Analysis of Socially Shared Regulation in CSCL

Abstract An increasing number of studies show that socially shared regulation is very crucial for successful and productive collaborative learning. However, the elaborate analysis of behavioral patterns of socially shared regulation remains lacking in a CSCL context. This study aims to examine the behavioral pattern characteristics of socially shared regulation in a CSCL environment. In this study, 41 college students participated and they were randomly assigned into 13 groups of 3 or 4 people. All of the group members completed an instructional design plan using the online collaborative learning platform. Content analysis and LSA methods were adopted to analyze the discussion transcripts. The results indicated that group members can socially regulated their behaviors to orientate goals, make plans, monitor the collaborative learning processes, evaluate solutions, and make adaptations. However, high-achievement groups perform better than low-achievement groups regarding their socially shared regulation abilities. The implications for teachers and developers as well as for future studies are also discussed.

Keywords Socially shared regulation · Behavioral pattern · CSCL

5.1 Introduction

With the development of educational technology, many benefits of CSCL are well-documented and demonstrated in educational research. Learners benefit from collaborative learning because of productive interactions (Dillenbourg 1999), knowledge building (Bereiter and Scardamalia 2003), and mutual regulation (Blaye and Light 1990). Previous studies revealed that successful collaborative learning depends on many conditions, such as a CSCL environment (Stahl et al. 2006), task characteristics (Schellens et al. 2007), teachers' intervention (Van Leeuwen et al. 2013), scripts (Dillenbourg 2002), and so on.

Recently, regulatory challenges have emerged and have been presented to students in collaborative learning groups (Iiskala et al. 2011; Lee et al. 2014). Within CSCL contexts, group members need to jointly regulate their goals, plans,

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and strategies (Järvelä et al. 2010) to maintain a shared understanding of the subject matter. However, there is limited research investigating how group members collectively regulate in CSCL contexts. This study proposes that the consideration of socially shared regulation in CSCL can offer valuable and important insights into the nature of collaborative learning.

5.1.1 Regulation in a CSCL Context

Strategically regulating one's own learning and that of others is viewed as one of the important skills in the 21st century (Järvelä et al. 2014). Previous studies indicated that strategically planning and adapting one's learning requires the ability to tactically regulate oneself (i.e., self-regulated learning, SRL), others (i.e., co-regulated learning, CoRL), and a whole group (i.e., socially shared regulated learning, SSRL) (Hadwin et al. 2011; Winne et al. 2013). The main difference between these three kinds of regulation is who is regulating during the learning processes. Self-regulation is described as an individual process in which one regulates his/her own learning in order to improve academic performance (Zimmerman 2008). Co-regulation focuses on an individual's attempt to regulate others' cognition, meta-cognition, motivation, and emotion (Järvenoja et al. 2013). Socially shared regulation emphasizes all group members jointly regulating collective activities (Järvelä and Hadwin 2013). Self-regulation, co-regulation, and socially shared regulation of learning can contribute to successful collaborative learning.

In a CSCL context, it is more crucial to regulate others' cognition, motivation, emotion, and behavior as well as that of the whole group. This is because collaborative learning means to co-construct shared understanding via interaction with group members (Roschelle and Teasley 1995). It is also important to regulate goals, plans, and strategies to foster productive collaborative learning. Drawing on the information processing models of SRL, regulated learning involves defining tasks, setting goals and planning, enacting tactics, and adapting to meta-cognition (Winne and Hadwin 1998). Defining the task means that learners generate perceptions of the task. Setting goals and planning refers to frame goals and planning in order to achieve them. Enacting tactics includes selecting and applying strategies during learning processes. Adaptation to meta-cognition means that learners make major adaptations under their control (Winne and Perry 2000).

5.1.2 Socially Shared Regulation in CSCL

Successfully collaborating in a CSCL context requires collective or shared regulation. Shared regulation occurs when group members co-construct shared task perceptions or shared goals and plans (Järvelä and Hadwin 2013). Socially shared regulation of learning refers to processes by which group members jointly regulate

their collective activities (Järvelä and Hadwin 2013). Socially shared regulation of learning involves the construction and maintenance of collectively shared regulatory processes, knowledge, and beliefs (Hadwin et al. 2010).

In a CSCL context, a group needs to regulate beliefs, motivations, emotions, plans, strategies, resources, and efforts to achieve shared goals. The previous studies indicated that the high quality of collaborative learning relies on the abilities to cyclically regulate group activities (Erkens et al. 2005). Failure to coordinate group activities will result in negative outcomes, such as social loafing or the sucker effect (Kwon et al. 2014). Furthermore, it is necessary to establish a shared common ground for students who work in a collaborative learning group. There are two strategies for establishing common ground, one is adapting to partners, and the other is to ensure joint attention when needed (Janssen et al. 2010). However, the timing of maintaining common ground depends on the task and group members. The previous research suggested that early group regulation is helpful with establishing shared common ground and enhanced shared understanding (Lajoie and Lu 2011).

Group coordinated and regulating behaviors are essential for the whole group to work. However, learners cannot exhibit these kinds of abilities as you would expected in some cases (Puntambekar 2006). Therefore, group regulatory behaviors need to be initiated and facilitated by group members' autonomy or teachers' intervention. However, which kind of regulatory behavior can affect successful collaboration is still unclear. This study aims to investigate the behavior pattern of socially shared regulation in CSCL so as to identify which one can contribute the most to successful and productive collaborative learning. The research questions are addressed as follows:

1. What are the behavioral characteristics of socially shared regulation?
2. Do any differences exist in the behavioral patterns of socially shared regulation between high- and low-achievement groups?

5.2 Method

5.2.1 Participants

In this study, 41 students majoring in history participated. Of these, 29 % of them were male and 71 % of them female. This study was conducted in the information communication technology (ICT) course, integrated into K-12, worth two academic credits. All of the participants were enrolled in the ICT course for the first time. In order to create probabilistically equivalent groups, all of the participants were randomly divided into 13 groups of 3 or 4 people. They all had experience about collaborative learning from previous courses.

5.2.2 Experimental Procedure

The study was conducted in two phases. In the first phase, all of the participants took a one-day course about how to integrate ICT. In the second phase, all of them conducted online collaborative learning for 3 h via a platform that supported collaborative learning. Every group needed to complete the same collaborative learning task online. The collaborative learning task was about instructional design in a flipped classroom. The topic of instruction was about farm life in a primitive society, which was taught in Grade 7. The group product was an instructional design plan. Every group member needed to discuss how to design and implement this topic using ICT. In order to facilitate socially shared regulation, students needed to set a goal at first, and then make a plan and select appropriate strategies. They could monitor the whole collaborative learning process and make adaptations when necessary. All of the discussion logs were automatically recorded via our platform. Therefore, it was feasible to analyze the behavioral pattern of socially shared regulation.

5.2.3 Data Analysis

In order to analyze discussion transcripts of 13 groups, a content analysis method was adopted in this study. The coding scheme proposed by Zheng and Huang (2016) was adapted in order to analyze the behavioral pattern of socially shared regulation, as shown in Table 5.1. The data analysis included two phases. The first phase was to conduct content analysis. The episode was chosen as the unit for analysis. The episode consisted of pieces of dialogue that shared the same focus and a joint regulation of the activity within the group (Grau and Whitebread 2012). Two raters independently coded all of the discussion transcripts based on the scheme. In order to determine the inter-rater reliability, Cohen's kappa was adopted to calculate the coding results. Cohen's kappa achieved a score of 0.81. All of the discrepancies were discussed and solved face-to-face. In the second phase, LSA (Bakeman and Gottman 1997) was conducted using GSEQ 5.1. In this study, LSA was mainly used to investigate the probability of behavioral occurrence (Hawks 1987). This method has been adopted in past studies in order to analyze behavioral patterns (Hou 2015; Yang et al. 2015).

5.3 Results

5.3.1 Analysis of the Behavioral Characteristics of Socially Shared Regulation

Behavior frequency analysis of socially shared regulation

In order to analyze the behavioral characteristics of socially shared regulation, the frequency and distribution of each kind of behavior were calculated, as shown in

Table 5.1 The coding scheme of socially shared regulation

The first-level category	The second-level category	Examples
Orientating goals	Establishing task demands and setting goals (ES)	"This collaborative learning task is to conceive an instructional design in a flipped classroom setting"
Making plans	Making plans about how to reach goals, including selecting strategies, setting timelines, and so on (MP)	"We need to make a schedule about our task immediately"
	Negotiating the division of labor (ND)	"I think we need to discuss about the division of labor"
Enacting strategies	Advancing and explaining solutions (AE)	"Let me explain this solution by examples"
	Coordinating conflicts (CO)	"As a group leader, I can coordinate the conflicts soon"
Monitoring and controlling	Monitoring or controlling the whole group progress (MC)	"Everyone needs to be responsible for the collaborative learning task. Otherwise we can't finish it on time"
	Claiming (partial) understanding or Comprehension failure (CC)	"Both of us cannot understand what you have said. Can you explain it in detail?"
	Detecting errors or checking plausibility (DC)	"We need to check the feasibility of our instructional design plan now"
Evaluating and reflecting	Evaluating current solutions (EV)	"The current plan is difficult to implement because students have no enough time to visit the museum"
	Reflecting on the group goals and progress (RE)	"Now it is time to reflect whether we have achieved the group goal"
Adapting meta-cognition	Making adaptions to goals, or plans, or strategies (MA)	"Maybe we need to revise our strategies so as to complete the task on time"
Off-topic	Messages irrelevant to the discussion task (OT)	"After we submit our group product, we will have lunch together"

Table 5.2 Frequency and distribution of behavioral codes

	ES	MP	ND	AE	CO	MC	CC	DC	EV	RE	MA	OT
Frequency	23	56	30	141	15	32	110	24	63	13	22	97
Percentage (%)	3.7	8.9	4.8	22.5	2.4	5.1	17.6	3.8	10.1	2.1	3.5	15.5

Table 5.2. It was very clear that the most frequent behavior was advancing and explaining solutions, which accounted for 22.5 %. This indicated that learners could advance their solutions during collaboration. Claiming (partial) understanding or comprehension failure (CC) accounted for 17.6 %. They could also claim comprehension failure when they did not understand what group members

discussed. However, the off-topic discussion accounted for 15.5 %, which revealed that sometimes students discussed some topics that were not related to the collaborative learning. In addition, reflecting on the group goals and progress (RE, 2.1 %) occurred the least, which indicated that students seldom reflected upon whether they had achieved the goal.

Sequential analysis of socially shared regulation behavior

In order to analyze the behavior sequential characteristics of socially shared regulation, an LSA was conducted using GSEQ. Table 5.3 shows the adjusted residuals of all behavioral sequences. Only the Z-value of a sequence was above 1.96, the behavioral sequence was significant (Bakeman and Gottman 1997). Therefore, 11 behavioral sequences were significant based on Table 5.3. Figure 5.1 shows the transition diagram for the 11 significant behaviors. It is very clear that these socially shared regulation behaviors can be divided into 5 sections based on the sequential relationships between the behaviors. They were ES-MA-RE (establishing task demands and setting goals, making adaptions to goals, plans, or strategies, and reflecting on the group's goals and progress), ND-CC-AE-DC (negotiating the division of labor, claiming partial understanding, advancing and explaining solutions, and detecting errors or checking plausibility), MC-EV (monitoring or controlling group progress and evaluating current solutions), CO (coordinating conflicts), and OT (off-topic). In a word, all of the group members could socially regulate their behaviors in order to orientate goals, make plans, monitor collaborative learning processes, evaluate solutions, and make adaptations.

5.3.2 Comparison of Behavioral Sequences Between the High- and Low-Achievement Groups

In order to identify the high- and low-achievement groups, the group product was evaluated by the teacher at first. The instructional design plan was the final group product of each group. The top four groups were selected as high-achievement groups and the last four groups were considered the low-achievement groups based on the scores of the instructional design plan. Subsequently, frequency analysis and LSA were conducted so as to examine the behavioral differences between the high-achievement groups and low-achievement groups. Table 5.4 shows the frequencies of the socially shared regulation behavior of the low-achievement and high-achievement groups. As shown in Table 5.4, the higher proportion of socially shared regulation behaviors occurred in the high-achievement groups including establishing task demands and setting goals (ES), making plans (MP), advancing and explaining solutions (AE), coordinating conflicts (CO), evaluating current solutions (EV), reflecting on group goals and progress (RE), and making adaptions to goals, or plans, or strategies (MP). While negotiating the division of labor (ND),

Table 5.3 Adjusted residuals of all behavioral sequences

	ES	MP	ND	AE	CO	MC	CC	DC	EV	RE	MA	OT
ES	2.39*	−0.77	−0.12	−0.62	−0.77	−0.16	0.53	0.11	−0.93	0.84	2.48*	−0.88
MP	−1.55	1.02	−0.48	0.77	−1.24	−0.53	1.89	1.31	−0.77	−0.10	−1.51	−0.98
ND	−0.12	−1.09	3.06*	−2.59	−0.89	−0.44	2.81*	−1.13	−0.64	0.56	−1.08	1.28
AE	0.38	−0.79	−0.38	0.29	−1.51	−0.47	1.60	4.23*	0.91	0.18	−0.01	−3.55
CO	0.60	−1.22	−0.89	−1.50	17.99*	−0.90	−1.13	−0.79	−0.45	−0.55	−0.76	−1.66
MC	1.85	−1.09	−1.27	−1.25	−0.89	0.41	−0.63	−1.13	3.08*	0.56	0.93	0.23
CC	−0.03	−0.19	1.83	4.69*	−1.81	1.23	−1.12	−1.76	−1.03	−0.85	0.07	−3.07
DC	0.11	−0.08	−0.17	0.77	−0.79	−0.20	−0.12	1.14	−0.30	0.80	1.27	−1.53
EV	−0.18	0.82	−0.59	0.45	−0.41	−0.64	−0.20	−0.24	2.22*	−0.17	−0.11	−1.55
RE	−0.69	−1.09	−0.79	−0.50	1.33	1.85	−0.85	−0.71	0.76	1.61	2.46*	−0.67
MA	−0.92	1.68	−1.06	−0.40	0.70	−1.08	0.76	−0.94	1.38	−0.66	1.49	−1.35
OT	−0.90	1.47	−0.31	−3.03	−1.67	0.64	−3.11	−2.13	−2.79	−0.68	−2.03	11.48*

*$p < 0.05$

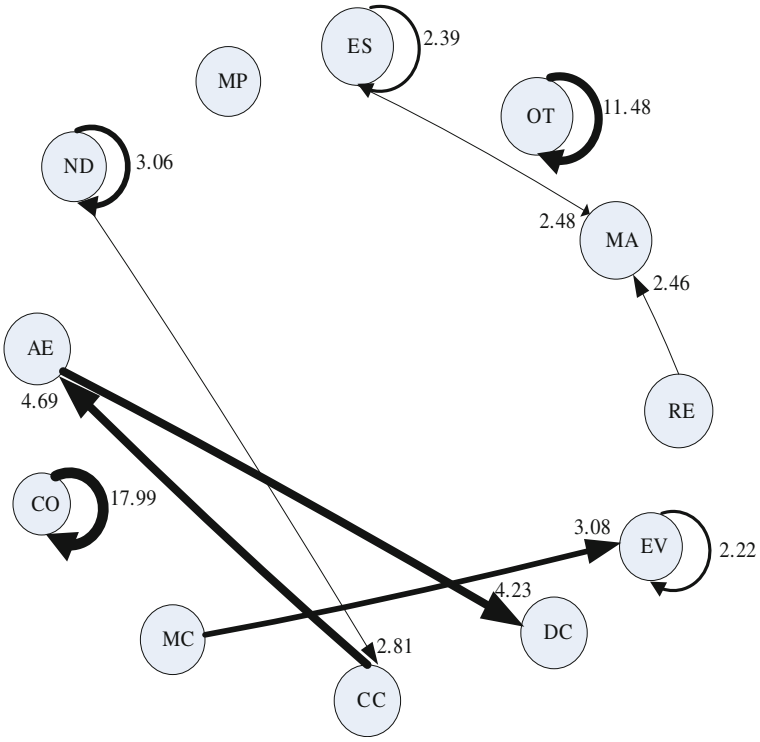

Fig. 5.1 Behavioral transition diagram for all participants

monitoring or controlling the whole group's progress (MC), claiming (partial) understanding or comprehension failure (CC), detecting errors or checking plausibility (DC), and off-topic discussion (OT) occurred more frequently in low-achievement groups.

Tables 5.5 and 5.6 show the adjusted residuals of low-achievement groups and high-achievement groups, respectively. In addition, Figs. 5.2 and 5.3 visualized the behavioral transition paths of the low-achievement groups and high-achievement groups. Overall, the high-achievement groups demonstrated more significant behavioral paths than low-achievement groups. The findings indicated that eight statistically significant behavioral paths occurred in the low-achievement groups, including ES → MA, MP → DC, RE → EV, CC → AE, MC → EV, MA → CC, ND → ND, and OT → OT. Eleven statistically significant behavioral paths occurred in the high-achievement groups, including MP → CC, ND → CC, ND → OT, AE → DC, CO → CO, MC → ES, CC → AE, EV → EV, RE → MA, OT → MP, and OT → OT.

Table 5.4 Frequencies of the socially shared regulation behavior of the low-achievement and high-achievement groups

	ES	MP	ND	AE	CO	MC	CC	DC	EV	RE	MA	OT
Low	5	9	8	26	0	8	22	6	7	2	1	31
	4 %	7.2 %	6.4 %	20.8 %	0	6.4 %	17.6 %	4.8 %	5.6 %	1.6 %	0.8 %	24.8 %
High	13	18	11	53	15	10	36	10	24	8	11	34
	5.4 %	7.4 %	4.5 %	21.8 %	6.2 %	4.1 %	14.8 %	4.1 %	9.9 %	3.3 %	4.5 %	14 %

Table 5.5 Adjusted residuals (low-achievement groups)

	ES	MP	ND	AE	CO	MC	CC	DC	EV	RE	MA	OT
ES	1.82	−0.65	−0.61	−1.19	0.00	−0.61	1.37	−0.52	−0.52	−0.30	4.84*	−0.21
MP	−0.65	−0.88	−0.83	0.06	0.00	0.56	0.40	2.48*	0.88	−0.40	−0.28	−0.94
ND	−0.61	0.56	2.17*	−0.64	0.00	−0.78	−0.38	−0.67	−0.67	−0.38	−0.27	0.93
AE	1.09	0.12	0.31	0.89	0.00	0.31	0.98	0.79	−0.25	1.03	−0.51	−3.15
CO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MC	−0.57	−0.77	−0.73	−1.43	0.00	0.84	0.81	−0.62	2.96*	−0.35	−0.25	0.29
CC	0.11	1.22	1.47	3.03*	0.00	−0.43	−1.13	−0.10	−1.18	−0.67	−0.47	−2.36
DC	−0.52	−0.71	−0.67	0.72	0.00	−0.67	1.06	1.36	−0.57	−0.33	−0.23	−0.43
EV	−0.52	0.88	−0.67	0.72	0.00	−0.67	−0.05	−0.57	−0.57	−0.33	−0.23	0.55
RE	−0.30	−0.40	−0.38	−0.75	0.00	−0.38	−0.65	−0.33	2.96*	−0.18	−0.13	0.87
MA	−0.21	−0.28	−0.27	−0.53	0.00	−0.27	2.19*	−0.23	−0.23	−0.13	−0.09	−0.56
OT	−0.25	−0.19	−0.83	−2.28	0.00	0.86	−1.78	−1.44	−0.47	0.83	−0.58	4.84*

*$p < 0.05$

Table 5.6 Adjusted residuals (high-achievement groups)

	ES	MP	ND	AE	CO	MC	CC	DC	EV	RE	MA	OT
ES	1.63	−0.99	0.55	0.81	−0.96	0.76	−0.76	0.65	−0.29	0.90	0.55	−1.51
MP	−1.06	−0.20	−0.97	0.05	−1.14	0.41	2.25*	0.30	0.16	0.54	−0.97	−0.39
ND	−0.81	−0.91	0.73	−1.79	−0.88	−0.67	2.89*	−0.71	−1.13	1.08	−0.75	2.15*
AE	−0.61	−1.59	0.42	0.55	−1.49	0.82	0.88	3.72*	0.35	−0.67	−0.33	−1.58
CO	0.22	−1.07	−0.88	−1.46	11.06*	−0.79	−0.94	−0.84	−0.45	−0.74	−0.88	−1.63
MC	3.50*	0.43	−0.71	−1.70	−0.84	1.06	−1.36	−0.68	1.07	1.19	−0.71	0.53
CC	0.08	−0.25	1.21	2.83*	−1.66	−0.31	−0.65	−1.34	−0.31	−0.17	0.34	−1.04
DC	0.65	1.72	−0.71	−0.14	−0.84	−0.64	0.45	−0.68	0.00	1.19	0.83	−1.32
EV	−0.29	0.34	−1.13	0.93	−0.45	−1.02	0.23	0.00	2.57*	−0.96	0.92	−2.10
RE	−0.64	−0.72	−0.59	−0.49	0.89	1.48	−0.06	−0.56	−0.90	1.63	3.07*	−1.09
MA	−0.77	1.72	−0.71	0.65	0.50	−0.64	−0.46	−0.68	0.00	−0.60	0.83	−0.39
OT	−0.66	2.09*	1.33	−1.90	−1.60	−0.24	−2.08	−1.29	−1.44	−1.15	−1.36	7.14*

*$p < 0.05$

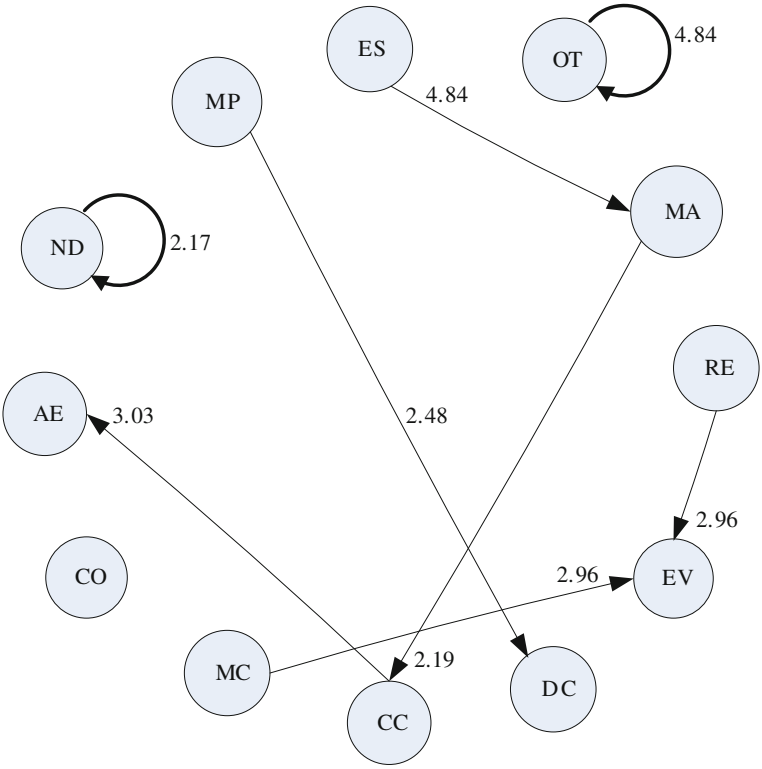

Fig. 5.2 Behavioral transition diagram for low-achievement groups

In addition, the high-achievement groups and low-achievement groups demonstrated different behavioral paths. First, ND → CC occurred in the high-achievement groups, while ND → ND appeared in the low-achievement groups. This revealed that the high-achievement groups could claim (partial) understanding or comprehension failure after negotiating the division of labor, while the low-achievement groups continually negotiated the division of labor. Second, although OT → OT occurred both in the low-achievement groups and high-achievement groups, the high-achievement groups could make plans after an off-topic discussion (OT → MP). This indicated that the high-achievement groups could socially regulate and then return to planning so as to achieve their goals. Third, RE → EV occurred in the low-achievement groups and RE → MA appeared in high-achievement groups. This revealed that the high-achievement groups could make adaptations to goals, or plans, or strategies after reflection, while the low-achievement groups only evaluated the current solutions after reflection.

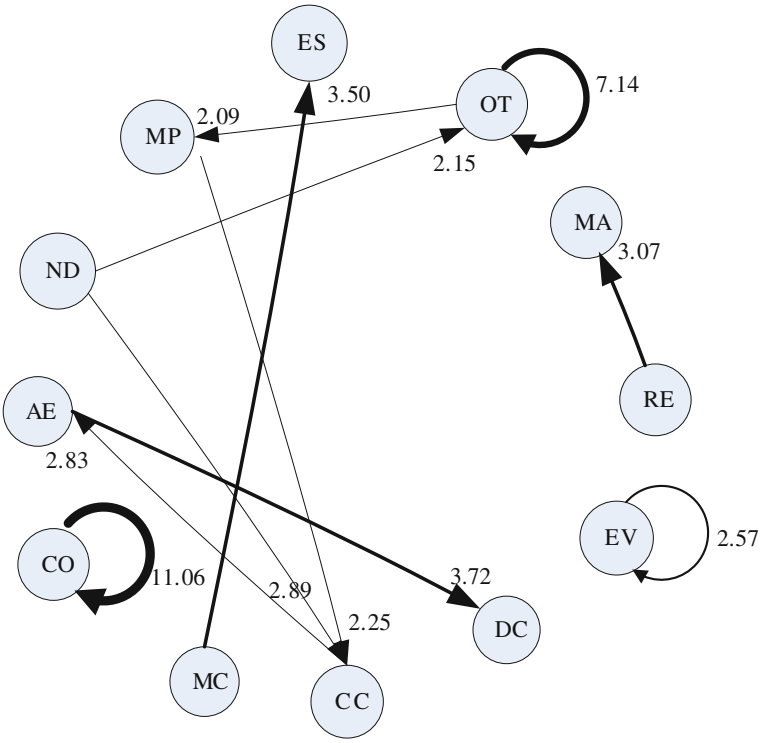

Fig. 5.3 Behavioral transition diagram for high-achievement groups

5.4 Discussion and Conclusion

This study mainly adopted a content analysis method and LSA to identify the behavioral characteristics of socially shared regulation as well as the differences between the high- and low-achievement groups. Socially shared regulation was considered as collective regulation in which group members established shared goals, monitored the collaborative learning processes, and reflected upon and evaluated progress (Järvelä and Järvenoja 2011). Perry and Winne (2013) believed that socially shared regulation is a crucial aspect for productive and successful collaborative learning. The findings indicated that group members could collectively orientate goals, make plans, enact strategies, monitor and control, evaluate and reflect, and adapt meta-cognition during collaborative learning. The results of the sequential analysis revealed that group members could advance new solutions when they claimed partial understanding. They could also detect errors or check plausibility when they advanced new solutions. When they monitored group processed, they could evaluate the current solutions. They could jointly make adaptations after they reflected upon the group's goal and progress. These findings were consistent with a previous report which found that socially shared regulation of

learning appeared when group members negotiated shared goals, plans, and strategies (Hadwin et al. 2011). This means group members could collectively regulate their cognition and meta-cognition in the context of CSCL.

This study also examined the behavioral differences between the low- and high-achievement groups. The results indicated more frequent off-topic discussion occurred in the low-achievement groups. Off-topic discussion means that group members do not discuss the concepts to be learned, but they discussed some topics that were not related to the collaborative learning. In addition, no significant behavioral sequences connected off-topic discussion to other on-topic behaviors. This means when learners in the low-achievement groups conducted off-topic discussions, others continued the off-topic discussions. They could not regulate themselves so as to transfer into task-related discussion. This is what the low-achievement groups typically lack during collaborative learning. In addition, the findings revealed that the high-achievement groups could regulate goals, plans, and strategies more frequently than the low-achievement groups. They could also smoothly coordinate conflicts during collaboration. Therefore, they could regulate the aspects that related to the tasks as well as the social aspects. This was consistent with a previous study reported by Malmberg et al. (2015) who found that the high-performing groups could regulate cognitive and motivational aspects as well as social challenges. This finding was also corroborated by Järvelä et al. (2016) who reported that high-achievement groups involved more socially shared regulation activities and that the low-achievement groups lacked socially shared regulation. In short, the analysis of the low- and high-achievement groups' behavioral sequences could help us understand how the groups jointly regulated themselves and what specific aspects may be lacking in the low-achievement groups.

This study has several implications for teachers and developers in the educational field. First, since the low-achievement groups failed in the socially shared regulation of collaborative learning tasks, it is very necessary for teachers to intervene with them in a timely manner. Teachers are recommended to promote participation by extra praise so as to reduce off-topic discussions. Teachers can also introduce several rules to facilitate socially shared regulation when certain circumstances occur. For example, all the group members should collectively make a decision or jointly complete the collaborative learning tasks. Second, this study examined the behavioral patterns of socially shared regulation during collaborative learning. It is strongly recommended that the tools that can automatically analyze user behavior need to be developed for further analysis. These tools can also help to detect off-topic discussion and remind students of this immediately. Third, some specific interaction strategies can promote socially shared regulation. For example, peer assessment or role-playing can facilitate jointly regulation of group work and improve team task coordination (Sipos and Mironescu 2009).

This study was constrained by several limitations. First, the sample was small and only 41 students participated in this study. Future studies will explore the behavioral pattern of socially shared regulation for larger sample sizes. Second, the quality and depth of knowledge building has not been examined in this study. Future studies will detect how students co-construct knowledge during

collaborative learning so as to shed light on the relationships between knowledge building and socially shared regulation. Third, the analysis of behavioral patterns was conducted manually in this study, which was time-consuming. Therefore, it is suggested to automatically analyze behavioral patterns and sequences using specific software in future studies.

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