Exploring college English language learners' self and social regulation of learning during wiki-supported collaborative reading activities

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Abstract Students' regulation has been conceptualized as an important impetus for effective and efficient collaborative learning. However, little empirical evidence has been reported about language learners' regulatory behaviors in computer-supported collaborative learning (CSCL). The purpose of this study is to investigate the occurrence of self and social aspects of regulation during wiki-supported collaborative reading activities in the context of learning English as a foreign language (EFL). Sixty Chinese college students organized in twelve groups participated in this study over a sixteen-week semester. Using an integrated method of content analysis and sequential analysis, students' chat logs were coded and analyzed to explore the characteristics of students' self and social regulatory behaviors in terms of regulation type, regulation process, and regulation focus. Results indicate that all groups demonstrated active social regulation in the collaborative activities. Compared with low-performing groups, high-performing groups displayed distinctively different patterns of regulatory behaviors in "social regulation," "evaluating," "content monitoring," and "social emotional regulation." Moreover, the analysis further reveals a more continuous and smooth regulation in the high-performing groups, while low-performing groups tended to be lost in a single repeated regulatory behavior pattern such as "self-regulation" or "organizing". This study not only fills a gap in the current collaborative English learning literature, but also contributes to our knowledge of social regulation in CSCL. Pedagogical implications and future research are also addressed.

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Introduction

Students' regulation of learning has been recognized as a significant variable for understanding their learning performance. As students' regulation is situation-specific, most models of regulated learning propose that social and contextual features affect students' regulatory behaviors and strategies (Hadwin and Oshige 2011; Malmberg et al. 2015). One of the contexts that has gained increasing attention from self-regulation research is the collaborative learning setting (Grau and Whitebread 2012), due to the unique challenges it poses for students' strategic regulation of cognition, emotion, motivation, and behavior (Isohätälä et al. 2017). Since students' success in collaboration is usually associated with their engagement in self and social forms of regulation of learning processes (Järvelä and Hadwin 2013), researchers are calling for more studies that consider both individual and social regulation to achieve a better understanding of learning regulation during collaborative tasks (Hadwin and Oshige 2011; Järvelä et al. 2016a).

Several studies have explored the occurrence of self and social aspects of regulation in collaborative learning activities (Schoor et al. 2015). However, most of these studies were conducted in traditional face-to-face collaborative environments without the support of technology (e.g., Grau and Whitebread 2012; Isohätälä et al. 2017). Few empirical investigations focused on these questions have been carried out in CSCL environments (Lee et al. 2015), and thus little is known about how groups engage in, sustain, and regulate the collaborative processes (Järvelä and Hadwin 2013; Järvelä et al. 2016a). In addition, most of the exploration of regulation in collaborative learning has been situated in domains like science (Ucan and Webb 2015), mathematics (Hurme et al. 2006; Isohätälä et al. 2017), and medicine (Lajoie and Lu 2012). There is scarce literature reporting language learners' regulation in CSCL contexts, though collaborative learning has been widely advocated for use in today's language teaching practice (Chang and Windeatt 2016).

Wikis have unique potential for learning and collaborative knowledge building (Biasutti 2017; Cress and Kimmerle 2008). In the domain of second language acquisition, a considerable body of research has documented the benefits of wiki affordances in supporting students' formation of shared knowledge (Li and Zhu 2013), promoting students' motivation to use the foreign language (Ducate et al. 2011), developing learner autonomy (Kessler 2009), and advancing innovative and active learning (Wang 2015). As with other forms of online learning, wikis can also pose additional challenges for students' strategic regulation of collaborative learning (Kennedy and Miceli 2013). Examining how students engage in regulation of their individual and shared learning enables us to better understand successful interaction that enables collaborative learning (Ucan and Webb 2015). For these reasons, this paper aims to explore college EFL learners' self and social regulation of learning during wiki-supported collaborative reading activities, and further investigates differences between high- and low- performing groups.

Literature review

Conceptualizing regulation of learning

Regulation of learning is perceived as an intentional, goal-directed, metacognitive activity in which students monitor and control certain aspects of their cognition, emotion,

motivation, behavior as well as some features of the learning environments in order to achieve optimal learning (Pintrich 2004; Zimmerman and Schunk 2011). Although students' regulation of learning has been conceptualized from different theoretical perspectives (for a summary, see Panadero 2017), most models on self-regulated learning (SRL) share the assumption that self-regulated students efficiently manage their own learning through continuous use of regulatory strategies that usually involve planning, monitoring, regulating and evaluating processes (Hadwin et al. 2011; Pintrich 2000). It is also commonly acknowledged that students' regulation of learning processes plays a crucial role in influencing their learning and achievement (Pintrich 2004; Winne and Perry 2000).

Earlier models of self-regulated learning have portrayed it as an individual process influenced by social context (Ucan and Webb 2015; Zimmerman 2000). However, emerging theories of learning and SRL suggest increasing interest in placing social context at the core of SRL instead of viewing it merely as a component in the regulatory process (Hadwin and Oshige 2011). Contemporary theoretical perspectives have considered students' regulation of learning as a social process at the interpersonal level (Hadwin et al. 2011). For instance, the social-cognitive perspective of regulated learning has acknowledged the mediating role played by peers in the participation and learning of others, through bidirectional, reciprocal, or mutual modes of regulatory activities (Iiskala et al. 2004; Volet et al. 2009). The sociocultural perspective has emphasized the need to consider the intersubjective and interpersonal aspects of learning where group members can reduce the metacognitive and cognitive demands by sharing, monitoring, and regulating task processes (Hadwin and Oshige 2011; Lee et al. 2016). The situative perspective understands regulation of learning as both individual- and group-level processes that take place in social learning situations (Hadwin and Järvelä 2011). This perspective addresses the fact that individual and social regulation processes function equally without either being subordinate to the other (Järvenoja et al. 2015). These theoretical perspectives have established the foundation for drawing a broader picture of what is regulated in the learning process. Researchers are calling for adopting an integrative perspective of self- and social regulation in learning contexts (Volet et al. 2009). This is especially important with collaborative learning, because students bring their own ideas, conceptions and self-regulatory abilities to the group-work (Järvelä and Hadwin 2013; Volet et al. 2013).

Previous research has identified three types of regulated learning that contribute to successful collaboration, namely, self-regulation, co-regulation, and socially shared regulation of learning (Grau and Whitebread 2012; Järvelä and Hadwin 2013; Ucan and Webb 2015). Self-regulation refers to individuals' regulatory processes ("I perspective") in which students monitor their own performance and contributions to the group task (Järvelä and Hadwin 2013). The goal of self-regulation is to adapt or change one's own learning process, with no apparent intentions to influence other members' cognition, emotion and behavior (Grau and Whitebread 2012). Co-regulation represents episodes in which the regulation process is aimed at influencing other's cognition, metacognition, motivation or emotion in order to assist and guide his/her learning (Grau and Whitebread 2012). In other words, the goal of co-regulation is to guide, support, shape, or influence one another's regulation of the learning process through interpersonal interactions (Ucan and Webb 2015). In co-regulation of learning, individuals hold goals or standards for each other ("You perspective") in relation to progress and contributions to the group work (Järvelä and Hadwin 2013). Socially shared regulation of learning emerges when multiple group members ("We perspective") regulate their collective learning process

(Hadwin and Oshige 2011). The verbalizations are usually directed to everyone in the group or no one in particular (Grau and Whitebread 2012). Its goal is to optimize the progress and contributions to the group task via jointly negotiating, realigning, or adapting group regulation processes (Järvelä and Hadwin 2013).

This study adopted an integrative perspective of self- and social regulation in learning contexts (Grau and Whitebread 2012; Volet et al. 2009). Following previous studies' definitions of self-regulation, co-regulation, and socially shared regulation (Grau and Whitebread 2012; Järvelä and Hadwin 2013), the current study further abstracts co-regulation and socially shared regulation into a more general term of social regulation to refer to the regulatory processes directed to planning, monitoring, regulating, and evaluating learning on the group level (Schoor and Bannert 2012; Volet et al. 2009). In other words, social regulation captures how individuals reciprocally regulate each other's metacognitive, cognitive, and emotional processes and engage in genuinely shared modes of regulation (Volet et al. 2009).

Regulation and learning performance in collaborative learning settings

Researchers have uncovered empirical evidence concerning the contribution of students' regulatory behaviors to effective and efficient collaborative learning (Järvelä et al. 2013, 2016a, b). For instance, in a study with secondary school students working on a historical inquiry task, Janssen et al. (2012) found that group performance could be predicted by social regulatory activities such as planning the collaboration, monitoring, and evaluation of group processes. Similarly, an investigation of students in a Learning and Educational Technology master's program identified a positive relationship between students' use of social regulation and the quality of their collaborative product (Järvelä et al. 2013). Another study conducted with small groups of upper elementary students in America also suggested a link between students' achievement of deeper mathematical understanding and their social regulatory processes of planning, monitoring, and behavioral engagement (Rogat and Linnenbrink-Garcia 2011). Although promising findings have been achieved on the role of regulatory behaviors on students' performance in collaborative learning contexts, research targeting how foreign language learners regulate their collaborative learning is scarce. In the area of English language learning and teaching, the capacity to regulate learning has also been regarded as a crucial factor that enables one to become a proactive language learner (Dörnyei 2005; Dörnyei and Ryan 2015). Researchers anticipate that regulation of learning would have great potential for further research (Dörnyei and Ryan 2015; Su et al. 2018). Hence, it is of significance to explore how EFL learners regulate their learning during collaborative learning activities.

Most of the investigations on regulation in collaborative work have been carried out in face-to-face learning settings. However, a computer-supported collaborative learning context, being different from the traditional classroom learning environment, may play a role in students' regulation of learning (Järvelä and Hadwin 2013; Liu and Hmelo-Silver 2010). One issue is that the CSCL setting poses unique challenges for groups of students when they try to collaboratively regulate their learning (Lee et al. 2015). These challenges are mainly caused by insufficient access to the social and affective reactions from group members when communicating via a technological interface (Hurme et al. 2006; Volet et al. 2009). Therefore, caution should to be exercised when directly drawing findings from face-to-face contexts to CSCL environments (Volet et al. 2013), and additional studies are still needed for better understanding students' regulatory

mechanisms in CSCL settings. Due to the growing interest in integrating technology-enhanced learning activities into the language teaching curriculum, researchers highlight the importance of exploring the mechanisms of EFL learners' regulatory behaviors in technology-supported learning environments in order to enhance the effectiveness of learning (Lai and Gu 2011; Su et al. 2018).

In addition, the majority of research on regulation of learning neglects the temporal order of students' regulatory behaviors during task completion (Schoor and Bannert 2012; Malmberg et al. 2017). However, most models on self-regulated learning bear the assumption that self-regulation is a dynamic and task-specific process that develops over time (e.g., Winne and Perry 2000). Regulation implies a time-ordered sequence of adaption or change (Azevedo 2009; Järvelä et al. 2013). Focusing on process data will lead to advances in theory, methods, analytical techniques, and ultimately instructional recommendations (Azevedo 2014). Since different temporal patterns may have totally different influence on group learning (Kapur 2011; Malmberg et al. 2017), researchers argue for a need for adopting sequential pattern mining methods to reveal information about regulatory sequences and transitions that are associated with better group performance (Järvelä et al. 2016b; Kapur 2011; Schoor and Bannert 2012; Zheng and Yu 2016).

The scant research that has been conducted only recently has begun to explore sequences of social regulatory processes during collaborative learning tasks. For instance, Malmberg et al. (2015) examined how groups progress in their socially shared regulation of learning, and found that regulation focus and function shifted from regulating external challenges towards regulating the cognitive and motivational aspects of their collaboration. In a subsequent study, Malmberg et al. (2017) also found that high-performing groups differed from low-performing groups in progressing in their regulation in terms of evidencing temporal variety in challenges and regulation strategies across time. Likewise, Zheng and Yu's study (2016) also conducted lag sequential analysis to analyze the behavioral patterns of co-regulation for four weeks, showing that high-achievement groups and low-achievement groups presented distinct differences in behavioral sequences. However, in contrast to the aforementioned research findings, Schoor and Bannert's (2012) study showed no difference between the participants with higher group performance and those with lower group performance in both frequencies and patterns of regulatory activities. Since sequences vary in different types of learning activities (Järvelä et al. 2016b), more studies in other learning contexts should be carried out to shed more light on those regulation processes that are clearly characteristics for better groups.

Therefore, the current research attempts to address the abovementioned research gaps by exploring the self-, co- and socially shared regulation of Chinese college English language learners in the context of wiki-supported collaborative reading activities. Grounded in an authentic learning situation, this study analyzed students' group dynamics from three aspects, that is, regulation type, regulation process, and regulation focus, to address the following three questions:

(1) How do college English language learners regulate their learning during wiki-supported collaborative learning activities?

(2) What differences can be found in the self and social regulation of learning between high- and low- performing groups during the wiki-supported collaborative learning activities?

(3) What differences can be found in the sequential patterns of regulatory behaviors between the high- and low-performing groups?

Method   211

Research context   212

This study was carried out in a regular course named Intensive English Reading, which   213
was taught by the department of English at a comprehensive university in Beijing, China. 214
The university requires all the undergraduate students to learn English for two and a half 215
years and it has established a solid tradition for integrating technologies with English 216
language education. This compulsory course lasted for 16 weeks and its target students   217
were second year non-English majors pursuing a bachelor's degree. Each week students   218
were scheduled to meet the teacher once for a 100-min of in-class instruction. The   219
objective of the course is to promote students' overall language competence, with a special 220
focus on expanding their vocabulary through reading, help them develop reading strate-   221
gies, and improve accuracy and fluency in expressing ideas in English.   222

Participants   223

This research involved 60 s-year undergraduate students (around 19~20 years old) from the 224
same university where the study took place. Since most of the participants majored in   225
computer science, telecommunications, and electronic information science, more male stu- 226
dents (40 males) were included in this research. Consistent with Grau and Whitebread's (2012) 227
earlier study, students were assigned into groups of five by the instructor under the criteria of 228
mixing the students by gender and their English language proficiency. In order to develop 229
students' sense of belongingness to their group, these groups remained stable throughout the 230
semester once they were formed.   231

All the participants had finished six years of formal English language learning in high 232
school before entering the university. The participants were representative of the EFL   233
learners at the university in terms of the general English language proficiency and   234
language learning experience. Like most Chinese college students, they had a vocabulary 235
size of only around 4000 words (Xu and Nie 2016). Due to the test-oriented culture in   236
English language education and the lack of opportunities to communicate in English, the   237
participants still had difficulties in understanding long and complex texts and expressing 238
themselves accurately and fluently in English.   239

Learning activity   240

In this study, the collaborative learning takes the form of wiki-supported literature circles. 241
Literature circles are also known as reading circles and book clubs. As Shelton-Strong   242
(2012) defines, literature circles are "small peer-led discussion groups, involved in reading 243
the same piece of literature, and who come together on a regular programmed basis to   244
share interpretations of what they have read" (p. 214). This instructional model has been 245
widely implemented in EFL programs and has been found to be helpful in creating a   246
supportive environment where students engage in interactive and collaborative reading   247
tasks (Widodo 2016). Researchers and teaching practitioners have advocated for using   248
wikis to do online literature circles because of its unique advantages for fostering literacy 249
skills, strengthening communication and collaboration, and boosting student motivation   250
and engagement (Larson 2009; Moreillon et al. 2009).   251

The five articles used for the literature circles were taken from students' course book, which aligns with the third level of College English Curriculum made by Ministry of Education of China (2007). The texts are at a length of around 1200 words covering topics like American civil rights movement, American dream, and modern security problems. The texts have the same level of difficulty in terms of topic familiarity, vocabulary, grammar, and sentence complexity. In the light of previous studies of literature circles (Shelton-Strong 2012; Widodo 2016), each of the group members in this study played one of the roles listed below:

(1) *Discussion leader*: raises questions for group discussion, and summarizes group discussion.
(2) *Word master*: identifies at least 5 interesting or difficult words he/she has just learned and uses them to compose a coherent passage.
(3) *Passage person*: expresses his/her ideas about the sentences that are interesting or difficult to understand, and imitates them to make new sentences.
(4) *Summarizer*: prepares a summary of the chosen text, which clearly spells out a topic sentence, main ideas, and a concluding sentence.
(5) *Connector*: makes notes to draw connections between the story and the world outside.

The wiki space of the Moodle platform was adopted for use in this study. All the students in this study were trained to use the wiki in terms of logging on, page creation, editing texts and so on. On the wiki group page, students were encouraged to share ideas, feelings, questions, connections, and judgments about the materials they had read. In particular, the discussion leader writes 3 questions about the reading materials. After other group members write their answers, the discussion leader makes a summary of the responses. The word master analyzes the words he/she selects and uses them to compose a coherent passage. Other group members need to help the word master select the words, brainstorm ideas, and revise the passage. The passage person writes the sentences or paragraphs he/she has selected together with the corresponding text analysis and imitation sentences or paragraphs. Other group members need to help the passage person brainstorm ideas and revise the imitation texts. The summarizer drafts a summary of the reading material and other group members should also help revise the summary to make sure it meets the requirements. Finally, the connector writes the connections he has identified on the group page, and then other group members respond by correcting the language errors, giving their comments, or providing their own connections.

Following Zorko's (2009) suggestions for better facilitating students' collaboration in the wiki for English language learning, each group was instructed to create a chatroom on Tencent QQ, an instant messaging software service that was found to be effective in promoting peer communication and collaboration (Zheng and Yu 2016). Groups were required to communicate via their chatrooms on all issues they needed to discuss during the collaborative reading activity. To help them solve problems, the teaching assistant also joined the groups' chatrooms so that technical assistance and support was available for them.

Students were given two weeks to complete each literature-circle activity online after class. The final version of their group wiki page, consisting of each role's work, was to be regarded as the product of their collaboration. With an assessment guide covering criteria concerning content, language control, creativity, and critical thinking, each contribution was evaluated by the teacher and 10 students randomly chosen from other groups. Finally, students were also scheduled to meet the teachers once a week for a two-hour face-to-face

discussion and sharing of their literature circle artifacts. Through the semester, students 297
conduct five different literature-circle tasks based on five articles of different genres. Group 298
members were also required to switch roles within their group when starting a new task so 299
that each of them would have experience in each role for doing literature circles. 300

Data collection and analysis 301

Tencent QQ archived all discussion messages in the chatrooms. The chat logs were coded and 302
analyzed. The coding schemes employed in this study were adapted from previous research 303
(Grau and Whitebread 2012; Ucan and Webb 2015) that similarly considered both self and 304
social aspects of students' learning regulation in collaborative learning contexts. Since these 305
schemes were originally constructed to measure regulation in the domain of science learning, 306
modifications were made to match the context of English language learning in this study. 307
The first coding scheme examined the types of regulation to identify *social intentionality* of 308
students' regulatory learning in collaboration (Grau and Whitebread 2012). Among the codes, 309
self-regulation refers to the regulatory behavior used by the students to regulate their own 310
activity. Co-regulation represents the regulatory behavior that aims at influencing other's 311
metacognition, motivation or emotion in order to assist and guide his/her learning (Ucan and 312
Webb 2015). For each event that is identified as socially shared regulation, the analysis 313
identifies the collective activity serving the purpose of achieving a shared goal. Appendix 314
Table 6 shows definitions of each category together with an example from the data. 315
Secondly, grounded in theoretical models of self-regulated learning (Pintrich 2004; 316
Zimmerman 2000) and previous work in developing categories of regulatory processes in 317
collaborative learning (Grau and Whitebread 2012; Hadwin et al. 2011), four regulation 318
processes were included in the coding scheme, that is, planning, monitoring, regulating, 319
and evaluating. Appendix Table 7 presents definitions of each category together with an 320
example from the data. 321
The third coding scheme analyzed students' focus of regulation in the collaborative 322
reading activity. It was designed to differentiate between different kinds of regulatory 323
utterances in the group activities. Drawing from previous coding schemes (Grau and 324
Whitebread 2012), three dimensions were included in this study: task, social emotion, 325
and organization. To better serve the purpose and context of the present study, the original 326
coding scheme was modified accordingly. In their study, Grau and Whitebread (2012) used 327
fundamental versus *surface aspects* as a qualifier of the sub-code *task*. However, through 328
reading the chat logs in this study, we found it difficult to make a distinction between the 329
fundamental and *surface* aspects. Therefore, this study did not include these two codes but 330
used another three categories to label students' regulatory utterances regarding the code 331
task, namely, task understanding, content monitoring, and process monitoring. These three 332
categories still echo the descriptors used by Grau and Whitebread (2012) to examine the 333
regulatory verbalization related to the code task (e.g., activation of relevant prior content 334
knowledge, time management). Moreover, we further divided the *social emotion* dimen- 335
sion into three categories: positive emotion, negative emotion, and joking (Zheng and 336
Huang 2016). This dimension deals with deal with students' regulation of emotional and 337
motivational processes when they experience socio-emotional challenges during group 338
learning (Grau and Whitebread 2012; Ucan and Webb 2015). This includes students' 339
awareness of their own or others' emotional or motivational states, or their use of strategies 340
for controlling motivation, emotion, and social processes (Grau and Whitebread 2012; 341

Järvelä and Hadwin 2013). The description of each category together with an example from 342
the data is shown in the Appendix Table 8. 343

All students' chat logs were coded by two independent coders who received training in 344
applying the coding schemes. Following the coding approach of previous research (see 345
Grau and Whitebread 2012; Iiskala et al. 2011; Volet et al. 2009; Ucan and Webb 2015), the 346
unit of analysis in this study was at the episodic level. The episodes consisted of a certain 347
number of students' utterances or pieces of dialogue that reflected individual or group-level 348
regulation of the learning activity within the group. A coding could be assigned to a single 349
turn or alternatively to several consecutive turns together. An example of episodes can be 350
seen in Table 1, which illustrates a co-regulation episode that consists of 11 turns. In this 351
episode, one student (Jiang) prompts another group member (Xu) to reflect on the coher- 352
ence of his writing on the group wiki page, and stimulates him to detect the errors and 353
rephrase the sentence. In other words, Jiang monitors the quality of Xu's contribution by 354
checking the accuracy of his task responses so as to improve the group product. Besides 355
being coded as co-regulation, it is also coded from the perspective of regulation process 356
(monitoring), and regulation focus (content monitoring). 357

As Lee et al. (2015) did in their study, the two coders coded 15% of the utterances of chat 358 **Q3**
logs. The Cohen's kappa coefficient was calculated to judge the inter-rater reliability of the 359
coded variables. It showed that the kappa values regarding the three coded variables, namely, 360
regulation type, regulation process, and regulation focus are 0.79, 0.90, and 0.68 respectively. 361
The kappa values were considered acceptable for this type of study involving categories that 362
include higher levels of inference (Bakeman and Gottman 1997; Ucan and Webb 2015). After 363
the independent coding, the two raters also discussed all of the discrepancies face-to-face until 364
a consensus coding was achieved. 365

To examine the regulatory behavioral characteristics across the groups, comparison 366
was made in terms of the frequency and percentages of the three regulation codes. 367
Following the criteria for grouping high/low performance groups by Kelley (1939) and 368
Hou (2015), we also ranked the groups from high to low based on the mean scores given 369
by the teachers on their reading circles. Groups who scored in the top 27% were 370
categorized into the high-performing group and those who scored in the bottom 27% 371
into the low-performance group. According to the criteria, high-performing groups were 372

t1.1	**Table 1** An example of the analysis unit at the episode level		
t1.2	Code	Turns	Transcript
t1.3	Co-regulation	1	*Jiang: (to Xu) I think there should be some problems about the coherence between the two sentences (posting a screenshot of the group's wiki page).* (content monitoring)
t1.4		2	*Xu: What? Let me check it (emoji).*
t1.5		3	*Jiang: Ok.*
t1.6		4	*Xu: So I should change "at" into "with"?*
t1.7		5	*Xu: Or do you mean other mistakes?*
t1.8		6	*Cui: (Post a funny emoji)*
t1.9		7	*Jiang: I just think that these two sentences don't seem to be logically connected.*
t1.10		8	*Xu: (In this sentence), I wanted to say that "he always has many questions, and this makes him busy reading many books to search for answers".*
t1.11		9	*Jiang: Well, then you need to add one more sentence to directly show the reason why he is always busy reading many books.* (content monitoring)
t1.12		10	*Xu: Okay. Done!*
t1.13		11	*Jiang: (Post an emoji showing "OK")*

more successful in fulfilling the task roles required by the literature-circle activities. More 373
specifically, the discussion leader raised open questions and wrote a clear summary of 374
members' responses. The word master clearly explained the meanings of the words he/she 375
chose and creatively used them to produce a clear and smoothly flowing passage. The 376
passage person clearly expressed his/her ideas about the sentences that were interesting or 377
difficult to understand, and accurately imitated them to make new sentences. The sum- 378
marizer produced a summary of what they read, which clearly spells out a topic sentence, 379
main ideas, and a concluding sentence. The connector critically thought about what they 380
read and clearly presented his/her reflection on it in the writing. 381

In order to further explore the differences between the high- and low-performing 382
groups, lag sequential analysis was conducted to ascertain their sequential patterns of 383
both regulation types and regulation focuses. According to Bakeman and Gottman 384
(1997), in the sequential analysis, all the regulatory behavioral codes of the groups were 385
chronologically arranged, and then the frequency of each behavior code immediately 386
followed by another was calculated. Analyses were then conducted on the transfer matrix 387
of behavioral frequency, conditional probability matrix, and expected value matrix. 388
Finally, the adjusted residuals table (z-score table) was inferred. This allows for an in- 389
depth analysis of groups' behavioral patterns (Hou 2015). Being similar to previous 390
studies on students' behavior patterns in collaborative learning activities (Hou and Wu 391
2011; Yang et al. 2015; Zheng and Yu 2016), the present study also used GSEQ 5.1 to 392
analyze the sequential patterns of both regulation types and regulation focuses of high- 393
and low- performing groups. 394

Results 395

Overview of students' regulation types, process and focus 396

Table 2 displays the frequency and distribution of each type of behavior. The most 397
frequent regulation type was socially shared regulation, followed by co-regulation, and 398

		Total frequency	Mean ($N = 12$)	S.D
Regulation type				
	Self-regulation	73	6.08	6.80
	Co-regulation	156	13	6.24
	Socially shared regulation	339	28.25	14.45
Regulation process				
	Planning	140	11.67	5.68
	Monitoring	362	30.17	14.19
	Regulating	75	6.25	6.12
	Evaluating	25	2.08	2.23
Regulation focus				
	Task understanding	153	12.75	4.61
	Content monitoring	37	3.08	3.53
	Process monitoring	329	27.42	19.63
	Positive emotion	51	4.25	3.86
	Negative emotion	14	1.17	1.34
	Joking	107	8.92	7.27
	Organizing	108	9.00	5.70

Table 2 Overview of the frequency, mean, and standard deviation of students' regulation

t2.1
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t2.3
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self-regulation. This analysis indicates that most of students' discussion centered on the 399
social aspect of regulation, such as the collective joint activity aiming at achieving a 400
shared understanding and the co-regulative behavior that guided and influenced other 401
group members' learning. 402

Among the behaviors concerning regulation process, monitoring appeared to be the most 403
frequently used behavior, followed by planning, regulating, and evaluating. In other words, 404
students' regulation in the collaborative activities mainly concerned monitoring the learning 405
process while the evaluation of their learning performance was in a way neglected. 406

As for the regulation focus, process monitoring was the most common regulatory 407
strategy used by the groups, followed by task understanding, organizing, joking, positive 408
emotion, content monitoring, and negative emotion. This suggests that four aspects, that 409
is, process monitoring, social emotion (positive emotion, negative emotion, joking), task 410
understanding, and organizing, account for the highest frequency. Nevertheless, students 411
exhibited limited regulatory behaviors in discussing content or linguistic knowledge that 412
should be applied in the resolution of the task. 413

Figures 1, 2 and 3 show the patterns of rates of regulation type, regulation process, 414
and regulation focus respectively during the 5 tasks over the time of the whole semester. 415
These figures offer us a general picture of the way students' self and social regulation 416
changed and progressed during the whole semester's wiki-supported collaborative read- 417
ing activities. Overall, we see that there was a decrease in rates of all the coded 418
regulatory behaviors from task 1 to 5 across the semester. This might be due to 419
similarities among the five tasks. Groups would employ less regulatory strategies after 420
they have become familiar with the task goals and requirements. 421

Comparison of percentages of regulation between the high- and low-performing groups 422 423

Table 3 shows the frequency and percentage of students' regulation in terms of regulation 424
type, regulatory processes, and regulation focus of both high- and low-performing groups, 425
giving a general picture and indicating some differences between the groups. We can see 426
that the high-performing groups had relatively higher proportion of regulatory behaviors 427
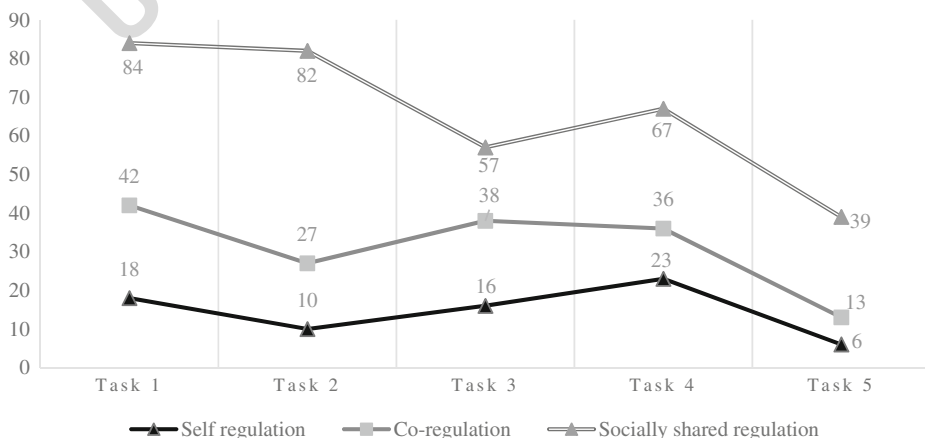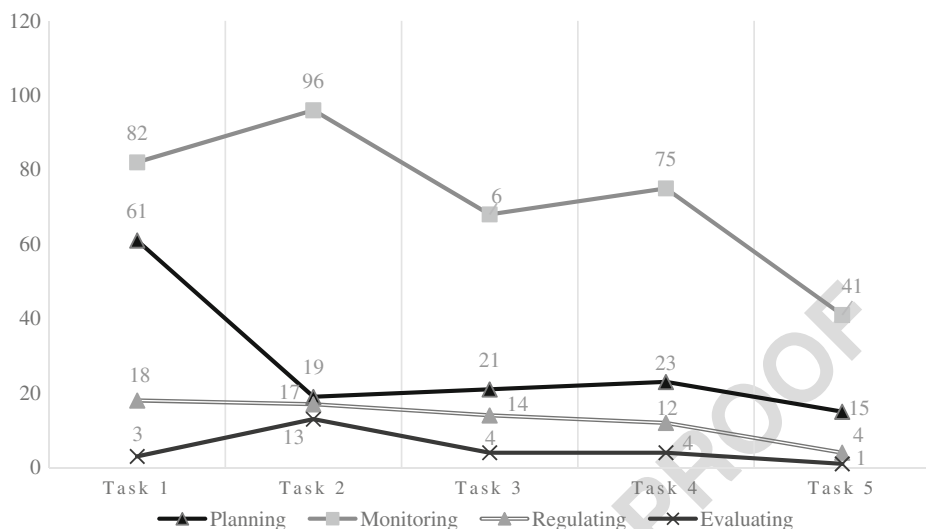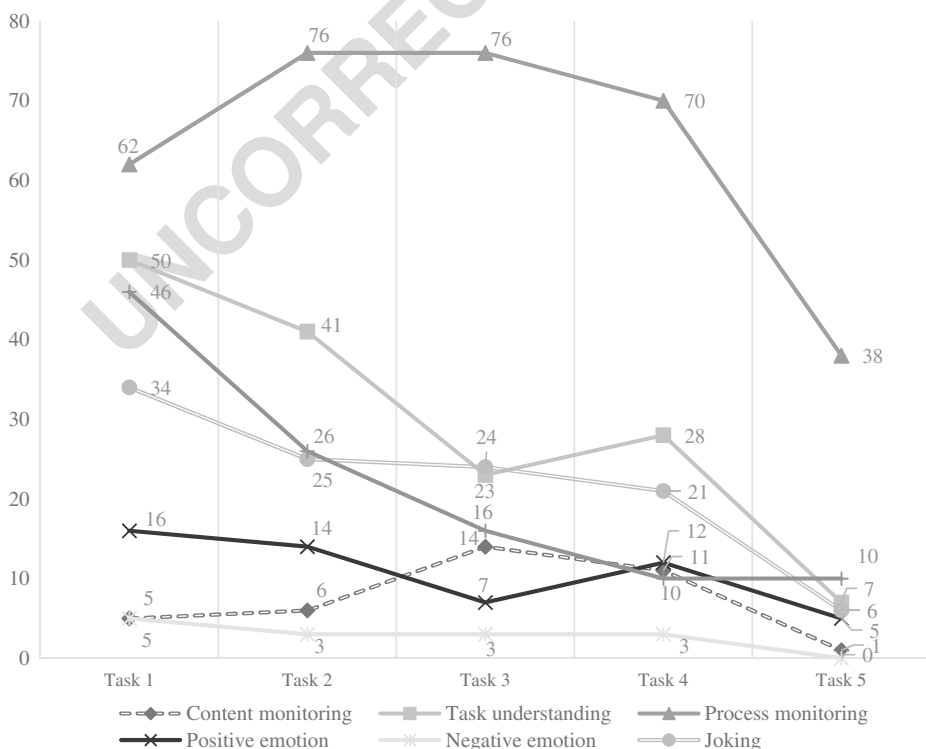

Fig. 1 Rates of regulation type

Fig. 2 Rates of regulation process

directed towards co-regulation (32%) than that of the low-performing groups (21.43%). 428
However, the high-performing groups had a slightly lower proportion of socially shared 429
regulation (60%) than that of the low-performing groups (69.07%). Chi-square was used to 430

Fig. 3 Rates of regulation focus

t3.1 **Table 3** Frequency and percentage of students' regulation across the student groups

	High-performing groups		Low-performing groups		χ2	P
	(F)	(%)	(F)	(%)		
Regulation type					3.59	0.166
Self-regulation	10	8%	12	9.5%		
Co-regulation	40	32%	27	21.43%		
Socially shared regulation	75	60%	87	69.07%		
Regulation process					6.31	0.097
Planning	43	26.54%	22	21.57%		
Monitoring	98	60.49%	72	70.59%		
Regulating	10	6.18%	7	6.86%		
Evaluating	11	6.79%	1	0.98%		
Regulation focus					24.98	0.00
Task understanding	31	15.12%	37	24.34%		
Content monitoring	22	10.73%	3	1.97%		
Process monitoring	65	31.71%	71	46.71%		
Positive emotion	16	7.80%	4	2.63%		
Negative emotion	5	2.44%	5	3.29%		
Joking	40	19.52%	10	6.58%		
Organizing	26	12.68%	22	14.48%		

(Row labels t3.2 through t3.20 correspond to the table rows above.)

further analyze the proportions of regulation types in each subcategory. The result indicat- 431
ed that there was no significant difference between the high- and low-performing groups in 432
the distribution of regulation types ($\chi2 = 3.59$, $df = 2$, $p = 0.166$). 433

As for the regulatory processes, it was found that the high-performing groups had higher 434
frequencies of regulatory behaviors than the low-performing groups. The result of Chi-square 435
analysis indicated that there is a marginally significant difference between the high- and low- 436
performing groups($\chi2 = 6.31$, $df = 3$, $p = 0.097$). The proportion of the high-performing 437
groups' planning behavior (26.54%) was a bit higher than that of the low-performing groups 438
(21.57%). Although the proportion of the high-performing groups' monitoring behavior 439
(60.49%) was slightly lower than that of the low-performing groups (70.59%), they still had 440
higher frequency (98) than the low-performing groups (72). We can also see that the amount of 441
regulating in low-performing groups (6.86%) was almost the same as that of the high- 442
performing groups (6.18%). Moreover, it is worth noting that the low-performing groups 443
seldom evaluated their learning (0.98%) in doing the collaborative learning task. 444

When it comes to regulation focus, Table 3 indicates that high-performing groups showed 445
more regulatory behaviors in content monitoring (10.73%), positive emotion (7.80%), and 446
joking (19.52%) than those of the low-performing groups (1.32%, 1.99%, 6.62% respectively). 447
The Chi-square analysis also confirmed such a result, indicating there is a significant differ- 448
ence between the high- and low-performing groups in the frequency of regulation focuses 449
($\chi2 = 24.98$, $df = 5$, $p = 0.000$). This suggested that compared with low-performing groups, 450
high-performing groups not only spent more effort on cognitive regulation concerning content 451
knowledge required to complete the tasks, but also exhibited more emotional regulatory 452
behaviors than the low-performing groups. Figures 4 and 5 show that the difference was 453
maintained across the semester. 454

Figures 4 and 5 also indicate a sharp decrease for the high-performers on both content 455
monitoring and emotional regulation. The reason is that the reading materials used in task 5 456
was not included in the final exam of this course. Students may feel demotivated to participate in 457

Fig. 4 Rates of content monitoring
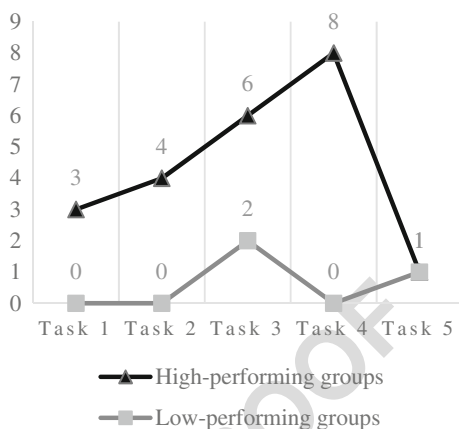
discussion and regulate their collaborative learning. Previous study shows that achieving success in English tests was found to be crucial in language learning motivation (Li et al. 2012), and negative association has been identified between "testing" and students' online regulatory behaviors (Zheng et al. 2016). If the group task is not related to what is tested, students show less inclination to engage in experiences of setting objectives, managing time, or utilizing strategies for online language learning.

On the other hand, for students in the high-performing groups, the percentage of task understanding (15.12%), process monitoring (31.71%), and organizing (12.68%) was slightly lower than those in low-performing groups (25.16%, 47.02%, 14.57% respectively). This indicates that low-performing groups spent relatively more effort in understanding the task, managing the learning process, and planning the organization of the task.

Comparison of behavioral transition between the high- and low-performing groups

To further explore the difference between the high- and low-performing groups, lag sequential analysis was employed to examine the behavioral patterns of both regulation type and regulation focus across the groups. The behavior codes (regulation type and regulation focus) of high- and low- performing groups were imported into GSEQ 5.1 to perform the sequential analysis.

Fig. 5 Rates of emotional regulation
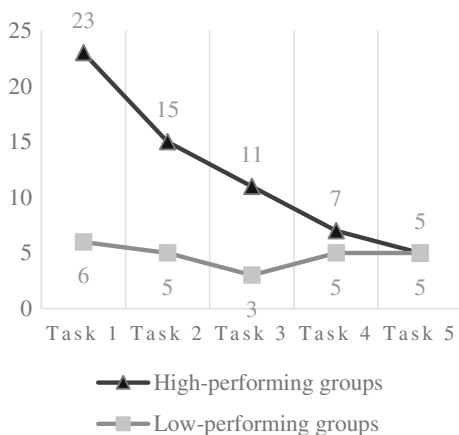
The adjusted residuals table for the high- and low-performing groups' regulation types is shown in Table 4. This is a contingency table in which the rows represent the initial behaviors and the columns show the behaviors that follow the initial behaviors. A behavior transition will be considered statistically significant ($p < 0.05$) if the Z-score is greater than 1.96 (Bakeman and Gottman 1997; Hou 2015). According to Table 4, the behavior patterns of regulation type of the high- and low-performing groups can be derived. As shown in Fig. 6, the regulatory behaviors are denoted by the nodes, and significance sequences were indicated by an arrow pointing in its direction.

As can be seen in Fig. 6, there were distinctive differences in the behavior patterns of regulation types between the high- and low- performing groups. One significant behavior pattern was identified in the low-performing groups (SR → SR), indicating that they were prone to self-regulation in a repeated manner. For instance, in one low-performing group, a team member posted. For the high-performing groups, they showed the significant sequential link between co-regulation and socially shared regulation of learning (CR → SSR, SSR → CR). A typical pattern involved a student initiating an effort to monitor the learning process of another specific group member (e.g., Xin, "Peng, it looks like you haven't answered the questions raised by the discussion leader. Rembert to do it."), and all the other group members responding collectively to adapt group regulation processes or negotiate common task perceptions (e.g., "Didn't the teacher say we don't need to answer the questions?"). Another example is when a student posts a message for monitoring the whole group's learning process (e.g., Wang, "Hey guys, do you notice that the deadline is coming up very soon? I guess we need to move faster and have a discussion about the problems we have.") and the remaining group members respond by not only showing agreement (e.g., "Sure!"), but also starting to support or influence a team member's regulation processes (e.g., Hong, "Meng, I think it is totally fine if you want to write about American dream. It's a topic worth digging deep. Just go ahead."). This suggests that students in high-performing groups exhibited better bi-directional connection of co-regulated learning and socially shared regulated learning.

We further conducted the sequential analysis on the seven behavior codes of regulation focus (KM, TU, PM, PE, NE, J and O) of both the high- and low-performing groups. The adjusted residuals table is shown in Table 5. The behavioral transition diagrams were drawn to aid visual observation of the significant behavioral sequences. All the sequences that reached statistical significance were indicated in Fig. 7.

Figure 7 illustrates the significant behavior sequences of regulation focus of the high- and low-performing groups respectively. There were six significant behavioral sequences for the high-performing groups (J → O, O → J, O → PM, PM → KM, KM → NE, PE → PM),

Table 4 Adjusted residuals Table (Z-scores) for the high- and low-performing groups' regulation types

	High-performing groups			Low-performing groups		
	SR	CR	SSR	SR	CR	SSR
SR	−0.99	−0.20	0.74	4.95[*]	0.27	−3.39
CR	−0.14	−1.98	1.97[*]	−0.47	−0.49	0.73
SSR	0.68	1.99[*]	−2.28	−2.74	0.26	1.51

SR self-regulation, *CR* co-regulation, *SSR* socially shared regulation

[*] p < 0.05
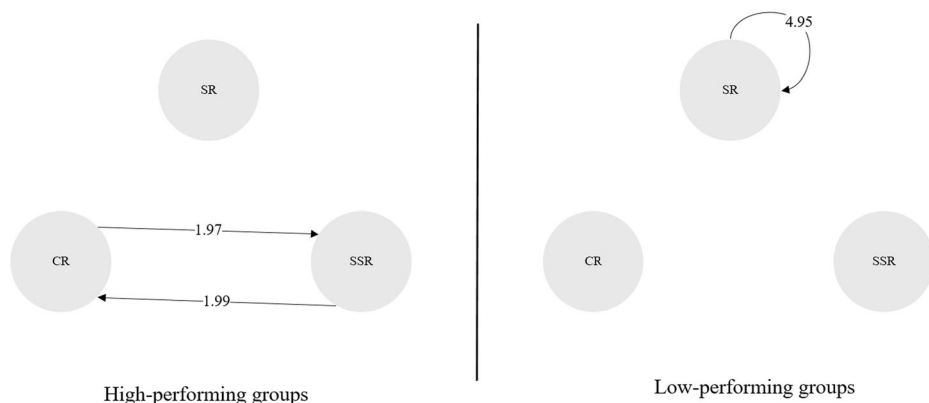
Fig. 6 Behavioral sequence of regulation types of the high- and low-performing groups. SR = self-regulation. CR = co-regulation. SSR = socially shared regulation

while three significant behavioral sequences were found in the low-performing groups (TU → J, PM → TU, O → O). This showed remarkable difference in the patterns of behavioral sequences across the groups.

First, The significant behavioral path O → O ($z = 4.03$, $p < 0.05$) in the low-performing groups indicates that students often lost in repeated organization of the task roles rather than moving on to manage their learning process as the high-performing students did in their learning activities. On the other hand, we found that the z-scores of the sequence O → O ($z = -2.05$) was lower than -1.96 in the high-performing groups, suggesting that this behavior rarely happened in the high-performing groups. Instead, the significant behavioral path O → PM ($z = 2.15$, $p < 0.05$) suggests that students in the high-performing groups tended to manage the process of their learning after they planned the organization of the task. For example, group members first briefly negotiate the organization of the task roles (e.g., Xin, Can I be connector this time?" Jiang, "OK, I will be word master then." and Peng, "Well, I will take the role of discussion person."). This brief negotiation of task responsibilities proved productive and efficient as it facilitated the group directly proceeding to the process monitoring phase (e.g., Peng, "I just have too much work to do this week. Anyway, I will try to finish my part later").

Second, it is worth noting that students in the low-performing groups tended to constantly check their understanding of the task itself when monitoring their learning process (PM → TU) ($z = 2.46$, $p < 0.05$). This means that students of the low-performing groups were likely to encounter some difficulties in achieving a clearly shared understanding of the learning task, which in turn have resulted in their poor performance in the learning activity. Nevertheless, high-performing students' monitoring and controlling the group progress would stimulate them to talk about the content knowledge that should be applied in doing the reading circles (PM → KM) ($z = 2.99$, $p < 0.05$). For example, after checking and negotiating when to submit the final work (e.g., "Isn't it due on Saturday?"), the students in a high-performing group continued to reflect on what they wrote on wiki and prompted each other to clarify their understanding (e.g., "I think there should be some problems about the coherence between the two sentences?).

Third, Fig. 7 also indicates that in the high-performing groups there were more significant sequential links between social emotional regulation (PE, NE, J) and other

Table 5 Adjusted residuals Table (Z-scores) for the high- and low-performing groups' regulation focuses

	High-performing groups							Low-performing groups						
	KM	TU	PM	PE	NE	J	O	KM	TU	PM	PE	NE	J	O
KM	1.16	−0.80	0.99	0.22	2.12*	−0.77	−1.87	−0.06	−0.73	1.56	−0.06	−0.10	−0.20	−0.41
TU	−1.49	−1.98	1.33	1.84	0.29	0.42	−0.50	−0.75	−1.00	−0.75	−0.75	0.75	2.50*	0.00
PM	2.99*	1.56	−5.54	0.01	0.43	1.72	1.02	0.62	2.46*	−0.62	0.62	0.70	0.41	−4.19
PE	−1.46	1.19	2.20*	0.71	−0.66	−2.07	−0.78	0.94	−0.73	0.56	−0.06	−0.10	−0.20	−0.41
NE	0.66	0.33	−0.57	−0.66	−0.36	−1.13	1.90	−0.10	−0.22	−0.40	0.90	−0.17	−0.34	0.32
J	−1.29	0.10	1.40	−0.72	−1.11	−1.67	2.26*	−0.20	−0.43	1.20	−0.20	−0.34	−0.68	0.65
O	−1.24	−0.51	2.15*	−1.60	−0.87	2.03*	−2.05	−0.45	0.65	−1.55	−0.45	−0.74	−1.49	4.03*

KM content monitoring, *TU* task understanding, *PM* Process monitoring, *PE* positive emotion, *NE* negative emotion, *O* organization

* $p < 0.05$

t5.1
t5.2
t5.3
t5.4
t5.5
t5.6
t5.7
t5.8
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t5.10
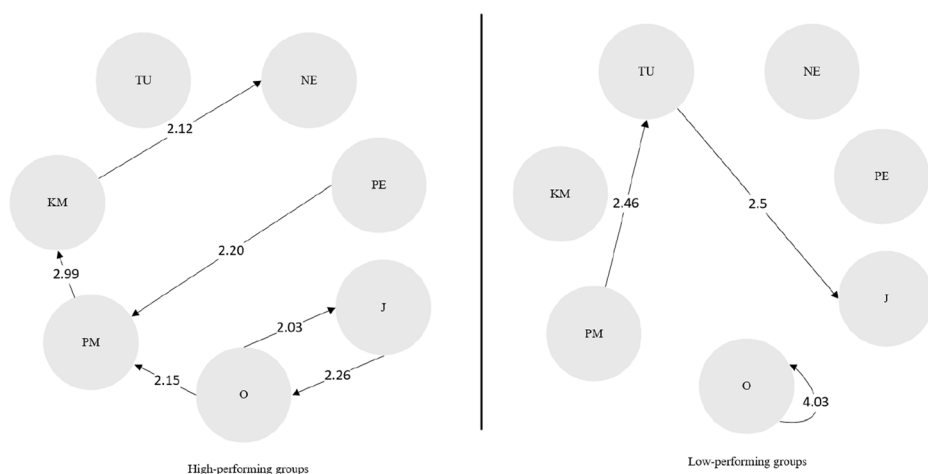
Fig. 7 Behavioral sequence of regulation focus of the high- and low-performing groups. KM = content monitoring. TU = task understanding. PM = process monitoring. PE = positive emotion. NE = negative emotion. O = organization

regulatory behaviors such as process monitoring (PE → PM) ($z = 2.20$, $p < 0.05$), content monitoring (KM → NE) ($z = 2.12$, $p < 0.05$), and organizing (J → O, O → J) ($z = 2.26$, $p < 0.05$; $z = 2.03$, $p < 0.05$). This suggests that compared to the low-performing groups, high-performing groups showed more active emotional engagement in their collaboration. For example, when a group member felt stressed out and found it hard finish his/her work (e.g., "Sorry, I haven't got time to do my part. Could you guys be more patient?"), other members would show awareness of the emotional state and respond with comforting words (e.g., "Don't worry. Take your time." "Cheer up."). Moreover, the episodes of high-performing groups also showed that after assigning individual roles or negotiating responsibilities concerning the task, group members would usually give compliments to each other (e.g., "Nice job." "Perfect plan!"), and post various emojis that express their emotional or motivational state such as enthusiasm, excitement and interest in doing the task.

Discussion

The purpose of the present study was to gain foundational insights into language learners' self and social regulation during computer-supported collaborative learning tasks and their linkage to group performance. Using an integration of methods of content analysis and lag sequential analysis, this study not only reveals general characteristics of EFL learners' regulatory behaviors, but also enhances our understanding of social regulation through identifying patterns of regulation that differentiated high-performing groups from low-performing groups.

The study reveals some overall characteristics of EFL students' regulation of learning during collaborative learning. The results suggest that the groups demonstrate more social forms of regulation (co-regulation and socially shared regulation). This result was in accordance with previous findings about active social regulation in collaborative learning contexts (Grau and Whitebread 2012; Ucan and Webb 2015). Analysis of the regulatory focus further

indicates that students did not exhibit much regulatory behavior in terms of content monitoring 566
during the reading tasks. This may be due to the regulatory challenges imposed by online 567
chatting. One challenge related to content monitoring in CSCL contexts involves concurrent 568
postings. Some responses might be neglected in light of the simultaneous nature of the group 569
exchange (Lee et al. 2015). In addition, as Iiskala et al. (2011) has argued, the task itself might 570
also have played a role in lowering the overall frequency of regulation in content monitoring. 571
Although students were required to negotiate and respond to group members' work, the clear 572
division of roles set by the literature circle task still encourages some students to focus only on 573
their own work and be reluctant to engage in content monitoring. 574

Comparison between the groups revealed that the high-performing groups demonstrated 575
more regulatory behaviors in content monitoring than the low-performing groups across all the 576
learning tasks. In this study, content monitoring usually involved regulatory moves focusing on 577
checking, elaborating, revising and improving group members' task response (Lee et al. 2015; 578
Rogat and Linnenbrink-Garcia 2011). Content monitoring has been regarded as an indication of 579
high quality regulation that plays a critical role in enhancing successful collaboration and 580
effective learning (Lee et al. 2015; Rogat & Linnenbrink-Garcia 2013; Volet et al. 2009). Our 581 **Q5**
study further verified this view in the context of wiki-supported EFL learning. Students' 582
monitoring of linguistic and content knowledge makes it possible for group members to pool 583
their knowledge to scaffold each other, build linguistic knowledge, and achieve shared under- 584
standing (Donato 1994; Hsieh 2017). Due to members' regulatory behaviors in checking 585
accuracy of task responses and incorporating task revision, the result was an improved answer 586
that reflected a group response. Similar evidence can also be found in Lee et al.'s (2015) study 587
with respect to the key role played by content monitoring in the high quality joint activity. 588

Another distinguishing feature between the high- and low-performing groups' regulation 589
processes was that the high-performing groups demonstrated a higher proportion of evaluation. 590
We can see that the low-performing groups employed very limited evaluation. The close 591
relation between evaluation and group performance in CSCL revealed in this study is in 592
accordance with previous research showing that evaluation plays a critical role in effective 593
collaboration and foreign language learning (Dolosic et al. 2016; Dörnyei and Tseng 2009; 594
Hou 2015; Su et al. 2018). Hou (2015) further argues that for students working in teams, 595
teachers need to provide opportunities for them to pause for reflection on their learning and 596
offer scaffolding and support to help groups evaluate their learning performance. Therefore, 597
evaluation mechanisms are recommended to be established in task design to enhance groups' 598
reflective practice of their collaboration effectiveness as well as their learning performance. As 599
suggested by Järvelä et al. (2016a), learning analytics could also be integrated into the online 600
learning system to monitor and support students' collaborative process. Then just-in-time 601
intervention could be provided to engage the groups with limited evaluation in reflecting on 602
the tasks they have completed. 603

The sequential analysis revealed that the high-performing and low-performing groups 604
applied different process patterns of regulated learning to deal with challenges during the 605
learning activity. The high-performing groups exhibited a significant bidirectional pattern 606
between co-regulation and socially shared regulation while the low-performing groups only 607
repeated self-regulation. This confirms the findings of previous study that co-regulation sets 608
the stage for groups to focus on engaging in socially shared regulatory behaviors and, 609
ultimately, better collaboration (Lee et al. 2015; Järvelä et al. 2016b). This interactive pattern 610
also extends research on the interplay between co-regulation and socially shared regulation by 611
suggesting that socially shared regulation promotes co-regulatory behaviors, particularly in 612

high-performing CSCL groups. This finding highlights the significance of co-regulation and socially shared regulation in maintaining productive collaboration in the CSCL setting (Järvelä and Hadwin 2013; Saab 2012). Via effective co-regulation and socially shared regulation, the collaboration quality can be elevated as group members work to improve task responses by providing revision and feedback (Rogat and Adams-Wiggins 2014; Rogat and Linnenbrink-Garcia 2011; Ucan and Webb 2015).

Sequential analysis also revealed that high-performing groups showed more sequential correlation between social emotional regulatory behaviors and other regulatory behaviors such as *process monitoring*, *content monitoring*, and *organizing*. This suggests that high-performing groups have more social-emotional engagement in their collaboration. This is consistent with the findings of a recent study that explores the effect of sentiment on group performance conducted by Zheng and Huang (2016). They found that sentiments, insightful sentiments in particular, are positively related to group performance in the CSCL setting. According to Kreijns et al. (2003), socio-emotional interaction plays a critical role in creating a sound social space where a student facilitates and reinforces social interaction and, in turn, influences the effectiveness of collaborative learning. Social-emotional regulation also contributes to advanced communication, interaction as well as engagement in the co-construction of knowledge (Jones and Issroff 2005). Without effective regulation, the socio-emotional challenges raised by collaborative learning situations can act as obstacles to motivate students' action in different phases of collaboration (Järvenoja and Jarvelä 2009).

In addition, another interesting finding from the sequential analysis was that the high-performing groups exhibited the pattern of *process monitoring after organizing*, which indicates a more continuous and smooth collaboration. However, the low-performing groups showed the pattern of *organizing after organizing*. The phenomenon that low-performing groups tends to repeatedly perform the same behavior is in line with previous studies (Hou 2015; Yang et al. 2015). Zheng and Yu (2016) further explains that this result from the limited regulation skills of the low-achievement groups. Therefore, it may be beneficial for timely guidance to be given when groups get lost in repeated behaviors such as planning the organization of their learning task.

Conclusion and pedagogical implications

The findings not only confirmed the results of studies that show a positive relationship between regulatory activities and performance (Winters and Alexander 2011), but also extended previous research by providing an initial insight into the dynamics of EFL learners' self and social regulation and their relationship to learning outcomes in CSCL contexts. The innovative sequential analysis method helped to capture the characteristics of groups' self and social regulation, and further identified the differences in regulatory behavioral patterns between the high- and low-performing groups. Additionally, the study also contributes to recent calls to investigate the socio-emotional regulation in the CSCL context (Jones and Issroff 2005; Lee et al. 2015; Zheng and Yu 2016), and further verified that socio-emotional regulation might play a role in explaining variations in the quality of group-work.

The findings of this study provide a starting place for improving EFL students' collaboration and learning outcome. First and for most, the findings point to the value of fostering students' ability to employ social forms of regulation during wiki-supported collaborative reading activities. Teachers and curriculum designers may need to design and implement

instructional programs that include more social aspects of regulation. This could be achieved by emphasizing the shared responsibility of the students and the value of collaboration for successful learning, and providing the students with written instructions about the learning goals and rules of the group activities (Ucan and Webb 2015). Second, this study underscores the role of co-regulation in explaining better learning performance. This might suggest that more emphasis be placed by tool developers on building CSCL environments that guide and facilitate learning groups' co-regulation in CSCL settings (Järvelä et al. 2016a). Furthermore, this also serves as a reminder for English teachers of the necessity to stimulate more co-regulated learning among group members. Third, the results prompt teachers to consider the potential need to pay more attention to those groups that rarely evaluate their learning. These students might be encouraged to stop when needed and think, reflect, evaluate, and adjust their collaboration and learning (Hou 2015). Fourth, the study highlighted that students' regulatory behaviors concerning content monitoring are associated with better learning performance. Teachers, therefore, might consider engaging students in active discussion of the linguistic and content knowledge that are relevant to the learning tasks. Finally, this study suggests that, if groups are also provided with scaffolding for socio-emotional regulation, there may be a chance to improve the effectiveness of collaboration and learning achievement.

Limitations and future work

These associations and potential design implications should be tested in experimental studies going forward. Although this study revealed significant differences in patterns of regulation between the high- and low- performing groups, we cannot determine to what extent these findings indicate causal connections. In addition, the number of participants was relatively small, which might limit our observation of students' regulatory behaviors. The method used for division of groups may also be limited in revealing differences in regulatory behaviors across the groups. Another limitation was that this study was situated in a specific setting, a wiki-supported collaborative reading of English as a foreign language. The findings cannot be directly generalizable to other CSCL contexts. Moreover, coding and analyzing students' collaborative discussion may still be insufficient for comprehensively probing into the dynamics of their self and social regulation in collaborative learning. The online chatroom technology systematically forces excluding some data such as expressive cues that would be available in a face-to-face situation (Winne 2015).

Drawing upon the above-mentioned findings and limitations, this study provides several suggestions for future studies. For example, other data collection methods, such as questionnaire surveys and interviews, are also recommended for providing a fuller understanding of EFL students' self and social regulation in collaborative learning. Future research on regulation of learning in CSCL context may also consider using other channels for data such as facial recognition of emotions and eye track data (Azevedo 2015; Järvelä et al. 2016b). Moreover, future studies should investigate in more detail students' regulation in evaluation, content monitoring, and social emotions, at both an individual and a social level, and how they are related to students' learning performance. Another reasonable step would be to further explore how to use tools to guide these regulatory behaviors among groups. Finally, research in other educational and cultural settings could shed more light on the complex phenomenon of EFL students' self and social regulation and their roles in successful collaboration and learning achievement in CSCL contexts.

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Appendix

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t6.1   **Table 6** Coding scheme for the students' regulation types

t6.2	Regulation types	Definition and examples
t6.3	Self-regulation (SR)	Regulation behavior used by the student mainly to regulate himself/herself, with no apparent intentions to influence other students' cognitions, emotions and behaviors. *I don't understand the goal of the task. I may need to ask someone to explain the requirements of the literature circles?* (task understanding). *I may not be able to write the questions now. I will do it tonight.* (process monitoring)
t6.4	Co-regulation (CR)	Regulation processes directed to influence the cognition, motivation or behavior of one specific member of the group. This interaction always reveals certain asymmetry in the relationship. *It seems you are not doing what you are supposed to do? Are you sure you have finished the task role of discussion leader required by the teacher?* (task understanding) *Tomorrow is the deadline, so you have to speed up!* (process monitoring)
t6.5	Socially shared regulation (SSR)	Regulation processes more related to group planning, monitoring and regulation of a joint activity. The verbalizations are usually directed to everyone in the group (or no one in particular) and the talk is mainly in plural such as 'we should do this', 'we are taking too long' *Hi everybody. Do we all need to write some questions on Wiki about what we read? What kind of questions shall we ask?* (task understanding) *Hey guys, it seems that we have to speed up a little bit. The assignment is due this Wednesday.* (process monitoring) *How are we going to divide the task roles?* (organizing)

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t7.1   **Table 7** Coding scheme for the students' regulation processes of learning

t7.2	Regulation types	Definition and examples
t7.3	Planning (P)	Planning/decision making/initial appraisal of the task. *Example: Let's start off our task and assign the roles first!*
t7.4	Monitoring (M)	Monitoring/awareness and monitoring of various aspects of cognition, beliefs, affects and motivational states. *Example: Tomorrow is the deadline of the task. Make the best use of your time!*
t7.5	Regulating (R)	Regulation/selection and use of various cognitive strategies for learning, reasoning, memory, thinking, motivation and emotion. It comes after a monitoring of the task. This usually includes verbalization showing a change of strategies that seems to be less effective. *Example: Maybe next time we can use Microsoft Word to check the spelling before we put it on the Wiki page.*
t7.6	Evaluating (E)	Evaluation/involves students' judgement, evaluation attributions and emotional reactions to their performance *Example: By doing the literature circles, I realized how poor my English is.*

t8.1 **Table 8** Coding scheme for the students' regulation focus

Focus	Description and examples
Task	
Task understanding (TU)	Talking about understanding of the task goals and requirements. *Example: We are supposed to write the summary in English.*
Content monitoring (KM)	Regulatory moves focusing on checking, elaborating, revising and improving group members' task response. It involves talking about knowledge concerning language, grammar, word choice, or relevant content about the reading materials. *Example: I think there should be some problems about the coherence between the two sentences.*
Process monitoring (PM)	Discussion about the management of time *Example: Hurry up. We have to submit the final version tonight.*
Emotion	
Positive emotion (PE)	Awareness of positive emotional experience such as encouragement, compliments, enthusiasm in the task. *Example: A really wonderful explanation. Many thanks!*
Negative emotion (NE)	Awareness of negative emotional experience in the task that hinder task progress and make others upset. *Example: What you said is not true. I don't want to listen to your explanation.*
Joking (J)	Emoji or graphic emotions that regulate the atmosphere of the team. *Example:*
Organization	
Organizing (O)	Talking about the organization of the task in a pragmatic way (who does what). *Example: How shall we assign the task roles this time?*

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