A Preliminary Study on Socially Shared Regulation during Online Collaborative Mathematics Learning

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***Abstract*— Successful online collaboration demands coordination among all the group members. This can be achieved through socially shared regulation of learning. Most studies deal with social shared regulation focusing on collective individual regulations during collaboration and absence of one of these processes would affect mathematical problem solving during collaborative learning. This study contributes to the emerging research on social shared regulation in collaborative learning where collaborative groups are analyzed as the unit of analysis. Participants include 21 students who are learning mathematics at a vocational training institution in an online collaborative learning setting. Students' discussion scripts were collected and analyzed to identify the group strategies to regulate learning during solving Mathematics problem based on a coding scheme. Preliminary findings indicated that content-monitoring, content-evaluation and task-planning were the most frequent applied regulation strategies during online collaborative learning. Online collaborative learning results in socially shared regulation in groups however co-occurrence of self-, co- and shared regulation in online collaborative learning varies in relation to the type of regulation strategies implemented by the group. Future study should investigate on the ways to encourage all forms of regulation to co-occur during online collaborative learning. Also, investigation on the quality of socially shared regulation (based on acquisition of mathematical knowledge and content of discussion) during online collaborative learning in relation to group learning performances should be carried out.**

Keywords—e-learning; regulated learning; collaborative learning; metacognition; Mathematics education.

I. INTRODUCTION

Collaborative learning involves a coordinated effort to solve a problem together [1]. To achieve coordination, it is important for group members to have their thinking visible to each other. This can be done by sharing and explaining to members of the group which in return allows individual group members to activate and strengthen their own understanding about the learning context and task [2]. Online collaborative learning in mathematics has become more common as more studies have reported the benefits of learning mathematics with collaboration. Students are able to increase their ability to generalize mathematical problems by negotiating with each other their ideas during collaboration [3]. They were also found to have improved understanding of mathematical concepts as they shared and exchanged knowledge with each other during collaborative problem solving and making their thinking visible to others [4]. Although a lot of studies reported on the benefits of collaborative learning for learning mathematics, more in-depth research is necessary to discover how online collaborative learning contributes to their learning success particularly based on students' regulation strategies of how they plan, monitor and evaluate their collaboration to finally solve mathematics problems in an online learning setting. Orientation, planning, monitoring, evaluating and reflecting are processes involved during learning regulation [5]. The ways students regulate their collaboration have a significant impact for knowledge acquisition and improved understanding about mathematic knowledge [4]. Most research in studying learning regulation in online collaborative learning setting emphasize on the collective individual learning regulation to represent group regulation. According to [6], group regulation cannot be reduced to individual regulation as the dynamics of group elicit different characteristics. As such, in collaborative learning, understanding the regulation processes requires information about self- and socially formed regulation (based on interaction with others during collaboration) [7]. This is because a handful of studies described online collaborative mathematics learning results in more social talks [4, 8] where content-related talks were mostly demonstrated by teachers [8] and absence of socially shared regulation processes would affect students' mathematics problem solving process during collaboration [9]. Understanding group regulation process would provide insights on how students coordinate group activities when learning mathematics through orientation to task, planning the group process, monitor group progress, and evaluate group products. This study explores how students socially shared their knowledge and regulate their learning to solve mathematics problems based on the perspective that the collaboration process is a result of regulation of students' interacting socially.

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II. Background of Problem

A. Collaborative Learning in Learning Mathematics

In Malaysia, students undertaking engineering courses are required to learn calculus as a requirement to complete the course. Reference [10] stated that 'calculus is one of those topics in mathematics where the algorithmic manipulation of symbols is easier than understanding the underlying concepts'. Learning calculus requires students to solve 'real life' problem that demands them to first understand the problem by translating the 'context of the problem' to an abstract level of calculus. Next, students solve the identified abstract calculus and finally translate the abstract calculus solution back to the problems' context [11]. A lack of conceptual understanding about calculus leads students to face difficulties in translating the real life problems into calculus formulation [12]. Learning calculus becomes less problematic when students are introduced to the mathematical rules of differentiation and integral as the inverse process. However, some students have difficulties to select the correct mathematical representation of the problem [12]. As a result students tend to memorize the mathematical rules to arrive at the answer. Mathematical problem solving processes is proven to be important for students' improved understanding of mathematics as a process of thinking rather than the rote memorization of steps [13].

Reformation of teaching strategies shows that learning in groups can improve students' mathematical problem-solving processes [7]. Learning collaboratively in groups allows students to have access to each other's understanding and perspectives about the problem. They gain more insight about the mathematical problem by negotiating each other's ideas and thus increasing the ability to generalize the given mathematical problem [3]. Collaborative learning is important particularly to stimulate students' metacognitive knowledge. In [4], students solving problems collaboratively were found to use metacognitive knowledge and metacognitive judgements during mathematics learning. That is, through collaborative discussions, students were more aware about their own mathematical knowledge. It encourages the students to have improved understanding about mathematics. It is particularly important for learning mathematics because students who know about the different strategies for solving a problem are more likely to use them [14]. Also, being aware about their own cognitions (metacognitive knowledge) promotes transfer of knowledge or strategies into different context of mathematical problem [14]. Students in collaborative learning discover various strategies to solve problems that increase their metacognitive knowledge thus helping them to be able to apply various strategies to solve various mathematical problems.

High quality collaboration requires group member to employ self-regulation strategies effectively to obtain synergistic mutual understanding from all group members and thus generating socially shared regulation [15]. It is important that during socially shared regulation, the group response and act on the strategize plan rather than exchanging ideas about the plan [16]. As a result, a synergy group can be formed which works collaboratively to understand the task and strategized plan to complete the task by involving active participation from all the group members [15,17].

B. Socially Shared Regulation during Collaboration of Mathematics Learning

In an online collaborative learning environment, the challenge for self-regulation increases [18]. As collaborative learning requires joint individuals to share and negotiate ideas to co-construct knowledge [19], the self-regulation of individuals can potentially affect the group process respectively. Reference [17] stated that during collaboration, three forms of regulated learning co-occur; self-regulated learning, co-regulated learning and shared regulation. Effective collaborative learning should be acknowledged based on socially shared regulation of the interacting students in a group rather than understanding individual self-regulation processes because regulation process to achieve shared understanding during collaboration is a result of group's shared cognition [1]. Self-regulation and socially shared regulation differs as self-regulation involves students constructing individual personal goals and alter individual strategies to achieve the personal goal while socially shared regulation occurs when collective goals are established within a group where all group members negotiate and adapt a regulation processes towards achieving the collective goals set by the group [17]. In turn, a collaborative group demands coordination and thus would suffer as a result of the different goals and regulation processes set by different individuals [17].

Research on the role of shared regulation for online collaborative learning is currently expanding with very little attention about acknowledging the 'collaborative group' as the regulating agent. In most empirical studies, socially shared regulation was investigated from the perspective of collective individual regulation as a result of group socially shared regulation [7]. Based on the assumption that collaborative learning is a social construction of knowledge [20], knowledge construction process is synergistic where the group processes shapes the individual group members. That is, collaborative learning group processes should be assessed based on the group as a whole [21]. Reference [9] described the role of socially shared regulation in mathematical problem solving where they found that individual students would monitor their own thinking during collaboration and thus adopted others' thinking of the group towards own thinking development. Hence, it is very important that collaborative learning occurs in a fashion that includes all the necessary socially shared regulation processes. The absence of several phases of regulation during collaborative learning would jeopardize students' learning. For example, lack of evaluation process during regulation of learning would lead to students applying incorrect strategies during mathematical problem solving [9]. Until now, little is known about how groups devise strategies and when cognition is shared to give us more information about the effect of socially shared regulation process on both collaborative learning and students' acquired knowledge during collaboration. Information on group regulated strategies (orientating, planning, monitoring, and evaluating) will help to draw conclusions on the quality of constructed knowledge [22] and inform teachers on how to improve group performance by acknowledging the regulation strategies that promotes or inhibits cognitive activities during online collaborative learning [7]. It is also important for providing instructional designing ideas and propose the necessary support for groups to regulate online learning. Hence, this study will explore group regulation strategies during online collaborative mathematics learning based on the perspective that shared regulation operates when groups construct shared goals in solving Mathematic problems. In specific, this study will answer the following research question:

- How do students socially share regulation during online collaborative mathematics learning?

III. Research Methodology

This study is part of a larger exploratory study about group regulation in a computer-supported collaborative learning environment. In this study, both qualitative and quantitative approaches were applied to explore how groups regulate strategies during online collaborative mathematics learning.

A. Participants

The participants of this study were 21 students studying Mathematic course at a vocational education training institution. All the students have to attend all the learning sessions as part of completing their Mathematic course. They are familiar with online learning platform as part of their learning resources to download notes, exercises and to receive updates about the course. However, online learning discussion in groups is relatively new for all the students. Students were divided into small groups consisting of three students in every group. Group formation was based on their previous semester CGPAs where more successful students were grouped with the less successful students. A heterogeneous group of high-achiever and low-achiever was form based on the assumption that regulation would most likely triggered by the high-achiever of the group. There were altogether 7 groups formed in this study. However, one group participation (Group 3) was dropped from the study as two of three of the group members were absent during the data collection process.

B. Research Procedure

Throughout the semester, the Mathematic course consists of calculus topics such as Differentiation, Integration and Limit. For this research, experimentation was carried out during students' learning about the topic Integration. The whole research spanned 5 lessons (Lesson 1-Lesson 5) where all the lessons required students to solve four related integration problems. Each lesson lasted for 75 minutes. The first 30 minutes was a teaching session where teacher explained the related mathematical concept to be learnt. Another 30 minutes was allocated for the students to access the online collaborative learning environment to solve the given mathematic problem. They have to post their group's result and the steps they took to come up with the answers on the online learning discussion board. For the purpose of this preliminary study, we report on the preliminary findings of Lesson 2.

C. Instrumentation

Participants in this study have to complete a collaborative Mathematics task called 'Predicting Jobless People in Malaysia' about the learning content 'Integration'. This task is about estimating the number of jobless people in Malaysia in the year 2015 based on the available data. During lesson 2, this content was still new among the students thus the teacher began the lesson by explaining the steps to solve the problem. Next, the students performed some exercises and then carried out the online collaborative task. The students' discussion thread in the online collaborative learning was collected to analyze the regulation processes during mathematic problem solving.

D. Data Analysis

Since regulation in online collaborative learning is understood from the perspective that students 'socially' regulate, a group represents the social entity as compared to collective individual regulation processes. Hence, analysis of discussion threads was carried out by observing how students' jointly regulate the discussion towards a common goal. We adopted steps taken by [7] who defined 'episode' as a set of turns taken by students during discussions. An 'episode' starts when a student triggers the conversation to start regulating (a turn) and in return, another student reacts to the first 'turn'. An 'episode' consists of at least two turns and an 'episode' ends when a student starts regulating about other regulation processes. All the episodes were analyzed qualitatively using the combination of coding scheme developed by [5] and [23] which are related to regulation strategies in online learning (Table 1).

The coding scheme divides regulation strategies into task-oriented and content-oriented. Task-oriented regulation strategy involves 'orientation', 'task-planning', 'task-monitoring', and 'task-evaluation'. Content-oriented strategy involves 'content-planning', 'content-monitoring', and 'content-evaluation'. The unit of analysis used for content analysis is 'meaning' of every identified episode. There were altogether 173 messages posted by the students during collaborative discussions. Analysis and coding of these messages result in 48 episodes. Two coders first decide on the number of episodes. The episodes were then coded independently and a comparison between the codes indicates an 87% agreement of the coded episodes.

TABLE I. Coding scheme

Regulation Strategy	Definition
Orientation	Orientation on prior knowledge, task demands, and feelings about task
Planning	Reading and interpreting task directions, designating task assignments, setting task goals, evoking relevant prior knowledge
Content planning	Discussing shared goals related to conceptual understanding
	Evoking task relevant content knowledge
Task planning	Discussing the shared task plans, such as role assignments and how to go about answering the task questions
Monitoring	Assessing content understanding, the developing product, assessing progress or plan for completing the task
Content monitoring	Monitoring content contribution or checking accuracy of task responses
Task monitoring	Verifying the progress toward or completion of each task prompt

Evaluation	Assessing content understanding, goal attainment, task completion and the final product
Content evaluation	Checking whether the group met initially set goals
	Evaluating accuracy of the final task solution
Task evaluation	Checking the completion of all the task prompts, evaluating having met task directions

Based on the coded episodes, frequencies and percentages were counted and calculated to provide an overview about the quantity of regulation episodes.

IV. Results

During collaboration all group members participated in the discussion except for members of Group 3 who discussed the task with the instructor (two members of Group 3 were absent). Table 2 shows the description of posted messages that were scrutinized as 'episodes' generated from the online collaborative discussions. Based on Table 2, most episodes were content-oriented rather than task-oriented. Generally, groups spent more time to arrive at the correct answer for the task by planning which algorithm they should perform (Content planning), checking if they calculated correctly (Content monitoring) and deciding within the group the final correct answer (Content evaluation). They rarely regulated learning by monitoring and evaluating whether they have met the task demand although at first, some of the groups determined how to carry out the task (Task planning). Table 2 shows that Group 4 (G4) did not apply any of the task-oriented strategies and thus their collaboration was more about exchanging and checking answers. One of Group 4's members said the following:

Amir: "Guys, I do the calculation first, then all of you check whether my answer is correct."

After doing the calculation, other group members check whether they got the same answer. During the discussion, none of the group members pointed out if they follow the steps correctly, instead same answer was perceived as having the correct answer.

None of the groups applied all the regulation strategies during solving the problem. The most frequent regulation strategy applied by the groups was 'content evaluation' where the group members discussed whether they have made the correct calculation, deduced the correct integrated model or substitute the correct value in their equation. An example of 'content evaluation' episode in Group 6 is shown as follows:

Mike : "Guys…what should we do now?"

Nasir : "t = 4 because it's given for t = 2. Add another 2 for 2008 until 2010".

Ali : "Correct. Back our answer. The question asks for the year 2015. So, t for 2015, t = 9. I calculate J and get J = 25781.4. To find the value of c, use t = 4. So c value c = - 15318".

[Mike write the whole calculation in the discussion].

Mike : "Is it okay guys? Anything else?"

Ali : "Yes...that's the answer".

TABLE II. Descriptive Frequencies of Students' Regulation Strategies for Socially Shared Regulation

Regulation Strategy	Frequency						Total	%
	G1	G2	G4	G5	G6	G7		
Orientation	2	1	0	0	2	1	6	12.5
Planning								
Content planning	0	0	1	1	0	1	3	6.3
Task planning	1	1	0	3	1	1	7	14.6
Monitoring								
Content monitoring	2	2	1	2	1	2	10	20.8
Task monitoring	1	0	0	0	0	0	1	2.1
Evaluation								
Content evaluation	5	3	2	0	7	2	19	39.6
Task evaluation	0	1	0	0	1	0	2	4.2
Total Episodes	**11**	**8**	**4**	**6**	**12**	**7**	**48**	**100**

As a group, Group 6 (G6) gave feedback on each other's findings and found fault in their previous calculations. Another group member made an effort to list all the iterative steps in order to double check their answer. In another group, regulation is not clearly shared within the group during 'content evaluation'. For example in Group 1, every group member calculated independently and checked answers with each other. An example of the 'content evaluation' episode for Group 1 is demonstrated as follows:

Khalis : "The c value is – 29, 163. Didi, what did you get for c? Can you calculate and see if we get the same answer?"

Didi: "Khalis, my c is -15318".

Opi: "I also got a negative value for c".

Didi: "Yup.."

Didi: "Khalis, I replace t with 4 so that is why I get that answer..".

The 'content evaluation' episode diversified in Group 1 and Group 6. Group 1 evaluated the content by one member trying to explain to another member about her personal understanding (co-regulation) to finally arrive at a mutual understanding (socially shared regulation). In Group 6, the group members had established mutual understanding and thus together, they socially regulated by evaluating the content.

During 'Content Monitoring' most of the groups were able to 'socially' share regulation. In Group 7, the regulation of content monitoring was carried out as follows:

Ahmad: "I think the parameter is J".

Aiman: "Then when we integrate dJ/dt to get a general model right? We integrate and get J = $254.4t^2/2$ + 3421.8t".

Amin : "I think that is correct Aiman but we have to add c to the equation. It becomes like this J = $254.4t^2/2$ + 3421.8t + c. Right? Ahmad, what do you think?"

Ahmad : "Hahaha...yes... that is correct Amin".

Group 7 first monitored each other's understanding about the decision to integrate dJ/dt. They monitored group members' contribution by identifying the mistake the group have made and then decided together the correct answer. Similarly, Group 5 regulated learning socially by monitoring content as shown in the following example:

Hamid : "2015 – 2008 we get 7. 7 x 2 we get 14. So, t value for the year 2015 is 14... t =2 is for the year 2008. Then substitute the value t".

Haziq : "Hamid, I think t = 4..."

Udin : "I think t = 5 because 2015 – 2010 = 5".

[After several minutes]

Udin : "The new t value is 7 + 2 = 9. Not by multiplying but add the value"

Haziq : "The new t value is correct Udin. The first t value is incorrect because in 2008, t = 2, so for 2010, we have to add 2… then we get t = 2+2 = 4"

[Hamid wrote the whole calculation for new t value as previously discussed]

Haziq : "Yes…that is right...we only made mistake when calculating the t value"

Udin : "Good job. Yup correct".

Group 5 was negotiating their understanding about the *t* value. Although initially Udin suggested a new *t* value, Haziq further justified Udin's answer. Hamid then took the initiative to write the whole calculations based on the discussion, which was further approved by the group. In Group 5, all group members contributed their understanding. Group 5 achieved mutual agreement based on their discussions rather than only one member contributing and making decisions about the correct answer.

'Task planning' is another regulation strategy that was quite frequently used during online collaborative learning (14.6%). All groups applied this regulation strategy except for Group 4. Group 4 kicked off their discussion with 'content planning'. They know that they have to integrate the equation and substitute the given value into the equation. Task planning was mostly demonstrated by Group 5. They discussed on what they have to do first and how they should proceed upon knowing. The example of task planning Episode 1 by Group 5 is shown below:

Haziq : "Hello guys..any of you remember how do we solve this problem?"

Hamid : "The parameter is J"

Udin : "Yup correct the parameter is J. Ok, so we have to find the value of J."

Hamid : "If we want to find what is the parameter, we have to integrate J."

Haziq : "Ohh really? So after we identify the parameter then only we can integrate right?"

As shown in the discussion, Group 5 made it clear on what they should do first before doing the calculation. Although some of the mathematical concepts were incorrect (such as 'integrate J' instead of ''integrate dJ/dt), they basically know what they should do first. Compared to content planning strategy, socially shared regulation is more transparent during task planning. During content planning, some students tend to provide the answer rather than discussing about the answer such as the following discussion by Group 7 in Episode 4:

Ahmad : "Now how??" ;([sad emoticon]

Aiman : "Insert the value t=2 and the value 404.4 in the equation right?"

Amin : "That is correct Aiman.. substitutes the value 404.4 in J.. 2 substitute in t.. understand? Because now we want to find the value of c."

V. DISCUSSIONS

From the perspective of socially shared regulation, as a result of group's shared cognition, this study attempted to investigate the co-occurrence of self-, co-, and shared regulation in online collaborative learning. Generally, online collaborative discussions during mathematical problem solving resulted in more content-oriented regulation strategies as compared to task-oriented regulation strategies. This is consistent with findings by [25] who also found that for socially shared regulation, students were found to elicit more content-related strategies as compared to the socio-emotional aspect of the task. Regulating task is rather time consuming and in this study we observed that students demonstrated more content-regulation strategies. Reference [24] highlights the importance of having a shared plan so that groups can always refer to their plan and ensure they have covered every aspect in the shared plan. However, most groups preferred to proceed with content-planning which focus on having the task done rather than spending some time to properly plan the steps they should take to ensure the task is completed correctly. Lack of task-orientation strategies could cause collaborative groups to be less efficient as they have lack of understanding of the task and more time would be needed to have all group members to understand the task by revisiting the task.

Reference [17] stated that for effective collaboration, three forms of regulated learning co-occur; self-regulated learning, co-regulated learning and shared regulation. In this study, not all of the three forms of regulation co-occur during collaboration. This aligns with the findings by [24] who pointed out that it is irregular for collaboration to fluctuate among the three forms of regulation. In this study, the forms of regulated learning that co-occur is related to the type of regulation strategies that the groups applied during online collaboration. It was found that three regulation strategies which were mostly applied by the groups were content-evaluation, content-monitoring and task-planning. In one of the groups, content-evaluation only involved the occurrence of self-regulation and co-regulation where group members solved problem individually (self-regulation) and checked each other's answers for clarification (co-regulation). Reference [15] indicated that this is an example that the group was not collaborating. Instead they were only sharing and exchanging opinions and findings, which affects the quality of the discussions.

In some groups, fluctuation of the three forms of regulation was observed during the application of content-evaluation strategy. In Group 6, the group checked individual understandings and together, took the initiative to list down the product based on the discussion and re-checked the group understanding of the answer. This is an important step for online collaborative learning because effective collaboration requires coordination before the shared goal can be achieved [1]. Not only Group 6 focused on solving the problem, they made joint effort to ensure all group members understood the group process.

Other than content-evaluation, 'content-monitoring' strategy was observed in all groups under study. It was found that during content-monitoring, self-regulation, co-regulation and socially shared regulation were also more likely to co-occur. This is possibly because monitoring requires the group to monitor content contribution and checking the accuracy of task responses [23] which cannot be achieved by simply self-regulating and co-regulating. For example, in Group 7, firstly, individuals self-regulate by monitoring one's own understanding, then individuals co-regulate by monitoring each other's understanding. When one of the group members identified the group's mistake, they socially regulate and the new information was again regulated at the individual level (self-regulation). Group 7 demonstrated how other's thinking were adopted to individual knowledge building. However, it is also more important to verify the adopted knowledge is the correct content knowledge.

This study also found that 'task planning' is another important regulation strategy that promotes more shared regulation during collaboration as compared to self- and co-regulation. Task planning marks the direction and the layout of the collaboration as the group makes clear indication about what they should do. During planning, decisions were made together as a group rather than one person directing another person. Collaboration becomes more synergistic when a group engages in early collaboration phases such as dividing labors, and identifying tasks [26]. In groups where 'task planning' was absent, collaboration was less coordinated as they act individually and gather their individual product to form the group product (Group 4). In this case, metacognition is very unlikely to be shared especially when they reached similar answer to the mathematics problem as collaboration will be immediately terminated.

An important aspect of the study was the level of students' understanding about mathematical concept during online collaborative learning for mathematical problem solving. This study found that when students tried to explain mathematical concepts to their friends, they tend to misinterpret the mathematical concept. However, no group members paid attention to the details of the mathematical content during discussion. This is consistent with findings by [4] who found that mathematical concept explanation was less transparent in students' utterances but more social talks were observed because they paid more attention to just solving the problem rather than solving the problem correctly. This scenario affects both the quality of discussion and the quality of knowledge being constructed. It is the similar concern raised by [9] who stated that students might leave the discussion with incorrect understanding about the mathematical content knowledge. This is mostly because of lack of content knowledge and discussions were built upon incorrect assumptions while correct answers were ignored during regulation. It further clarified the need to enforce students to repeatedly 'monitor' and 'evaluate' the collaboration that is still lacking in most groups as shown in this study. In this study, there were evidences of other's thinking being adopted to individual knowledge development (for example Group 7) but verification of the content knowledge has to be further made by the teacher.

In summary, not all regulation strategies were socially shared and applied during online collaborative learning. Content monitoring (CM), content evaluation (CE) and task planning (TP) were the most frequent shared regulation while content planning, orientation and task evaluation were frequently absent in most groups. Although CM, CE and TP were observed, these regulation strategies influenced the quality of discussions. That is, lack of content knowledge (mathematics) leads to students adopting incorrect understanding into building own thinking. It reaffirmed the need of task monitoring and task evaluation to assess the overall group product that were absent in most online collaborative groups due to urgency to complete the task.

Methodologically, the findings of the content analysis of online collaborative discussions using episodes to describe socially shared regulation gives more information about forms of regulation that co-occurs. The students discussed mathematical knowledge at self-, co- and shared regulation although the co-occurrence of these regulation forms differed when different regulation strategies were implemented. It informs us that not all regulation strategies results in co-occurrence of all forms of regulation. Social shared regulation appears to be the case that it depends on the type of regulation strategies operationalized by the group.

VI. Conclusion

Effective online collaboration requires co-occurrence of self-, co- and shared regulation. This preliminary study demonstrated the co-occurrence of different forms of regulation by groups that signifies (but remains insufficient) effective collaboration. However the form of regulations varies in relation to the types of regulation strategies applied during online collaboration and thus presents future needs to investigate the intertwining role between self- and co- for shared regulation. This study is far from sufficient to generalize to the population due to small samples. However, it adds to the understanding about socially shared regulation in online collaborative learning based on the analysis of discussions from social perspectives. This study highlights the importance of nurturing shared regulation for more effective online collaboration despite co-occurrence of many methodological challenges. The domination of self-regulation during online collaboration not only demolishes collaboration between group members but also affect the quality of discussion. Although almost all groups were able to reach conclusions and solve the collaborative task, the mathematical knowledge of the students was mostly at the superficial level as they used incorrect terms to refer to several mathematical operations. It reflects the level of students' understanding about mathematical knowledge and thus requires further investigation. A further study should also focus on the quality of shared regulation (for example, do students explain their opinions?) in online collaborative learning as aiming at solving the problem might undermine the quality of the content of the discussions.

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