Article

How Individual Self-Regulation Affects Group Regulation and Performance: A Shared Regulation Intervention

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Abstract

This study explored the relationship between individual self-regulated learning (SRL), socially shared regulation of learning (SSRL), and group performance plus the effect of an intervention promoting SSRL. We hypothesized that SRL would influence SSRL and group performance as groups with high SRL students will be better regulated and that the intervention would promote SSRL over time. The results revealed a significant relationship between SRL and SSRL, but no significant effects of the intervention on group performance. The limitations of the intervention are discussed and form the basis for future design of environments to promote SSRL. The main conclusion is that SRL is an important predictor of SSRL and should be considered when designing small group activities and their environments.

Keywords

self-regulated learning, socially shared regulated learning, shared regulation, collaborative work, computer-supported collaborative learning

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When learners learn alone, they must regulate their own learning. Research has shown that while this is crucial for success, it is also difficult to do (Zimmerman & Schunk, 2011). But what about regulation in collaborative learning? Learners who collaboratively learn with others—independent of whether it is with a peer in a dyad or with a larger group—not only need to regulate their own learning but also play a role in regulating the learning of others (i.e., co-regulation of learning [CRL]) as well as the learning of the group (i.e., socially shared regulation of learning [SSRL]; Hadwin, Järvelä, & Miller, 2011). This brings a number of important questions such as the following: What is more important for successful collaborative learning: individual self-regulation or SSRL? Is it better (i.e., do collaborative learning groups learn better) when groups are composed of students with well-developed individual self-regulatory skills or when groups are composed of students who can successfully regulate the learning of the group in a shared fashion? Is self-regulation a prerequisite (i.e., is it necessary and sufficient) for socially shared regulation? How are self-regulated learning (SRL) and socially shared regulated learning related to each other? Are there dependencies between the two?

While research on learning has made the jump from individual learning to learning in groups, research on SRL has primarily focused on individual skills, paying little attention to how social interaction and/or collaboration is regulated within a learning group. This, however, is slowly changing as recently there has been a subtle shift from research on self-regulation of learning (SRL) to research on how groups of learners interact to produce shared products and achieve shared goals (Hadwin et al., 2011; Panadero & Järvelä, 2015). Examples are research on CRL (e.g., Saab, 2012), shared metacognition (e.g., Hurme, Palonen, & Järvelä, 2006; Iiskala, Vauras, Lehtinen, & Salonen, 2011), and SSRL (e.g., Grau & Whitebread, 2012). Newest is research on the difference between co-regulation and SSRL (Hadwin et al., 2011; Panadero & Järvelä, 2015). Hadwin and colleagues have identified CRL as a regulative behavior that can explain three different situations: (a) *temporary mediation* of regulated learning to instrumentally promote SRL of the other learner, (b) *distributed regulation* of each other's learning in the context of collaborative work, and (c) a *macro-analytic* approach focusing on interactions and processes through which social environments co-regulate learning. SSRL is possibly of more interest in collaborative learning situations. Socially shared metacognition and SSRL can be characterized by exploring the interactions among group members and how they relate to each other, make joint decisions, and scaffold each other during the learning process. Shared metacognition considers primarily the metacognitive aspects of learning regulation (e.g., goal setting, planning, monitoring), while socially shared regulation goes a step further and includes the emotional and motivational aspects of collaboration (e.g., Järvenoja, Volet, & Järvelä, 2012).

A recent review of SSRL research (Panadero & Järvelä, 2015) showed that shared regulation approaches to collaborative learning can produce better learning and performance in collaborative tasks than co-regulation. The review also identified three areas which need additional research, two that are of special interest for this study. One area was the study of the role of the individual skills that each group member brings to the collaboration process and how the presence or absence of those skills influences the occurrence of SSRL and the overall quality of the joint learning activity. A first aim of the research presented in this article is, thus, to explore whether there is a relationship between individual SRL and SSRL.

The second area (Panadero & Järvelä, 2015) is the need to implement interventions that promote SSRL. Until now, the vast majority of SSRL research has focused on characterizing how SSRL occurs, in other words, its ontology and development (e.g., Grau & Whitebread, 2012; Järvenoja & Järvelä, 2009; Iiskala, Vauras, & Lehtinen, 2004; Volet, Vauras, & Salonen, 2009). While a few researchers have made initial steps to implement techniques to enhance performance in collaborative activities (Janssen, Erkens, Kirschner, & Kanselaar, 2012; Järvelä, Järvenoja, Malmberg, & Hadwin, 2013; Volet, Summers, & Thurman, 2009), the study presented here goes a step further, namely, studying an intervention to enhance SSRL. The article proceeds with a discussion of the relation between SRL and SSRL.

Importance of Individual Self-Regulation

The influence of SRL in learning and performance is compelling (e.g., Dignath & Büttner, 2008) and has shown that SRL activates and influences different learners' strategies (i.e., cognitive, motivational, and emotional) to achieve their learning goals. SRL is divided into different phases of a process which is cyclical in nature: (a) *planning*—where learners analyze the task, choose strategies that best address a specific learning challenge, and set their learning goals; (b) *execution* (also practice)—where learners perform the task, adjust their plan while self-monitoring progress, and activate strategies to attend to it; and (c) *evaluation*—where strategies and results are evaluated with respect to the strategies used and results achieved (Panadero & Alonso-Tapia, 2014; Zimmerman & Moylan, 2009). It is cyclical in that feedback from the evaluation phase can start a subsequent SRL cycle (see Figure 1).

While there is an increasingly large corpus of research on how SRL influences individual learning (e.g., Cellar et al., 2011; Zimmerman & Schunk, 2011), there is no evidence on the influence of SRL on group learning and regulation. Two possible reasons lie at the basis of this. First, group regulation as research area is relatively new (Panadero & Järvelä, 2015). Second,

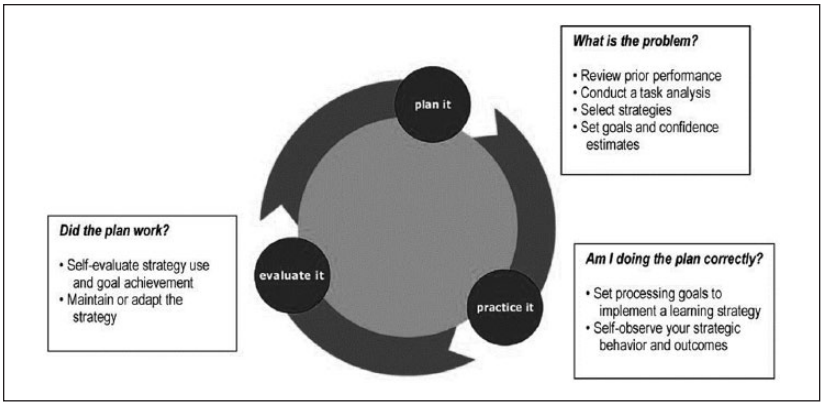

Figure 1. Self-regulated learning cycle.
Source. Adapted from "An enhanced formative assessment and self-regulated learning program: From the classroom to the workplace" by J. Finkelman, J. Hudesman, B. Flugman and S. Crosby, 2014, *Journal of Psychiatry Behavioral Sciences,* 1, p. 2. Copyright 2014 by Finkelman et al. Adapted with permission.

the focus of most research on regulation within groups has been on observable events that occur during collaboration. If we consider that certain individual characteristics such as knowledge and expertise (Dunbar, 1995; Hutchins, 1991, 1995; Müller, Herbig, & Petrovic, 2009), roles (Strijbos, Martens, Jochems, & Broers, 2004), and amicability (Phielix, 2012) have been shown to influence group performance, then it is an interesting next step to explore what the influence of SRL in the group joint activity is.

Importance of Group Regulation

Learning groups (i.e., teams of learners that work together on a task or problem with the goal of learning) are often not completely successful. One reason for this is that members of the group often lack necessary information about the other group members (Fransen, Weinberger, & Kirschner, 2013; Van den Bossche, Gijselaers, Segers, & Kirschner, 2006). In other words, there is no real group awareness. For a group to acquire and access that information (i.e., make it explicit and available to the members), the group and its members need to activate and make use of strategies at the group level to plan, monitor, and evaluate what both the individuals and the group are doing and how the work being done by the group is progressing. In other words, the group needs to regulate its learning at the group/social level. According to Järvelä and Hadwin (2013), shared regulation

> occurs when groups regulate as a collective such as when they construct shared task perceptions or shared goals. In this case, goals and standards are co-constructed, and regulation is distributed and shared with multiple ideas and perspectives being weighed and negotiated until consensus is met. (p. 28)

This shared regulation is crucial for success (e.g., DiDonato, 2013; Rogat & Linnenbrink-Garcia, 2011) and is carried out with respect to the cognitive, motivational, and emotional aspects of learning. For example, a group's emotional tone has been linked to its creativity (Shin, 2014).

As presented, Järvelä and Hadwin (2013) proposed a theoretical framework for three different types and three different levels of regulation that can occur while working as a group on a collaborative task. First, there is the individual level or SRL. Even when working within a group, individuals still need to activate their own personal strategies and will have their own personal goals that may or may not be aligned with or the same as the goals of the group (e.g., the group might want to get its task done as quickly as possible while a member of that group might want to deliver the best completion of the task). Second, co-regulated learning occurs at the group level when one group member promotes and/or influences another group member's regulation (e.g., when one group member has the role of chair and plans and coordinates what the others should do). Third, SSRL also occurs at the group level when group members jointly negotiate and determine the group actions (e.g., when the group works to arrive at a consensus with respect to its goals, strategies, processes, etc.). Research shows that SSRL can lead to better learning results than CRL (Grau & Whitebread, 2012; Janssen et al., 2012; Järvelä et al., 2013; Panadero & Järvelä, 2015; Volet, Summers, & Thurman, 2009).

SSRL, however, does not occur automatically. Simply providing opportunities for collaboration does not guarantee success (Dillenbourg, Järvelä, & Fischer, 2009) nor does it guarantee that SSRL processes will occur. To promote SSRL, we, as educators, need to intervene in the process and provide tools for facilitating and enhancing SSRL in the group which (a) cover the cognitive, motivational, and emotional aspects of the regulation and (b) take place during the planning, monitoring, and evaluating of the learning activity.

Features of Our Intervention

With this in mind, we tailored an existing CSCL tool for our purposes. The Virtual Collaborative Research Institute[1] (VCRI; Kirschner, Kreijns, Phielix, & Fransen, 2015; Phielix, 2012) is a feedback tool which has been shown to help the students learning in groups self-assess themselves and peer-assess their group members with higher accuracy, which in turn led to better collaborative work. Within

VCRI, we created two new functions (OurPlanner and OurEvaluator) to feed-forward group regulation and performance (Järvelä et al., 2015).

Aims and Hypothesis

The aim of this study was to (a) explore the relationship between SRL and SSRL and (b) intervene in the regulation process to promote SSRL. The hypotheses are as follows:

Hypothesis 1 (H1): A relationship between individual SRL and group regulation exists whereby better self-regulated learners will exhibit a wider array of learning strategies that could apply to the collaborative situation.
Hypothesis 2 (H2): Individual SRL skills will predict group performance as the individual strategies will be used in the joint activity.
Hypothesis 3 (H3): The intervention using the tailored VCRI environment will increase the use of shared regulatory strategies in the groups.

Method

Participants

A total of 103 first-year teacher education students (M_{age} = 24.2 years, SD = 2.2; 84.5% female, 15.5% male) at a large Finnish university participated in a 2-month course. The *multimedia as a learning project* course was compulsory for all students within the university's teacher education program. Participating in the research was part of the course as the research activities were embedded within the pedagogical framework.

Instruments

Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & Mckeachie, 1993) is a 7-point Likert-type scale (1 = *not at all true of me*, 7 = *very true of me*) designed to assess use of learning strategies and motivation of college students. It is composed of 81 items in two sections with a total of 15 scales with Cronbach's α ranging from .52 to .93. The learning strategy section includes 50 items organized in two second-order scales: 31 on (a) cognitive and metacognitive strategies, and 19 on (b) student management of learning resources. The other 31 items are divided into three motivation second-order scales: (a) value components, (b) expectancy components, and (c) affective components.

Motivational regulation strategies (MRS; Wolters & Benzon, 2013) measures the use of different strategies for the self-regulation of motivation in the form of a 7-point Likert-type scale (1 = *strongly disagree*, 7 = *strongly agree*). The instrument is composed of 31 items, some partially derived from MSLQ in six scales: (a) regulation of value (α = .91), (b) regulation of performance goals (α = .84), (c) self-consequating (α = .91), (d) environmental structuring (α = .77), (e) regulation of situational interest (α = .88), and (f) regulation of mastery goals (α = .88).

Academic Emotion-Regulation Strategies (AERS; see appendix) is an 18-item questionnaire (1 = *never use this strategy*, 7 = *always use this strategy*) created for this study to measure students' emotion-regulation strategies in individual and group situations using Boekaerts (2011) taxonomy: expressing emotions, suppressing emotions, denying or ignoring emotions, reappraising emotions, and asking for social emotional support. After an exploratory factor analysis, one-factor solution was taken (α = .817).

Intervention + Measurement Instruments

VCRI is a collaborative learning environment (Jaspers, Broeken, & Erkens, 2004) which contains the following features: *Radar* (a self-report tool individuals use in the group to share their cognitive, motivational, and emotional status before starting group work), *OurPlanner* (a shared planning tool for collaboration), and *OurEvaluator* (a shared evaluation tool for collaboration; Järvelä et al., 2015). These tools were meant to promote and measure SSRL within the groups. Radar is a spider-web diagram with six axes (see Figure 2). Each axis represents a 100-point Likert-type scale where group members report on five aspects related to their individual self-regulation and one related to the group work. The axes are as follows: (1) I understand the task, (2) I know how to do this task, (3) This task is interesting, (4) My feelings influence on my working, (5) I feel capable of doing this task, and (6) My group is capable of doing this task. OurPlanner consists of six open items aimed at facilitating group planning before starting to perform the activity, namely, (1) What is your group current task? (2) What is the purpose of the task? (3) What is your group goal for the task? (4) What you need to do to achieve that goal as a group? (5) What is your main challenge as a group? and (6) What are you going to do as a group to overcome this challenge? In this study, we use data from Questions 3, 4, 5, and 6. OurEvaluator focuses on evaluating what the group has been doing while performing the task. It is composed of seven open items: (1) How did your group work match the task purposes? (2) Did you achieve your goal as a group? If so: How? If not: Why not? (3) How did your group work to achieve that goal? (4) How did your

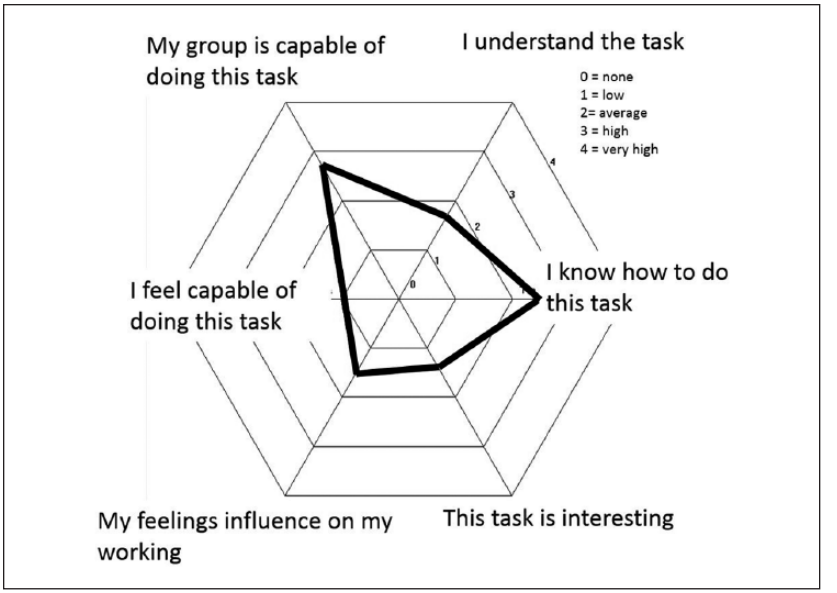

Figure 2. Radar.

group plan work in action? (5) What was your main challenge as a group? (6) What did your group do to overcome this challenge? and (7) Are you satisfied with your group work? In this study, we use data from Questions 2, 3, 5, and 6. We decided not to incorporate Questions 1 and 2 from OurPlanner and 1, 4, and 7 from OurEvaluator because the quality of the groups' answers were low (e.g., answers to Question 1 in OurPlanner: "We did what we were supposed to," "To perform the task"). Therefore, they were not good indicators for the groups' regulation.

Group goal regulation data. The data from Items 3 and 4 of OurPlanner and Items 2 and 3 of OurEvaluator were used to explore group regulation with respect to setting and achieving shared goals. In the two OurPlanner items, the groups reported what the goal for the task was and what strategies were needed to achieve them. In the two OurEvaluator items, they reported whether the goals were achieved and how they worked to achieve them. The four items were coded by three raters in the nine repeated measures (the 9 times the groups filled out OurPlanner and OurEvaluator). To create the coding of these four items, the raters discussed different categories for each item in two cycles; the categories for each item can be found in Table 1. First, the

Table 1. Categories in Each Group Goal Regulation Item.

OurPlanner Item 3 What is your group goal for the task?	(1) Finalize, (2) Collaboration, (3) Strategy use, (4) Learning purpose, (5) Practicality, (6) Time, (7) Performance goal, (8) Social goal, (9) Learning goals, (10) Other, (11) Final score.
OurPlanner Item 4 What you need to do to achieve that goal as a group?	(1) Finalize, (2) Collaboration, (3) Strategy use, (4) Creativity, (5) Practicality, (6) Other, (7) Final score.
OurEvaluator Item 2 Did you achieve your goal as a group? If so: How? If not: Why not?	(1) Achieved, (2) Collaboration, (3) Creativity, (4) Strategy use, (5) Learning, (6) Practicality, (7) Other, (8) Final score.
OurEvaluator Item 3 How did your group work to achieve that goal?	(1) Achieved, (2) Collaboration, (3) Strategy use, (4) Motivation, (5) Other, (6) Final score.

raters analyzed the content of the responses to the items independently to identify common categories and then discussed them. Second, using the new categories, each rater independently analyzed more responses to see how the codes fit the data and a second discussion was carried out to decide upon the coding that was later used. Those categories represented the occurrence of different aspects indicating group regulation (e.g., naming a goal of the collaboration, using strategies, activating learning goals). The different frequency categories were summed up in four final categories that quantitatively (as a scale-level variable) represented the quality of the group regulation for that particular item and occasion. The raters evaluated the quality of the answers with an interrater agreement (Cohen's kappa) ranging from .85 to .91, calculated over 33% of the data (three of the nine OurPlanners and OurEvaluators).

Challenge and strategy regulation data. The data from Items 5 and 6 of OurPlanner and OurEvaluator were used to explore expected challenges and the regulation of group strategy. In the OurPlanner items, the groups reported expected challenges and the strategies that they would need to overcome them, and in OurEvaluator, the actual challenges they faced and the strategies that they used. The four items were analyzed by two raters in the nine repeated measures (the 9 times the groups filled out OurPlanner and OurEvaluator). To analyze the groups' identification of challenges (Item 5 in OurPlanner and OurEvaluator) and the groups' reported strategies to overcome the challenges

(Item 6 in OurPlanner and OurEvaluator), the reported challenges were coded into the following categories: (1) no challenge, (2) cognitive challenge, (3) motivational challenge, (4) time management challenge, (5) environment and technology challenge, and (6) social challenge. The different frequency categories were summed in four final categories (i.e., Items 5 and 6 of OurPlanner and OurEvaluator) that quantitatively (as a scale-level variable) represented the quality of the group regulation for that particular item and occasion. The interrater agreement (Cohen's kappa) for the four items ranged from .74 to .89, calculated over the 100% of the data.

Group performance. The groups were required to write a final essay about "threats and possibilities of technology in teaching and learning." To assess group performance, the instructor first provided a coding scheme for the essays and then rated them accordingly on a scale of 1 to 10. Then, a second independent rater evaluated 56% of the essays using the same coding scheme. Kendall's tau for the correlation between raters was .731. This teacher's score was later used to decide whether the students passed or failed the course, which were the only two options.

Procedure. The *multimedia as a learning project* course, where the intervention was implemented, consisted of nine sessions, each divided into a face-to-face and an online phase. Before the course began, students completed the MSLQ, MRS, and AERS questionnaires.

The students worked in groups of three to four members (31 groups) using the tailored VCRI environment as a platform to promote group regulation and measure it through the traces the groups left there (i.e., the answers to the different items from OurPlanner and OurEvaluator; see Figure 3). During the course, each group member filled out the Radar 18 times, one at each face-to-face and online phases of the nine sessions. Then each group used the Radar results (the different Radars were visible for the group) to detect students who were experiencing problems with the task (e.g., lack of motivation). At the same time, they used OurPlanner at the beginning of each face-to-face session to plan the activity (e.g., goals, strategies to use, etc.) for a total of 9 times. Then, the groups performed the face-to-face part of the task and, at a different time, moved to the online phase by which where they filled out OurEvaluator, for a total of 9 times to evaluate how well they did. At the end of the course, each group wrote their final essay, which reflected their major conclusions from the lectures and that was used to evaluate the groups' performance. An important characteristic of this course is that it was completed an either pass or a fail final grade.

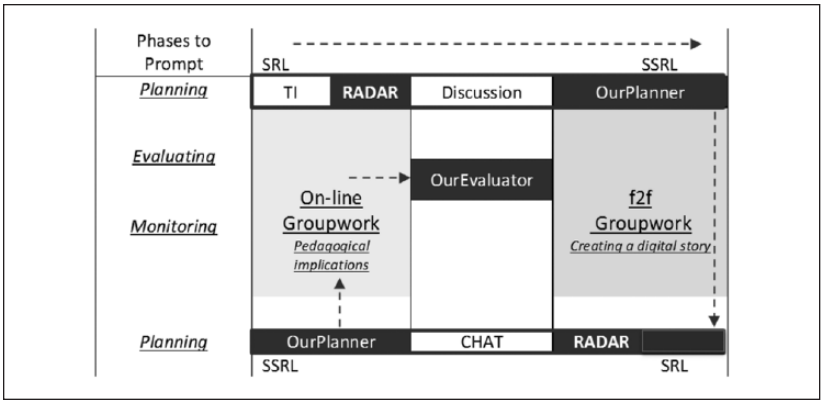

Figure 3. Intervention procedure for f2f and online phases.
Note. SRL = self-regulated learning; SSRL = socially shared regulation of learning; TI = teacher instructions; f2f = face-to-face.

Data Analyses

Multilevel analysis is the recommended statistical procedure for collaborative learning situations (Janssen, Cress, Erkens, & Kirschner, 2013). Two types of multilevel structure were used. First, to explore the influence of individual SRL in SSRL (H1) and group performance (H2), multilevel analysis was calculated using as dependent variables *group goal regulation* (the four scale-level variables created from OurPlanner Items 3 and 4, OurEvaluator Items 2 and 3), *challenge and regulation* for those challenges (the two scale-level variables created from the Items 5 and 6 from OurPlanner and OurEvaluator), and the *group score in the final essay*. As covariates for the multilevel analyses, group number and individual SRL skills (MSLQ, MRS, and AERS total scores) were used. Therefore, in terms of the nesting structure, the individual SRL (Level 1) was nested within the group number (Level 2). The individual SRL scores were centered using the group mean as our primary interest was in analyzing data in association with the variables measured at Level 1 (Field, 2013). The group numbers did not need to be centered as they were nominal type of variables (e.g., Group 1, Group 2).

The second type of multilevel structure used was growth model. Here the goal was to explore whether the intervention was successful (H3), and therefore, the occasion of measure was used as covariate. The multilevel analysis was carried out with Radar and the eight items from OurPlanner and OurEvaluator as dependent variables. The covariates were the group number and the occasion of measurement. In terms of the nesting structure, the different

occasions of measurement (Level 1) were nested within the group number (Level 2). Data needed to be restructured to conduct the growth model multilevel analyses (Field, 2013). Therefore, the eight items from OurPlanner and OurEvaluator, in addition to Radar, were restructured to run these analyses. The occasion of measure was centered at the zero point of the intervention (Time 1).

With respect to missing data, Radar was the most affected variable as it depended on the actions of the individual members of the groups; 52% of Radar data were not reported. It was decided to not use a computational technique to fill in the missing data as some of the students did not have more than 3 or 4 entries of the total 18. As there were equal quantities of data missing for groups with members that had low and high SRL—as measured using MSLQ, MRS, and AERS—there was no significant bias on the lost data, allowing analyses to be conducted with the existing Radar data.

Results

Individual SRL as Predictor of Group Regulation

Individual SRL (MSLQ, MRS, and AERS) and group goal regulation. Individual SRL skills were measured computing the total scores on MSLQ, MRS, and AERS. Four multilevel analyses were computed, one for each OurPlanner and OurEvaluator items included in this variable, using as dependent variable the final score category, MSLQ/MRS/AERS as covariates, and group number as the variable under which individual scores were nested (see Table 2). Individual scores in MSLQ was a significant predictor for the groups' goal regulation using OurPlanner while individual scores in AERS was a significant predictor for groups' goal regulation using OurEvaluator. Groups with higher self-regulated members as measured by MSLQ showed higher levels of group goal regulation while planning the tasks. In other words, those groups with higher levels plan more goals covering more categories (e.g., collaboration, practicality, etc.) and more advanced strategies to achieve those goals. Groups with members that had a higher emotional regulation as measured by AERS showed higher levels of group regulation strategies use as reported in OurEvaluator after performing the tasks. In other words, they reported having more different types of goals and having used more advanced strategies to achieve those goals.

Individual SRL (MSLQ, MRS, and AERS) and challenges identified and regulation. For this, two items from OurPlanner and two from OurEvaluator were used. Four multilevel analyses were computed, one for each OurPlanner and OurEvaluator items included in this variable, using as dependent variable the

Table 2. Estimates of Fixed Effects for Individual SRL (MSLQ, MRS, and AERS) and Group Goal Regulation.

	Outcome variable							
	OurPlanner Item 3		OurPlanner Item 4		OurEvaluator Item 2		OurEvaluator Item 3	
	What is your group goal for the task?		What you need to do to achieve that goal as a group?		Did you achieve your goal as a group? If so: How? If not: Why not?		How did your group work to achieve that goal?	
Variable	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Intercept	−2.12	7.18	−2.06	7.81	18.96***	4.24	15.35**	5.60
MSLQ	.065***	0.020	.071***	0.022	−.012	0.012	−.007	0.016
MRS	.047	0.032	.050	0.035	.001	0.019	.007	0.025
AERS	.019	0.054	−.019	0.058	.103***	0.032	.125**	0.042

Note. SRL = self-regulated learning; MSLQ = Motivated Strategies for Learning Questionnaire; MRS = motivational regulation strategies; AERS = academic emotion-regulation strategies.
*$p < .05$. **$p < .01$. ***$p < .001$.

final score category, MSLQ/MRS/AERS as covariates, and group number as the variable under which individual scores were nested (see Table 3). As happened with group goal regulation, MSLQ and AERS were significant predictors for the challenges identified by the groups and the strategies they activated to overcome those challenges. Group with members that reported higher level of emotional regulation in AERS identify more potential challenges in OurPlanner before starting the task and after the task in OurEvaluator. Groups with higher self-regulated member (MSLQ) activated significantly more strategies to overcome those challenges as reported in OurEvaluator and almost significantly ($p = .065$) planned to use more strategies in OurPlanner.

Summing up the results in these two areas, the hypothesized relationship between the members' individual self-regulation skills and the group regulation is supported. Groups with higher self-regulated members showed higher levels of socially shared regulation (SSRL) at the group level.

Individual SRL as Predictor of Group Performance

Individual SRL skills were measured computing the total scores on MSLQ, MRS, and AERS. Performance was computed using the score given to each

Table 3. Estimates of Fixed Effects for Individual SRL (MSLQ, MRS, and AERS) and Challenges Identified and Regulation.

	Outcome variable							
	OurPlanner Item 5		OurPlanner Item 6		OurEvaluator Item 5		OurEvaluator Item 6	
	What is your main challenge as a group?		What are you going to do as a group to overcome this challenge?		What was your main challenge as a group?		What did your group do to overcome this challenge?	
Variable	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Intercept	5.400	5.664	−.215	5.773	6.724	5.273	−6.920	6.238
MSLQ	−.012	0.015	.029†	0.016	−.011	0.014	.038*	0.017
MRS	.031	0.024	.007	0.024	.025	0.022	.029	0.026
AERS	.093*	0.041	−.004	0.042	.080*	0.038	.010	0.045

Note. SRL = self-regulated learning; MSLQ = Motivated Strategies for Learning Questionnaire; MRS = motivational regulation strategies; AERS = academic emotion-regulation strategies.
†$p = .065$. *$p < .05$. **$p < .01$. ***$p < .001$.

group final essay. A multilevel analysis was calculated using performance as dependent variable, MSLQ/MRS/AERS as covariate, and group number as the variable under which the individual scores were nested. The relationship between group performance and different individual SRL skills (as measured via MSLQ, MRS, and AERS) did not show significant results (MSLQ $p = .312$; MRS $p = .229$; AERS $p = .948$). Therefore, H2 that SRL would be a predictor of group performance has to be rejected.

SSRL Intervention Effects

First, it was explored whether there was a different use of Radar along the intervention. It could have been expected that our intervention would promote an increase in Radar scores as the group members would have gained more insights about, both, their own processing and that of the group. One growth model analysis (linear trend) was run using as dependent variable the 18 different Radar measures averaged in one score per occasion (i.e., Radar is compounded of six items that were averaged in one value). The Radar data were centered considering Occasion 1 as the zero point. There was no statistically significant variance ($p = .79$) attributable to the effect

Table 4. Time Intervention Effects on SSRL as Measured Via OurPlanner and OurEvaluator.

Outcome variable	*p* value
OurPlanner	
Item 3: What is your group goal for the task?	.76
Item 4: What you need to do to achieve that goal as a group?	.64
Item 5: What is your main challenge as a group?	.34
Item 6: What are you going to do as a group to overcome this challenge?	.24
OurEvaluator	
Item 2: Did you achieve your goal as a group? If so: How? If not: Why not?	.09
Item 3: How did your group work to achieve that goal?	.11
Item 5: What was your main challenge as a group?	.35
Item 6: What did your group do to overcome this challenge?	.22

Note. SSRL = socially shared regulation of learning.

of time, implying that the average reported use of Radar did not change across time.

Second, using the data from the eight selected questions from OurPlanner and OurEvaluator, eight growth model analyses (linear trend) were carried out, using the quality of the different groups' answer to the eight questions as dependent variable and time of measure and group number as covariates. The data for the eight questions were centered considering Occasion 1 as the zero point. There was no statistically significant variance attributable to the effect of time in any of the eight questions, implying that the average reported use of OurPlanner and OurEvaluator did not change across time (see Table 4). Therefore, H3 that our intervention would promote SSRL had to be rejected.

Discussion

The research aim was twofold: (a) to explore the effect of group members' individual SRL skills on group regulation and performance and (b) to test whether the intervention to promote SSRL would be successful.

With regard to the relationship between individual and group regulation (H1), results show that the relationship exists. Individual SRL, as measured via MSLQ and AERS, predicted group regulation as measured via OurPlanner and OurEvaluator. Groups that had better individual self-regulators showed

higher levels of group regulation. The latter was shown, on the one hand, by groups establishing more advanced goals and strategies to achieve those goals, and on the other hand by groups identifying more challenges and activating more strategies to regulate or overcome these. Currently, there are research findings dealing with peers' and other-regulation, conceptualized as efforts by one student to regulate their group's work. Rogat and Adams-Wiggins (2014) findings suggested that directive other-regulation resulted in moderate-low and low-quality regulation within the group. Schoor and Bannert (2012) found no difference between high-achieving and low-achieving dyads in the frequencies of regulatory activities.

There is an additional aspect to discuss in the relationship between MSLQ and AERS and group regulation. MSLQ and AERS were found to be significant predictors of group regulation in different questions from OurPlanner and OurEvaluator. MSLQ is an individual SRL questionnaire which emphasizes cognitive and metacognitive skills in addition to motivation, whereas AERS focuses exclusively on emotion regulation (both individual and in group situations). Therefore, they explore distinctly different aspects of SRL that predicted different aspects and phases of our intervention. Firstly, MSLQ was a predictor for group goal planning and AERS was a group goal evaluation. Here it seems that more advanced cognitive and motivational skills are better when groups establish their goals, and emotion regulation when they are analyzing goal achievement. Secondly, when it came to challenges and strategies used to overcome them, MSLQ was a predictor for the strategies students used to overcome challenges and AERS to identify challenges. A tentative conclusion, due to the lack of previous evidence on this matter, could be that individual (meta)cognitive and motivation skills are more important when groups plan their goals and establish strategies to overcome challenges, while individual and group emotion-regulation skills are more important when evaluating the achievement of the group's goals and identifying challenges. However, this conclusion is preliminary, and future research should explore this further.

With regard to the relationship between individual SRL and groups' performance, the results do not support H2. There is, however, an important limitation: The performance as measured here was not a strong indicator as it was based on only one essay (graded on a scale from 1 to 10) in a one-semester course that could only be given a grade of pass or fail as a final score. This affected the reliability and validity of the measure itself as the score for the essay was not a good representation of the group work. There is, however, a corpus of empirical evidence to support the initial hypothesis that individual self-regulation affects group performance. First, there are studies in which students who show higher SRL exhibit better performance and learning in

individual tasks (e.g., Panadero, Alonso-Tapia, & Huertas, 2012; Panadero & Romero, 2014; Zimmerman & Kitsantas, 2014). Second, there are studies in which groups that use more group strategies (e.g., planning, monitoring) exhibit higher group performance (e.g., Janssen et al., 2012; Volet, Summers, & Thurman, 2009). Therefore, as our first results show that groups with higher self-regulated learners showed higher group regulation, we are confident that if the performance measure had been stronger, then those differences would have been reflected in group performance. In any case, the relationship between individual SRL and socially shared regulation in one hand and group performance in the other could be more complex than initially expected, with both types of regulation modulating each other influence on group performance. For example, it probably takes more than just self-regulated individual members to have a socially shared regulated group because a team is more than people working in the same place and time (Van den Bossche et al., 2006).

With regard to our intervention and if it was successful in promoting group regulation (i.e., that the tailored VCRI environment would enhance group regulation), H3 has to be rejected. Results from Radar, OurPlanner, or OurEvaluator showed no significant effects on socially shared regulation over time. Two crucial factors for this lack of effect might have been the lack of modeling and not following-up on the use of the tools. Regarding modeling, the groups were told how the tools work but not how to use them to take advantage of them and further develop their regulatory activities. It seems as though the groups that had better self-regulated members were also the ones using the tools more advantageously, according to our data. Regarding following-up, the tools were only explained to the students in the first session of the course, but no feedback was given to them about how the students used them any later. Perhaps the groups developed strategies that they thought were adequate to cope with the task demands at the earlier stages of the course, so there was no real need to develop or fine-tune strategies for their group regulation as the nine collaborative tasks had a similar structure. This should have been more carefully controlled in our design.

Finally, there is one additional limitation to consider in our intervention with respect to Radar. In contrast with Phielix, Prins, Kirschner, Erkens, and Jaspers (2011) who used Radar both to let group members evaluate themselves (i.e., self-assessment) and the others (i.e., peer assessment) in the group, in our intervention, students only evaluated themselves using Radar based on their own projected performance (i.e., Radar was filled out prior to performing the task). It was, thus, not possible for the students to compare their ratings with an external evaluation, with others, or even with their own evaluations after each task to determine how accurate their ratings were. With

neither reflection nor comparison, the students might not have gained any insight from this tool, and therefore, no effect of the intervention could have been found for Radar data.

What can we extract from previous research to explain our results? There is a sizable corpus of research that shows successful interventions promoting either individual SRL skills (e.g., Dignath & Büttner, 2008) or group regulation (Janssen et al., 2012). More precisely, there is research that points out the efficacy of the VCRI environment (Phielix, 2012; Phielix et al., 2011). The VCRI environment was, however, not designed to specifically support socially shared regulation processes but rather group regulation processes which can be co-regulation or socially shared regulation type. Actually, our intervention is the first attempt to promote SSRL tailoring and modifying successful tools for group regulation. The next step is to leverage the group regulation support to metacognitive processes implementing feedback and modeling during the implementation, so that group members can learn to use the tools to increase their socially shared regulation (SSRL; Hadwin et al., 2011; Panadero & Järvelä, 2015).

Future Research

In the future, research should include online measures of the group regulation to provide detailed information of their processing activities. It would be of major interest to compare online measures of individual SRL with online measures of group regulation (SSRL). One viable approach would be measuring online SRL using traces (e.g., using *gStudy*; Winne et al., 2006) and then create groups accordingly, exploring groups' performance in a similar task.

A second line of research relates to group composition. Future research should consider how differences in individual SRL in groups might affect the processes and products of the collaboration as well as creating more balanced learning groups (Panadero & Järvelä, 2015). Therefore, future studies could create the groups attending to different profiles (e.g., high, average, and low self-regulators) exploring what are the differences in groups' regulation and performance.

Conclusion

This study represents a first exploration of the connection between individual self-regulated skills and group shared regulated skills and at the same time trying to intervene to promote the latter. One of the conclusions is that the relationship between SRL and SSRL is multifaceted and that there is need for

more research, but our results point out that there is a relationship between them and students with higher individual SRL use more advanced shared regulation strategies while working in groups. This holds important implications for the composition of the groups that future research needs to clarify controlling the formation of the groups. The second conclusion is that, though our intervention had limitation that impeded the promotion of shared regulation, intervening to promote SSRL is a much needed area for research that could prove fruitful results if, as suggested earlier, researchers leverage group regulation to support metacognitive processes implemented via feedback and modeling.

Appendix

Academic Emotion-Regulation Scale (AERS)

Could you report how often you do the following in regard to emotions triggered in relation with academic life? 1 = *I never use this strategy*, 7 = *I always use this strategy*.

Expressing my emotions so that anyone can notice how I feel
When I have positive emotions
When I have negative emotions
Working in a group when I have positive emotions
Working in a group when I have negative emotions
Suppressing or hiding my emotions
When I have positive emotions
When I have negative emotions
Working in a group when I have positive emotions
Working in a group when I have negative emotions
Denying or ignoring my negative emotions or what may trigger them
How often
Working in a group
Re-appraising the situation
To increase positive emotions
To reduce negative emotions
Working in a group when I have positive emotions
Working in a group when I have negative emotions
Asking for social support (peers, teachers, parents)
When I have positive emotions
When I have negative emotions
Working in a group when I have positive emotions
Working in a group when I have positive emotions

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Note

1. http://edugate.fss.uu.nl/~crocicl/vcri_eng.html

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