Effective Regulation in Collaborative Learning: An Attempt to Determine the Fit of Regulation Challenges and Strategies

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Abstract: University students often self-organize in groups for collaborative exam preparation. To learn effectively, they need to regulate emerging learning challenges through the choice of fitting strategies. So far, little is known about what strategies fit which challenges. We present a theoretical account for the definition of fit between regulation challenges and strategies in collaborative learning, thereby differentiating between direct and indirect strategies, and test its validity in an empirical study. We asked 163 university students in 90 groups to rate the challenges they encountered in their self-organized group meetings, and to report strategies by aid of which they regulated their biggest challenge. Answers were coded into 26 strategy types. We found that students mostly used strategy types that directly address their biggest challenges. Multilevel-modelling indicated that direct strategies are associated with higher satisfaction for coordination- and comprehension-related challenges only, but not for motivational challenges.

Keywords: regulation challenges, collaborative learning, regulation fit, exam preparation, self-regulated learning

Problem statement

Many university students choose to prepare for exams in groups. Potential benefits of this are to maintain one's own discipline or to improve one's own understanding by discussing learning material (Järvenoja, Volet, & Järvelä, 2013). Yet, groups often face coordination-related, motivational, or comprehension-related challenges. When such challenges are not regulated, group members may be dissatisfied and reach poor group outcomes (Freeman, 1996). However, little is known about what strategies actually fit what kinds of challenges that may occur during collaborative learning and how their application relates to learners' satisfaction with their learning process. We (a) provide a theory-based analysis of the fit between learning challenges and regulation strategies and (b) investigate whether this fit is predictive for learners' satisfaction with their group learning experience.

Theoretical Background

Types of challenges

We propose that most challenges that may occur during collaborative learning fall into one of the following three categories: (a) coordination between group members, (b) motivational aspects, or (c) comprehension of learning topics and materials. *Coordination-related challenges* may arise when group members set different priorities in learning the exam contents, or when they set different learning goals (Järvelä & Järvenoja, 2011). *Motivational challenges* may emerge when group members, for example, cannot find interest in the exam topics. Finally, *comprehension-related challenges* may arise when groups have too little subject-specific prior knowledge, or when the learning material is structured in a confusing way. For successful exam preparation, learners need to effectively regulate these challenges. So far, studies (e.g., Malmberg, Järvelä, Järvenoja, & Panadero, 2015) have tried to predict the regulatory success by the quantity or quality of strategy use. Yet, in line with theoretical models of self-regulated learning (e.g., Zimmermann & Moylan, 2009), we additionally suppose that in order to be effective, there is the need for a chosen strategy to match the specific challenge at hand.

Strategy fit

The fit of strategies to challenges has been described as an important factor that influences the success of learning regulation (Engelschalk, et al., 2015). Nevertheless, in collaborative learning, research about which strategy types are effective in what situation, i.e., what strategy types "fit" a given challenge, is scarce. Therefore, in this paper, we make an attempt to determine the appropriateness of specific strategy types to regulate specific coordination-related, motivational, and comprehension-related challenges.

We firstly assume that in a given situation some strategies may fit a current regulation challenge better than others. In one situation, group learners might for example differ in their ideas on how to proceed with the task (= a specific coordination-related challenge): One group member might want to recapitulate a topic that was already covered by the group, while other group members might prefer to improve their comprehension of a new topic. Now the group needs to react to the challenge by choosing a regulation strategy. It could, for example, apply a motivation strategy like planning to reward themselves after the learning session, or it could discuss these divergent plans and find an agreement on how to proceed. For the given situation, the latter strategy seems to be more effective to overcome the given challenge than the aforementioned strategy because it aims at directly eliminating the challenge. At least, communicating own plans and intentions is necessary to negotiate the further and joint proceeding (= to resolve the challenge). This does not mean at all that the reward strategy necessarily is inappropriate in this learning situation as a whole. Actually, it might support learning at a more general level because it might address different (motivational) problems that might be present in the same learning situation simultaneously. Nevertheless, it would rather not or not effectively help to dissolve the specific challenge of divergent plans. Hence, strategies that can help to *directly* eliminate a given challenge might be more likely to result in effective regulation than strategies that might support the learning process in a different, but non-direct way that leaves the central challenge itself unaffected. Thus, we regard the choice of strategies that directly aim at eliminating the challenge as "fitting".

Other challenges, e.g., "distraction", can be overcome by multiple strategy types. In this case, specific resource-oriented strategies (e.g., controlling the environment to reduce external stimuli), metacognitive strategies (discussing how to organize learning to hinder distraction), or a selection of motivational strategies (e.g., making the topic more fun to learn, i.e. increasing situational interest; see Table 1) seem promising, as they all address the problem in a direct manner (e.g., when any of these strategies is applied successfully, the problem should disappear). We assume that the amount of strategy types considered as being effective varies with the specificity or globality of the perceived challenge: Coordination-related and comprehension-related challenges seem more specific, thus less strategy types directly address them. Motivational challenges are more global and thus can be addressed by more different strategy types. Table 1 provides an overview about which strategy types theoretically can be considered to directly regulate different kinds of regulation challenges based on the considerations above.

Relation of adaptive strategy use and satisfaction with the learning experience

One (among several) way(s) to determine the effectiveness of specific regulation strategies is through measuring learners' satisfaction with the overall learning experience. This assumption can be derived from the cyclic phase model of self-regulated learning (Zimmerman & Moylan, 2009): In terms of this model, satisfaction is a self-reaction which depends on the goals that were set in the beginning of a learning activity (or the evaluation standards in the model of Winne, Jamieson-Noel, & Muis, 2001). Concerning self-initiated study groups in preparation for an exam, one may assume that the main goal these students set for their meetings is to learn effectively (and eventually to receive good grades). Thus, the (subjectively) acquired knowledge that is accumulated during collaborative learning may be understood as a measure for learning success in the self-reflection phase. If the goals/standards are met, satisfaction should result.

Even though the assumption that regulation strategies need to fit the regulation challenges to yield effective learning is immanent in models of self-regulated learning, it has rarely been empirically tested. In one study, Järvelä, Volet, and Järvenoja (2010) filmed the regulatory activity of 63 teacher education students during collaborative learning tasks, and had participants rate the perceived intensity of various emotional challenges they experienced during group work as well as their satisfaction with their group learning process. Using qualitative analyses, they showed that one group demonstrated effective social and self-regulation of different challenges, and, at the same time, rated its group learning as "relatively satisfactory" up to "very satisfactory". Even though this study investigated regulation fit only for emotional challenges, it suggests a link between the problem-specific fit of regulatory strategies and learners' satisfaction with the learning experience. If we find that learners who apply strategies that based on our theoretical analysis directly address their challenges are more satisfied with their learning than those learners who apply other strategies, this result could be regarded as evidence that is in line with our theoretical assignment of strategies to challenges.

Research questions and hypothesis

We ask the following research questions: To what extent do group learners use strategies that directly address a reported challenge compared to other strategies (RQ 1)? Can this extent be considered to be sensitive to the challenge type, i.e., is it more likely that direct compared to other strategies are chosen (RQ 2)? Are learners who apply direct strategies more satisfied with their learning than those who used other strategies and do differential effects depend on the problem type being regulated (RQ 3)? RQ 1 and RQ 2 will be answered in an exploratory

Table 1: Specific strategy types for direct regulation of specific coordination-related, motivational, and comprehension-related challenges

Specific challenge	Strategies directly addressing the challenge				Strategy example
	Cog-nitive	Metacog-nitive	Motiva-tional	Re-source-oriented	
Coordination-related Challenges					
A. The group members have different goals for the meeting.		PRL		EM	PRL: "I advised her to take a closer look at it at home, as I do not want it that much in detail."
B. The group members seem to have incompatible working styles.		PRL			PRL: "I gave them tips for learning."
C. The group members seem to have different communication styles.		PRL			(No examples available)
D. The group members understand concepts / tasks differently.	RDU	PRL			RDU: "I have justified my conception of the task. "
E. The group members have different ideas on how to proceed with the task.		PRL			PRL: "We discussed how we want to proceed."
F. The contributions of individual group members are differently strongly considered.				EM	(No examples available)
G. Not every group member always dares to participate.			ASI	EM	EM: "I participated in the study group."
I. Not all group members have enough time for the meeting.				TMC, KIM, AM	TMC: "I tried to use the time as effectively as possible through targeted questions."
Motivational Challenges					
H. The group has distraction problems.		PRL	SIT, DSG, ACC, FC	EC, AM	EC: "I have asked my classmates to turn off all phones."
K. The group members have motivational problems.			RS, SIT, IPS, LPS, ASI, DSG, AFC, HUG, ECG, UMS		RS: "I told her that there is only little content left and that we have already done most of the work"
M. The group members consider the study material to be boring.			RS, SIT, IPS, LPS, DSG, AFC, HUG, ECG		ESG: "Tried to keep them at it."
Comprehension Challenges					
J. The group members have only low prior knowledge of the learning contents.	SIC, CGP, ERM				SIC: "The mutual explanations were helpful for the whole group"
L. The group perceives the learning material as difficult.	ORR, SIC			TMC	SIC: "Tried to together clarify unclear contents"
N. The group members perceive the study material as confusing.	ORR, SIC				ORR: "We have created a mind map to structure the topic."

Note. *Cognitive*: Organizational / Knowledge Reduction Strategies / Knowledge Recall Strategies (ORR), Strategies for Improving Comprehension (SIC), Strategies for Closing Gaps in Prior Knowledge (CGP), Strategies to Resolve Differences in Understanding (RDU), Surface-oriented strategies / Knowledge Retention Strategies / Consolidation Strategies (SRC)
Metacognitive: Planning and Regulation of the Learning Process (PRL), Reflection and Evaluation of the current state of Knowledge (REK)
Motivational: Reward Strategies (RS), Increasing Situational Interest (SIT), Increasing Personal Significance (IPS), Learning and Performance-related Self-instruction (approach and avoidance) (LPS), Ability-related Self-Instruction (ASI), Declaring Successful Self-control as Goal (DSG), Accentuating Frame Conditions or Constraints (AFC), Highlighting Group Utility as a Goal (HUG), Emotional Contagion (ECG), Unspecific Motivational Strategies (UMS)
Resource-oriented: Time Management and Coordination (TMC), Environmental Control (EC), Knowledge and Information Management (KIM), Attention Management (AM), Effort Management (EM), External Resource Management (ERM), Care of the Social Atmosphere (CSA).

fashion. With regard to RQ 3, we hypothesize that learners who apply direct strategies to remedy their biggest regulation challenge are more satisfied with their group learning than students who use other strategies. Yet, we additionally explore whether there are differential effects of the problem type, i.e. that direct strategies are only related to satisfaction when addressing certain, but not other kinds of challenges.

Method

Sample

Participants were $N = 174$ university students (74.29% female, 25.14% male, 0.57% other) belonging to 90 self-organized study groups. They had an average age of 22 years ($M = 22.26$, $SD = 2.68$) and were, on average, in their 5th semester ($M = 4.64$, $SD = 3.03$) of their current studies and in their 6th ($M = 6.21$, $SD = 3.85$) semester of studies in general. Participants were enrolled in various study programs (e.g. teacher education, law, mathematics, computer science) at different German universities. The number of students per group participating in the study ranged from 1 to 5, with two participating group members being the most frequent fraction (23.27%). After each group meeting, participants were asked to (individually) answer an online questionnaire. Participants were reimbursed with 14 € if they filled in the questionnaire 3 times. For each additionally completed questionnaire, they received an additional 2.50 €. The maximum was 10 questionnaires (35 €).

Instruments

Questionnaire

The used questionnaire was a modified version of the Adaptive Instrument for Regulation of Emotions ("AIRE"; Järvenoja & Järvelä, 2009). It asked for the experience and regulation of coordination-related, motivational, and comprehension-related challenges during the current group meeting. Participants first were asked to rate on a five-point scale (1= "does not apply at all", 5= "does squarely apply") how intensively they experienced each of the 14 listed challenges during their group meeting (see Table 1). Then, they should mark their biggest of those 14 challenges and describe it briefly. This was followed by an item that asked students to rate their satisfaction with the respective group meeting on a seven-point rating scale (1= "totally unsatisfied", 7= "totally satisfied"). In the end, participants were asked to enter strategies they used to regulate their biggest self-categorized challenge at the self-, co-, and shared level in an open answer format (e.g. self: "What did you personally think, do or say to ensure high quality of your own learning in this situation?", co: "…of the learning of individual others", shared: "…of the learning of the group as a whole"; Järvelä & Hadwin, 2013).

Coding procedure

After data collection, a coding scheme to classify learning strategies was developed, based on established schemes of Mandl and Friedrich (2006), and of Engelschalk et al. (2015). It contained 26 categories: Twenty-four specific strategy types (see "Note" in Table 1 for a complete list), one residual category for unspecific strategies, and one category when no strategy was provided. Trained coders' categorization yielded a sufficient interrater agreement (Cohen's $\kappa = .85$). After coding, a binary "fit" variable was generated by assigning the values 1 or 0 based on the aforementioned theoretical scheme (1 if a person mentioned at least one strategy directly addressing the perceived biggest challenge, 0 if only other strategies were mentioned; see Table 1 for details about which strategies theoretically match which challenges).

Analysis

To answer RQ 1, we calculated absolute and relative frequencies of the use of the different strategies (together with 95% confidence intervals) and visualized them with a decision tree (see Figure 1). Concerning RQ 2, we added ratios "R" for each challenge type: To give an impression of how to interpret the magnitude of the relative frequencies of strategies directly addressing a challenge to other strategies (= whether regulation is adapted to a specific challenge), we calculated ratios of the empirical to the theoretical relations of direct and total strategy use. The theoretical relation signifies the probability to choose a direct strategy, if a random distribution across all strategy categories was assumed, weighted with the average number of strategies reported for each challenge type. In summary, this ratio expresses the empirical probability that a person directly addresses a specific challenge qualified by what would be expected if there was no adaption in the choice of regulation strategy to a challenge at all. Values above 1 signify that more participants actually chose direct strategies than one would expect under the assumption of random distribution of strategies, whereas values below 1 signify that less participants chose direct strategies than one would expect if there was no adaption to challenge. The deviation from 1 was tested by asymptotical X^2-tests.

To test if choosing a strategy type that fits a current challenge increases the satisfaction with learning (Hypothesis 1), hierarchical linear modelling using R (reml estimation) was conducted. Data was analysed using a three-level data structure (group meetings, persons, groups; Singer & Willett, 2003). Students' satisfaction with their learning and group differences were estimated by specifying the *unconditional means model* where satisfaction with learning is independent of predictors. Nevertheless, we allowed for random variations in satisfaction between groups and individuals in groups (random parameters r_0, u_{00}). We z-standardized the satisfaction variable to interpret differences in satisfaction in units of standard deviation. General development of students' satisfaction with their learning across group meetings and group differences in these developments were estimated by specifying the *unconditional growth model*. In this model, satisfaction with learning is modeled as dependent on the number of learning sessions (γ_{001}). This time effect is allowed to vary randomly between individuals and between groups (random parameters r_0, u_{00}). The group meeting was coded by number to approximately interpret the parameters of the time variable as changes per meeting (approximately because some groups already existed before our study). Then, we specified a *fit model* that included the effects mentioned above and additionally the effect of the fit between the challenge and strategy type on satisfaction. The fit variable was included as a fixed effect because there is no plausible argument for random variation over groups and individuals in groups. Last, we added the *interaction of fit and problem type* to the last model.

Results

Preliminary analysis

We first looked at whether the types of challenges we presented to participants actually fell into the three assumed categories "coordination-related", "motivational", and "comprehension-related" challenges. To judge this, we used the individual ratings to what extent the 14 challenges actually occurred in the group in exploratory and confirmatory factor analyses. The EFA supported the choice of 3 factors as the optimal factor structure by 3 (out of 9, 33.33%) methods (Optimal Coordinates, Parallel Analysis, VSS Complexity 2). A further CFA indicated a superior model fit for the three-factor structure compared to theoretically plausible one- or two-factor structures. However, the overall model fit was not optimal ($\chi2=2965.899$, $p< .001$, $\chi2/df =32.59$, CFI=0.89, RMSEA=0.07, SRMR=0.06). Since the following calculations are performed separately for each specific challenge, and grouping into larger problem dimensions was used for clarity of visualization only, the decision for a three-factor structure did not pose a problem for later analyses.

Distribution of fit between learning challenges and regulation strategies

Concerning RQ 1, Figure 1 shows the transition probabilities with which participants who encountered a specific challenge type chose a direct strategy. It also provides information on whether a larger or smaller proportion of participants regulated a specific challenge with a direct versus with other strategies. It can be seen that direct strategies were more frequent than alternative strategies across all types of challenges except for "boring learning material" for which the confidence interval includes equal frequency (50%). Overall, these results suggest that students predominantly choose strategy types for directly controlling specific challenge types, indicating high fit between selected strategies and regulation challenges. The exception for "boring learning material" was surprising since our theoretical model assumed a whole set of different strategy types to directly address this challenge type. Although the baseline probability of choosing a direct strategy was rather high, students chose other types of strategies equally often here. In figure 1, the ratios "R" signifying the relation of the empirical percentage of direct strategies to what could be expected under the assumption of a random distribution of strategies across all coding categories demonstrate values significantly (if testable due to low cell frequencies) greater than 1 for eleven out of 14 challenge types (coordination problems were not listed individually in the tree for lack of space). This hints towards a rather high ability of students to adaptively select direct strategies to remedy their regulation challenges (RQ 2). Though, the ratios of the three motivational challenges were significantly below 1, indicating regulation to be sensitive to the kind of challenge as well, but in an unexpected direction. For these problem types, students chose direct strategies less frequently and other strategies more frequently than expected when strategy selection would be random. In order to test whether the observed regulation differences between coordination- and comprehension-related problems on the one hand and motivational problems on the other hand also show up in regard to satisfaction, this split of problems was maintained in the multi-level models. So, we suppose that direct strategies are positively associated with satisfaction only for coordination- and comprehension-related challenges, whereas for motivational challenges, they might be negatively associated.

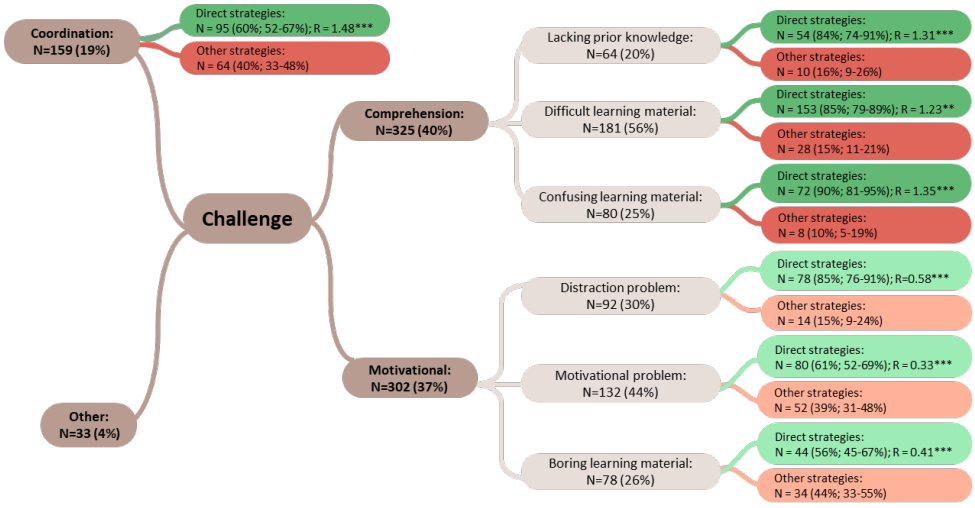

Figure 1. Decision tree with (relative) frequencies of challenges and direct vs. other strategy types (with 95% confidence intervals). Ratios "R" show the empirical probability for directly addressing a specific challenge compared to the probability expected with no adaptation in the choice of regulation strategy to a challenge. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Relation of fit with outcome

Regarding RQ 3, the *unconditional means model* (see Table 2) showed that 19% of the variance of satisfaction was explained by the group level. Thus, groups differed in the effectiveness of regulation. The *unconditional growth model* retained this effect but showed a main effect of time (γ_{100}) indicating that satisfaction decreased across learning sessions in average. Further, the *fit model* showed the effect of time again (γ_{100}) but yielded no significant effect for fit (γ_{200}). Thus, the fit between the biggest challenge and the selected strategy type to regulate this challenge did not significantly predict satisfaction. The *interaction of fit and problem type model* revealed a main effect for problem type (γ_{300}) indicating that group learners were more dissatisfied with their learning when facing motivational instead of coordination- or comprehension-related problems. This model further revealed a significant (one-sided according to hypothesis stated above) interaction effect between fit and problem type (γ_{400}). Thus, for coordination- and comprehension-related challenges, satisfaction was higher when direct instead of other strategies were chosen, but was lower for motivational challenges.

Table 2: Outcomes of multi-level models

	Satisfaction with the learning						
	Unconditional means model	Unconditional Growth Model		Fit Model		Fit, Problem type and Interaction Model	
		Fixed Effects					
Intercept γ_{000}	-0.030	0.116	(0.078)	0.115	(0.078)	0.107	(0.078)
Time γ_{100}		-0.037**	(0.011)	-0.036**	(0.011)	-0.036**	(0.011)
Fit γ_{200}				0.044	(0.034)	0.042	(0.034)
Problem type γ_{300}						-0.083*	(0.035)
Problem type*Fit γ_{400}						-0.061*	(0.033)
	Random Parameters						
Level 2 (Persons)							
Intercept Var(Γ_0)	0.053*	0.048*		0.050*		0.049*	
Level 3 (Groups)							
Intercept Var(υ_{00})	0.193***	0.205***		0.201***		0.197***	

Note. Standard errors are in parentheses. Time = the number of study group meeting (Level 1), Fit = the fit between biggest challenge and the chosen strategy type to regulate this challenge (Level 1). *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq .05$.

Discussion

The aims of our study were twofold. First, we wanted to investigate to what extent group learners who encounter specific coordination-related, motivational, and comprehension-related challenges during their exam preparation select strategy types that directly address those challenges. In this context, we also reflected on whether this extent can be considered to be sensitive to the challenge type. Second, we tried to validate our postulated fit categorization by regressing differences in satisfaction with the learning experience on the fit of the strategy types students selected with the biggest learning challenge they experienced during learning.

As expected, learners in groups particularly seem to choose strategy types directly addressing their biggest challenge. For thirteen out of 14 challenge types, they chose significantly more direct than other strategies. When additionally controlling for baseline probability of the measurement instrument, they still regulated eleven out of 14 challenges sensitive to the specific challenge. Thus, group learners seem to be able to adaptively regulate their learning challenges dependent on the kind of challenge they are confronted with. In line with the SRL model of Zimmerman and Moylan (2009), it may be that learners choose strategies that match their experienced challenges because they have turned out to be most effective for their control. However, this result seems to contradict observations of Engelschalk et al. (2015) who found that students did not differentiate much in their strategy choices and rather activate proven strategies repeatedly across situations. The diverging findings might be related due to the different study designs or contexts: In the study by Engelschalk and colleagues (2015), individual learning students were presented with hypothetical motivational problems and asked to describe how they would regulate each of them. Contrary to that, we asked group learners to report their real experienced coordination-related, comprehension-related, and motivational learning challenges.

For motivational challenges, though, we found regulation to be sensitive to the reported challenge as well−but in the opposite direction than we had expected. For one out of three motivational challenges, direct strategies were not more frequently used than other strategies. Since we proposed that there are more direct strategy types for regulating motivational than coordination- or comprehension-related challenges, this is even more surprising. When this baseline rate was controlled for, direct strategies were less significantly chosen for all three motivational challenges than expected under random distribution. Hence, learners who encounter motivational challenges seem to specifically avoid using motivational strategies. There are at least the three different explanations for this result: First, our theoretical considerations might have been wrong so that we failed to identify the right strategy types to directly address motivational challenges. Second, the matching we derived based on our theoretical understanding might be applicable but our participants were not able to select direct strategies and chose other strategies due to their lacking strategy knowledge or due to an inability to activate direct strategies here. Third, the social nature of the regulation situation might show differential effects of social desirability: According to this interpretation, it might be plausible that group members appreciate receiving help from another group member in understanding the learning content (= a comprehension-related challenge), or in negotiating the subsequent learning process (= coordination-related challenge). In case of motivational problems, however, it might be much less desirable to intervene as a group member. Trying to motivate a group member might be perceived as unwanted intrusion and attempt to change the attitudes towards the learning task and thus produce reactance within the group. For a less obvious and less socially conflict-loaded control of their group members' motivation, learners could have tried to indirectly motivate others through providing them assistance in learning the material.

Following Zimmerman and Moylan (2009), we supposed that if strategies were applied that match the learning challenge, then successful regulation should be likely. Regulation success, in turn, should result in satisfaction with the learning process. Therefore, we tested the association of the directness of strategy choice with satisfaction with the learning experience as an indication of criterion validity of our theoretical model on the fit between strategies and challenges. Controlling for random variations of satisfaction between groups and between individuals in groups, and for fixed and random effects of time, we found a significant link between the fit of strategy to challenge type and satisfaction with the learning experience only for coordination- and comprehension-related, but not for motivational challenges. Thus, we assume that our conceptualization of fit is actually predictive of regulation success measured by satisfaction rating, but differentially for specific challenge types. Additionally, this result mirrors the finding of the single case analysis of Järvelä et al. (2010).

Limitations and conclusions

Of course, this study has limitations: First, we did not have a direct measure of regulation success. Using satisfaction as a more distal measure surely is influenced by more than just the directness of chosen strategies. Perhaps the relationship between strategy-challenge fit and learning outcomes would be stronger if learning outcomes would be assessed by aid of objective measures (e.g. standardized test measuring the acquired knowledge). Second, even though we investigated regulation in real groups, analyses were based on self-reported

strategy use. Video-based analysis of real group interactions would be valuable and could nicely complement our more subjective data. Third, we looked for the fit between challenge and strategy types on an aggregated level. If the individual open-answer descriptions of each challenge and the corresponding regulation strategies would be used to propose a new fit, the results might provide a more precise picture of an even larger amount of direct strategies. Thus, as before, we believe that the estimated relative frequencies were also underestimated in this study. As a consequence, we plan to determine the fit for each individual strategy to each individual challenge as a future step. Furthermore, we have proposed strategy fit only in reference to the biggest challenge that participants experienced. Students who appropriately coped with all challenges during their group meetings except for their biggest challenge were likely to have lowered the empirical relationship between fit and satisfaction.

An important educational implication of our study is the following: We saw that students do not regulate motivational challenges much with strategies that (theoretically) would fit. In case that this results proves reliable in further studies, students should be trained in effectively regulating motivational challenges in particular, to increase their use of direct strategies for such challenges. For individual learning situations, Eckerlein, Steuer, and Dresel (2018) already showed that effective motivational regulation can successfully be fostered through dedicated training programs. Also, scaffolds or scripts (Kollar, Fischer, & Slotta, 2007) may additionally prompt group learners to adjust their use of strategies to challenges for more effective and satisfying collaborative learning experiences.

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