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Facilitating socio-cognitive and socio-emotional monitoring in collaborative learning with a regulation macro script – an exploratory study

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Abstract This study examines student teachers' collaborative learning by focusing on socio-12cognitive and socio-emotional monitoring processes during more and less active script dis-13 cussions as well as the near transfer of monitoring activities in the following task work. The 14 participants of this study were teacher education students whose collaborative learning was 15supported with a designed regulation macro script during a six weeks environmental science 16course. The script divided the group work into three phases, namely: the orientation phase, 17intermediate phase and reflection phase. The script was put in use by prompting questions that 18were delivered to the students on tablets. Question prompts instructed groups to plan their 19workings, to stop and reflect on the efficiency of their strategies and outcomes of their learning 20process. The data was collected by videotaping the groups' face-to-face work and analysed by 21focusing on verbalised monitoring interactions. More active and less active script discussions 22were differentiated in terms of the length and the quality of discussion. The results show that 23the macro script was used more thoroughly at the beginning of the group activities for 24orientation than for coordinating the progress or reflecting on the performance. Active script 25discussions involved more monitoring activities, especially providing socio-emotional support. 26Once socio-emotional support was stimulated in the more active script discussion, it tended to 27follow-up during the task working. It can be concluded, that the groups appropriated the script 28differently in different situations and with varied success. The implications of facilitating 29socio-cognitive and socio-emotional monitoring in collaborative learning are discussed. 30

Keywords Macro-script · Socio-cognitive monitoring · Socio-emotional monitoring	· 31
Regulation · Script appropriation · Video analysis	32
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Introduction

Research on collaborative learning has shown that when engaging in deep-level learning, group 35members coordinate their cognitive, metacognitive, motivational, and emotional efforts, as well 36 as the use of group resources in effective ways (DiDonato 2013; Janssen et al. 2012; Kwon et al. 37 2014; Saab 2012). This coordination as an intentional and goal-directed activity is defined as 38 group regulation in which students are engaged in the monitoring and controlling of motivation, 39 cognition, and behaviour – in addition to and as a prerequisite for task-level activities, such as 40knowledge co-construction (Khosa and Volet 2014; Näykki et al. 2017; Rogat and Linnenbrink-41 Garcia 2011). However, successful regulation is not self-evident in group interaction, and prior 42research has shown that learners in groups are infrequently aware of their goals, plans, and need 43for strategies during collaborative interaction (Hadwin et al. 2011; Miller and Hadwin 2015). A 44 lack of skills and missed opportunities for regulating group learning may cause weaker learning 45processes and outcomes (Näykki et al. 2014; Summers and Volet 2010). 46

Prior research has suggested that students need scaffolding to engage in, and to progress in, 47 active and effective collaborative learning interactions (Belland et al. 2013; Kirschner et al. 48 2006). Järvelä et al. (2014) emphasise a need for supporting groups' regulation at the cognitive 49level (i.e. task and content understanding) as well as at the emotional and motivational levels 50(i.e. goals and interests). Despite a growing consensus on the importance of group regulation 51within collaborative learning, empirical research on how regulation is enacted during collab-52orative learning, and how scripting can be used as a scaffold for regulation strategies, is still 53emergent (Järvelä and Hadwin 2013; Järvelä et al. 2016a). 54

Previous scripting approaches have studied how scripts can support collaborative learning 55by specifying the activities that learners are expected to engage in during collaboration 56(Dillenbourg 2002; Kollar et al. 2006). Typically, scripts have aimed to smooth coordination 57and to promote high-level collaboration in terms of arguing, explaining and question asking 58(Fischer et al. 2013). However, there is a lack of studies exploring how to support groups' 59social regulation strategies (i.e. planning, monitoring and evaluating group working) with 60 pedagogical scripts. Furthermore, prior studies in the context of computer-supported collabo-61 rative learning (CSCL) have mostly operationalised effective collaborative interaction either 62 from the socio-cognitive or socio-emotional points of view (Ludvigsen 2016). This type of 63 approach yields a narrow view of effective collaborative learning and lacks the opportunity to 64explore and explain the interaction and support systems among various facets of collaboration 65 (i.e. behavioural, cognitive, and emotional) (Ryu and Lombardi 2015). 66

In addition to specifying what effective collaborative learning is, what aspects and processes 67 it contains, and how it could best be supported, one emergent topic in the collaborative learning 68 research is how to increase students' transferable skills of collaborative learning. Particularly, 69 the current interest is in the question of *appropriation* of collaborative learning scripts 70 (Tchounikine 2016) that is defined as group members' perception, interpretation, and implementation of the script (Stegmann et al. 2016). However, there is a lack of empirical research on how learners appropriate and implement scripted processes in new learning situations. 73

Our research focuses on interactions from both socio-cognitive and socio-emotional points 74 of view and particularly explores group regulation in terms of socio-cognitive and socioemotional monitoring. This approach follows Järvelä et al. (2016a, b) work on collaborative 76 learning by considering group processes as a temporally evolving rather than state-like 77 phenomenon. In this paper, we examine a designed macro-script for effective collaborative 78 learning. We focus particularly on when and how forms of socio-cognitive and socio-79

Intern. J. Comput.-Support. Collab. Learn

emotional monitoring emerge and function during scripted collaborative inquiry learning in a80student teachers' environmental science course. We also extend the approach to explore how81monitoring processes emerge in the task work that follows the scripted phases.82

Scaffolding collaborative learning by scripting and prompting

In their seminal paper, Wood et al. (1976) explored how adults help infants' problem solving 84 and found that adults did not directly tell or demonstrate how to solve the problem, but rather 85 scaffolded the children. Wood et al. (1976, p. 98) noted how adults used the following six 86 strategies to support children's effort until they gained sufficient skills: "recruitment, reduction 87 in degrees of freedom, direction maintenance, marking critical features, frustration control, and 88 demonstration". Actually, as Belland et al. (2013) highlight, three of the six original scaffold-89 ing strategies that Wood et al. (1976) introduced are motivational (recruitment, direction 90 maintenance, and frustration control), and the other three are cognitive (reduction in degrees 91 of freedom, marking critical features, and demonstration). Thus, scaffolding in its original 92sense was equally focused on motivational and cognitive support. 93

Building on the scripted cooperation approach (O'Donnell and King 1999; O'Donnell and 94Dansereau 1992), scripts support collaborative processes by specifying, sequencing, and 95distributing the activities that learners are expected to engage in during collaboration 96 (Dillenbourg 2002; Kollar et al. 2006). Collaboration scripts are designed to shape the way 97 students interact with each other and to engage them in specific activities and discourse moves 98that are associated with high-level collaborative learning (Dillenbourg 2002). Overall, collab-99 oration scripts provide explicit guidelines for small groups to clarify what, when, and by whom 100certain activities need to be executed (Weinberger et al. 2007). 101

Scripts vary widely in terms the objectives, methods of delivery, and the types of activities 102 they support (Kobbe et al. 2007). Scripts typically aim to smooth coordination and communication, but there are also scripts that aim to promote high-level socio-cognitive activities (e.g. 104 explaining, arguing, and question asking) (Fischer et al. 2013). Furthermore, collaboration scripts have often been realised through prompts that can take the form of sentence starters or question stems (Ge and Land 2004) to provide learners with guidelines, hints, and suggestions 107 that facilitate the enactment of scripts (Weinberger et al. 2007). 108

The research on CSCL scripts broadly distinguishes between two types of scripts - micro 109and macro scripts – based on the level of granularity at which they support learners. 110 Specifically, micro scripts consist of, for example, sentence openers that prompt learners to 111 contribute domain content to the discussion and critique one another's contributions (i.e. 112Weinberger et al. 2005). Macro scripts support collaboration more broadly by orchestrating 113activities and processes expected to enhance collaborative learning and typically do not 114provide detailed support on how to enact these activities (Dillenbourg and Hong 2008; 115Dillenbourg and Tchounikine 2007; Hämäläinen and Häkkinen 2010). For instance, the 116classical example of Jermann and Dillenbourg's (2003) ArgueGraph macro script specifies 117 and sequences general phases in a classroom argumentation task. 118

A recent meta-analysis of scripting (Vogel et al. 2016) shows that learning with scripts can 119 lead to a small positive effect on domain-specific knowledge and a large positive effect on 120 collaboration skills compared to unstructured collaborative learning. Vogel et al. (2016) further 121 reveal that scripting is particularly effective when it is combined with additional contentspecific tools (i.e. worked examples and concept maps). Also, Järvelä et al. (2014) highlight 123 the possibilities for supporting collaborative learning with (1) scripting, (2) prompting, and (3)124utilising technological tools in collaborative inquiry tasks. In this study, we contribute to the125CSCL literature by scripting a combination of socio-cognitive and socio-emotional group126activities that characterise well-functioning and effective collaborative learning.127

Cognitive design principle: Socio-cognitive monitoring

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Socio-cognitive monitoring involves evaluating and judging one's own and each other's 129understanding, cognitive functioning, and progress during the group task (Goos et al. 2002; 130Näykki et al. 2017). Through monitoring processes, the group members may become aware of 131their own and each other's learning and understanding of the content as well as situation-132specific skills required for successful group activity (e.g. De Backer et al. 2014; DiDonato 1332013; Khosa and Volet 2014; Rogat and Linnenbrink-Garcia 2011). Previous studies have 134shown that groups where learners monitor their own and their peers' thinking and understand-135ing have been shown to engage in deeper-level learning processes compared to groups in which 136understanding is not actively monitored (Goos et al. 2002; Hurme et al. 2006; Iiskala et al. 2011; 137Lee et al. 2015; Näykki et al. 2017). For example, Roscoe and Chi (2008) evaluated events 138 where explaining one's own understanding by using monitoring statements, such as "I didn't 139understand this before", was useful for making new connections and building understanding at 140the group level. Recent findings from our own study (Näykki et al. 2017) as well as from Lee 141 et al. (2015) are related to the cognitive design principle by indicating that monitoring thinking 142and understanding plays a key role in high-quality engagement in a joint activity. Our previous 143study specifies that monitoring functions in parallel with knowledge co-construction, and it 144activates episodes of higher-level questions and answers (Näykki et al. 2017). 145

The basic assumption in regard to how scripting can support collaborative learning is that it 146is designed to guide students in performing meaningful and beneficial learning activities. 147These may result in positive learning outcomes with respect to domain-specific knowledge and 148collaboration skills (King 2007). Prototypical examples that have been supported with 149scripting are reciprocal questioning and explaining, creating, and sharing external representa-150tions of knowledge, as well as engaging in discursive learning activities (King 1992; Webb 151et al. 2009). Webb et al. (2009), for instance, reported in their study about elementary school 152students' algebraic problem solving that the collaborative activity of giving explanations 153154during small group learning dialogue was positively related to domain-specific learning outcomes. Teasley (1997) pointed out the importance of other-oriented transactive activities. 155The most important characteristic of these transactive activities was to take the learning 156partners' contributions into account (e.g. by criticising, refining, or extending these contribu-157tions). A similar finding was also evident in our previous work (Näykki and Järvelä 2008), 158where the most effective student groups were engaged in transactive learning activities by 159extending each other's ideas and contributions. 160

In all these examples, the processes of socio-cognitive monitoring are implicitly important 161for effective collaborative learning; monitoring is needed to control and modify the groups' 162shared learning processes. However, none of the earlier studies have explicitly focused on 163supporting socio-cognitive monitoring. Järvelä et al. (2016a, b) argue that one of the chal-164lenges in acquiring deep-level knowledge construction in a collaborative setting is the fact that 165students in groups are not engaged in self-regulating their own learning processes or those of 166their peers. Thus, this study highlights the need for focusing on students' success in increasing 167awareness of socio-cognitive monitoring and the productive adaptation of their learning 168

Intern. J. Comput.-Support. Collab. Learn

behaviours to their situated learning challenges (Järvenoja et al. 2015; Näykki et al. 2014). We 169 posit that designing a scripting approach to enhancing socio-cognitive monitoring may 170 increase students' awareness of their own learning and that of others and should therefore 171 increase the effectiveness and efficiency of learning processes and learning outcomes. 172

Emotional design principle: Socio-emotional monitoring

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Collaborative learning involves behavioural and cognitive operations, but also central to the 174success of collaborative learning is how learners feel and manifest their own feelings in the 175learning situation – what kinds of negative or positive emotional reactions are aroused before, 176during, and after the group task (Baker et al. 2013)? Students in academic learning settings (such 177as group tasks) frequently experience emotions such as enjoyement of learning, hope for success, 178pride in accomplishments, anger about task demands, fear of failing, or boredom (Pekrun et al. 1792002). More specifically, both negative and positive affective states and emotions experienced 180 within the group can derive from a variety of factors - from personality differences to the 181 dynamics and processes created within the collaborative group (Järvenoja and Järvelä 2009; 182Näykki et al. 2014; Van Den Bossche et al. 2006; Volet and Mansfield 2006). In general, emotions 183 can be defined as intense reactions that are usually generated by a process of appraisal of the 184situation or dispositions that are transferred to the situation (Frijda 1986; Lazarus 1991). 185

Research has shown that both positive and negative emotional states consume attentional 186resources by focusing attention on the object of emotion (Ellis and Ashbrook 1988). Over-187 consumption of attentional resources implies that fewer resources are available for task 188completion, thereby having a negative impact on performance (Meinhardt and Pekrun 1892003). Thus, emotion regulation as a goal-directed process of influencing the intensity, 190duration, and type of emotion experienced (Jacobs and Gross 2014) is needed for successful 191learning in individual as well as in group settings. The recent research on group emotions has 192shown that emotional experiences and expressions of emotions can be monitored, controlled 193and directed (Järvenoja and Järvelä 2009; Näykki et al. 2014) and socio-emotional monitoring 194is one of the main regulation processes for successful collaborative learning (Kwon et al. 2014; 195Lajoie et al. 2015; Rogat and Linnenbrink-Garcia 2011; Ucan and Webb 2015). 196

Emotion regulation in collaborative learning refers to the process involved in becoming 197 aware of one's own and others' affective reactions and having the ability to monitor and 198control emotional experiences to modify or temper aspects of emotional experiences (partic-199ularly when they interfere with the group's goals and with social interaction) (Boekaerts 2011; 200Schutz and Davis 2000; Thompson et al. 2003; Wolters 2003). An inability to increase or 201 decrease the intensity and duration of emotional arousal can hinder performance and interper-202sonal relationships, whereas the capacity to temper emotions facilitates functioning in social 203and academic contexts (Boekaerts 2011). 204

In fact, socio-emotional monitoring can be seen as a diverse set of strategies influencing 205which emotions are experienced, when and how they are experienced, and how they are 206communicated within group interaction. Monitoring and the use of diverse control processes 207does not mean that emotions should not be experienced and/or verbalised within group 208interaction. On the contrary, the expression of emotions is a sign of socio-emotional engage-209ment and can function towards effective collaborative interaction (Näykki et al. 2014). What is 210important for well-functioning group interaction, is how emotions are expressed and 211interpreted within group situations. When emotional reactions emerge, their interpretation 212can be positive and thus lead to increased engagement and efforts in group activities; 213

alternatively, it can be negative and lead to disengagement and withdrawal from the group and 214 its activities (Linnenbrink-Garcia et al. 2011; Näykki et al. 2014). 215

What is missing in the scripting and scaffolding literature of collaborative learning is emotion216regulation support at the individual and group levels of collaboration (Järvelä et al. 2016a, b).217These can mean, for example, tools and scaffolds for making group members' feelings and218intentions visible so the group can mirror its processes. This is important to be able to modify the219group processes when, for example, emotional experiences implicitly but negatively affect the220group interaction and learning (Linnenbrink-Garcia et al. 2011; Näykki et al. 2014).221

We agree with Ludvigsen (2016) that emotions play an important role in collaborative 222learning, and thus, more research is needed to understand how emotions contribute to and are 223co-constituted with the cognitive and social aspects of group interaction in CSCL. This study 224characterises and operationalises effective collaborative learning as a multidimensional process 225of socio-cognitive and socio-emotional interactions. Socio-cognitive monitoring in this study 226targets mindful and strategic activities related to students' own and each other's content 227 228understandings and monitoring possible content-related misunderstandings in an interpersonal level. Socio-emotional monitoring is defined as how each participant in a group monitors their 229own and others' emotions and what type of interactions they engage in about their emotions or 230providing socio-emotional support within the group (Kempler Rogat and Linnenbrink-Garcia 2312011; Näykki et al. 2014; Rogat and Adams-Wiggins 2014). We, thus, posit that the socio-232emotional aspects of collaboration are central in successful collaborative learning (Andriessen 233et al. 2013; Järvelä et al. 2013). 234

Appropriating scripts and transferring scripted activities

According to the study by Hämäläinen and Häkkinen (2010), learners may make use of a given 236script more ideally or less ideally. This relates to the question of how scripted activities are 237actually enacted in different learning situations. The *appropriation* of scripts is a current topic of 238discussion in CSCL scripting research. Tchounikine (2016) introduced the question of appropri-239ation of scripts by emphasising the need to understand how learners perceive, understand and 240make the script their own. Stegmann et al. (2016) replied to this request by emphasising the 241meaning of individuals' perception, interpretation, and implementation of scripts. These re-242searchers highlight that collaborative scripts are understood and enacted differently by different 243groups of students. How students enact the script varies on the basis of a complex set of 244intertwining factors, such as students' goals and other situational characteristics (Tchounikine 2452016). This further influences how scripted activities are internalised and, thus, have the 246possibility to influence collaborative learning situations (Stegmann et al. 2016). 247

So far, there is a shortage of empirical studies showing the variety of how scripted activities 248in collaborative learning are actually enacted and how such activities are reflected in a 249subsequent unscripted collaborative learning. The latter question relates to the notion of 250*transfer*. The transfer literature has long sought to identify possible ways to develop general 251cognitive skills, i.e. thinking skills and problem-solving skills that would be applicable across 252contexts (i.e. Adey and Shayer 1993; Berry 1983; Georghiades 2000; Halpern 1998; Osman 2532008). For example, Kalyuga (2009) demonstrates that appropriate instructional support and 254optimal levels of control over the learning processes may enhance learners' abilities to transfer 255their knowledge and skills. Because the goal of introducing CSCL scripts is to improve the 256internalisation of scripted activities (Fischer et al. 2013), the transfer of scripted activities to 257

Intern. J. Comput.-Support. Collab. Learn

unscripted interaction is naturally an interesting consideration. However, while it is known that 258CSCL scripts can enhance collaborative learning compared to unscripted collaboration (Vogel 259et al. 2016), empirical studies depicting the enactment of scripted activities and the near or far 260transfer effect of scripted interaction is scarce. 261

Research questions

The aim of this study is to examine student teachers' collaborative learning by focusing on 263both the socio-cognitive and socio-emotional monitoring activities during more and less active 264scripted interaction as well as the near transfer of socio-cognitive and socio-emotional 265monitoring activities in the subsequent task work. The particular research questions are as 266follows: 1) How do socio-cognitive and socio-emotional monitoring emerge in the situations 267where the provided script is used more actively and less actively? 2) How do socio-cognitive 268and socio-emotional monitoring activities transfer to subsequent task work after more active 269and less active script discussions? 270

Methods

Context and participants

The study was conducted in a Finnish University in a first year teacher education course about 273environmental science. During the six-week course, the students (N = 19, $M_{age} = 23$ years, 12 274women and 7 men) worked on five face-to-face collaborative tasks. The mixed-gender groups of 275three to four students were formed based on pre-questionnaire responses which assessed students' 276dispositions towards collaboration (Wang 2009). The Likert-scaled items included measures such 277as "I enjoy exchanging thoughts" and "I am open to all sorts of opinions". Based on their answers, 278students were divided into three profiles: students who were the most positive towards collabo-279ration, students who were the least positive towards collaboration, and students who were in-280between. Groups were formed so that each group included students from all three profiles. 281

Procedure

The groups were assigned to work on technology-enhanced tasks about five environmental 283science topics: Species, Eco Systems, Maps, Planetary Phenomena, and Climate. The teacher 284of the course planned the collaborative activities together with the first and the second author 285of this article. In each 90-min lesson, the teacher first introduced the topic and aimed to 286increase interest towards it. The following group tasks required students to discuss a specific 287topic and collaboratively design tasks for teaching the topics in elementary school. The 288pedagogical design tasks are at the core of Finnish teacher education. The teacher education 289students are taught to improve their pedagogical knowledge and skills while learning the 290subject matter. During these tasks, the students worked with content and phenomena they were 291familiar with based on their previous education and courses. They also had access to the 292various material sources where they could search for information if they were lacking 293knowledge of the topic. The students were asked to take advantage of provided materials, 294such as handouts and books, and the students were also encouraged to use laptops and tablets 295

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for searching for further information, documenting their task products, and sharing their 296 products online with other groups.

The goal of the tasks was to enhance students' conceptual and pedagogical understanding of given concepts and phenomena in environmental science. The open-ended tasks required students 299 to activate prior knowledge, to negotiate their understandings, to evaluate the relevance of various 300 environmental science topics for children, and to jointly design effective pedagogical methods for 301 teaching the topics in elementary school. To give an example of one of the tasks, the following 302 instructions were given for the collaborative task about weather and climate: 303

Choose a weather-related phenomenon based on your interests. 1. Discuss and plan how 304 you would teach and illustrate the chosen phenomenon using a whiteboard or interactive 306 board. Choose a grade and the goals of teaching. Discuss: How would you involve the 307 pupils? What kind of information is relevant for the pupils? How would you present the 308 information? Design a visualisation of the chosen phenomenon. Look for information 309 online. 2. Design a task for pupils about the chosen phenomenon. Consider the age of 310the pupils and your teaching goals. Discuss how to integrate other subjects. Save your 311 plan online in the shared folder. 312

Following each collaborative session, the students participated in a whole-class discussion 313 where they were encouraged to explain and extend their understanding of the scientific 314 concepts and topics. The data and analyses presented in this article are focused on the 315 small-group collaborative activities. 316

A macro script for regulated learning

The work in the student groups was supported with a designed macro script that implemented 318 the cyclical idea of regulated learning (Zimmerman 1989; Cleary and Zimmerman 2012). The 319script was divided into three phases. It started with orienting whereby groups set goals and 320 plans for their learning (orientation phase), continued with progress coordination (intermediate 321 phase), and ended with reflection on the process and performance (reflection phase). In 322 addition to dividing the group work into different phases, specific questions were prepared 323 to prompt groups' socio-cognitive and socio-emotional monitoring (see Table 1). The script 324included prompting questions that were delivered to the students with tablets, which were also 325used as information-seeking and sharing tools during the collaborative group work. Question 326 prompts instructed groups to stop and reflect on their thoughts and feelings and to consider the 327 efficiency of their group interaction. These question prompts were designed by taking into 328 account learning processes that characterise effective regulation in collaborative learning 329

1.1 Table	e 1 Script	questions	in three	script phases
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1.2	Script phase	Orientation-phase	Intermediate-phase	Reflection-phase
1.3	Script questions	What is the purpose of the task?	How has your work progressed?	How would you evaluate your work as a group?
1.4		What kinds of feelings does the task arouse?	What kinds of feelings does your work arouse?	How did you reach your results?
1.5		What kinds of strengths does your group have?	What kinds of challenges are you currently facing?	What helped or hindered reaching your goals?
1.6		What is the goal of your group work?	How will you proceed from here on?	How did you overcome possible challenges?

Intern. J. Comput.-Support. Collab. Learn

interaction (Hadwin et al. 2011). Specifically, the orientation phase focused on assisting
groups' planning processes by activating task understanding, prior knowledge, efficacy beliefs,
and goal setting; the intermediate phase's prompting question highlighted monitoring progress
towards goals, and challenge awareness; and the reflection phase asked groups to concentrate
on performance evaluation and challenge awareness.330330331331332333333334

Data collection and data analysis procedures

The exploratory study was conducted in a classroom-like research space (http://www.oulu. 336 fi/leaf-eng/) by using video tracks with a spherical 360-degree point of view. The five student 337 groups were recorded five times (30 h of video data). The setting made it possible to record all 338 the groups at once, and videos captured the students' discussions, movements, and gestures. 339 Because students' participation in group activities was not obligatory in this course, some 340 students were absent from some of the sessions. We selected those group sessions for the 341 analysis where a minimum of three group members were present. This selection criterion 342 excluded pair work from the study. After excluding videos with student absences, 20 videos 343 $(M_{\text{duration}} = 1 \text{ h } 9 \text{ min})$ were analysed. Thus we had three to five sessions for each group. 344

A multi-step analysis method was used to explore when and how processes of socio-345cognitive and socio-emotional monitoring emerged and functioned during scripted and 346 nonscripted collaborative learning. QSR International nVivo 10 data analysis software was 347 used for the coding of the videos with time-logged codes, and the generated frequencies and 348 durations were exported to the SPSS software for further analysis (i.e. Kruskall-Wallis test and 349Mann-Whitney test). First, the video data were segmented into 30-s events. The time-based 350segmentation of events gave a structured and consistent unit for analysis and allowed a 351temporally unfolding overview of the group situations (Miles and Huberman 1994; Sinha 352et al. 2015). Time-based coding reduced the challenges related to pinpointing the exact second 353 of the beginning or end of the observed phenomenon. Using segments as units of analysis was 354considered a sufficient means of providing the timing of the coding categories within the 30-s 355timeframe. The timeframe of 30 s was chosen, because it was long enough to observe several 356 conversational turns but short enough to make detailed and moment-by-moment observations. 357

Each 30-s segment was first briefly annotated with a description of what had occurred 358within the episode, such as, "The group finishes their first task. Emma shows the created mind 359 map to others. The group discusses whether they have justified their task sufficiently. Vilho 360 suggests that the group moves on to their second task". These annotations created a rough 361content log of each video. The content log was complemented with a short memo of the most 362 salient observations of each video. Second, each 30-s event was observed to see if the group 363 members showed socio-cognitive and socio-emotional monitoring (see Table 2). The event 364was coded if it met the criteria for a code. The implemented coding categories were not 365 considered mutually exclusive; instead, it was assumed that different monitoring strategies 366 could exist parallel to each other, and thus, the same 30-s event could be coded under more 367 than one category. This possibility for overlapping is based on the assumption that group 368 interaction reflects both socio-cognitive and socio-emotional aspects of learning (Kreijns et al. 369 2003). In those situations that included overlapping of the coding categories, the groups, for 370example, expressed positive or negative emotions while they simultaneously discussed cog-371nitive challenges and/or monitored task progress. 372

The coding categories and overall coding protocol were developed in several phases. First, 373 prior to viewing the videos, a list of preliminary areas of interest was developed according to 374

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Code	Criteria	Cohen's ĸ
Socio-cognitive monitoring		
Task understanding	Students verbally monitor their task understanding by expressing their understanding or lack of understanding about the task – for example by saying, "Does it have to be a question? It doesn't say it has to be a question".	.94
Task progress	Students voice out their perceptions of their progress towards task completion and their goals – for example by saying, "This has not been very fluent for us".	.95
Content understanding	Students explicitly express or discuss their understanding of the content – for example by saying, "This is not at all clear to me. You obviously had an idea about that".	.93
Socio-cognitive challenges	Students voice out the experienced socio-cognitive challenges – for example by saying, "We obviously have different under standings of the concept".	.83
Socio-emotional monitoring		
Socio-emotional experiences	Students share their socio-emotional experiences towards the task and/or towards the group. These can include for example explicit expressions of interest and task value by saying, "I'm interested in this, and I want to highlight it".	.91
Socio-emotional challenges	Students voice out the socio-emotional challenges they are experiencing – for example by saying, "uuuh, I don't have the energy".	.87
Socio-emotional support	A student compliments, praises, or encourages another team member or the group's work (e.g. "Yay!" "We did a great job".). A student expresses a desire to do a favour for someone (e.g. "Should I slow down?"). A student shares positive beliefs of group potency or group members' strengths (e.g. "We're super", or expresses sympathy ("I'm sorry – I'm a little tired today", "Poor you").	.76

the stated research questions. Second, the coding protocol was developed and elaborated 375further after viewing the videos several times. Third, the preliminary coding categories were 376 compared to previous research of sub-processes in social regulation (i.e. DiDonato 2013; 377 Khosa and Volet 2014; Kwon et al. 2014; Lajoie et al. 2015; Lee et al. 2015; Näykki et al. 378 2017; Rogat and Linnenbrink-Garcia 2011; Saab 2012; Ucan and Webb 2015), and finally, 379 coding sub-categories of socio-cognitive and socio-emotional monitoring were formulated and 380 tested several times. This involved the reorganisation and renaming of categories as well as 381 specifying subcodes and providing examples of the specified categories. 382

The final version of the coding protocol included the following main categories and subcat-383 egories: 1) socio-cognitive monitoring (subcategories: monitoring task understanding, monitoring 384content understanding, monitoring task progress, and monitoring socio-cognitive challenges) and 385 2) socio-emotional monitoring (subcategories: monitoring socio-emotional experiences, monitor-386 ing socio-emotional challenges, and providing socio-emotional support within group interac-387 tions). These monitoring strategies were considered to reflect how group members in different 388 task phases and situations were attentive and focused on effective collaborative learning interac-389 tion. The specific coding rules and examples of the analysis are presented in Table 2. 390

The reliability of the coding was assured by selecting 25% of the video data to be classified by 391 the independent coder. The first and second authors were responsible for the coding; they both 392 participated in the refinement of the coding system and, while coding, were blind to the 393

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performance of the students. Reliability analysis was used to refine the coding scheme and the 394 analysis. All the data were analysed by the first author of this article, and 25% of the data were 395used in intercoder reliability analysis by the second author. Cohen's kappa coefficient was 396 selected as a statistical measure for evaluating an inter-rater agreement for qualitative items. It 397 is generally thought to be a more robust measure than simple percent agreement calculation, since 398 it takes into account the possibility of agreement by chance. Cohen's kappa showed a good 399 reliability of the coding for all the categories. The first intercoder reliability values varied from 4000.65–0.76. Next, meaning making discussions were held and disagreements were negotiated and 401 resolved. The second round of intercoder reliability analysis gave Cohen's kappa values between 4020.76–0.95. The qualitatively analysed interaction data were quantified (based on durations) to 403detect possible differences between groups and tasks (Chi 1997; Strijbos et al. 2006). 404

Further analysis explored how these analysed processes were enacted in different phases of 405the script (i.e. orientation-, intermediate-, and reflection-phase) and during the following task 406work. The durations and qualitative characteristics of the scripted discussions were considered. 407 The groups self-determined how thoroughly they discussed the provided prompt questions and 408 decided when they were ready to continue with their task work. Therefore, the group situations 409 differed in terms of duration of the script discussions as well as the focus and the quality of the 410 discussions. In some of the groups, the provided external support was used more thoroughly 411 and each prompted question was discussed carefully, whereas some script situations were 412 weaker in terms of the time devoted and content provided by the groups. Thus, the group 413situations were referred to either as a more active (> $M_{duration}$ and high quality) or less active (< 414 $M_{\rm duration}$ and low quality) script discussion. Table 3 presents the criteria for the qualitative 415evaluation of the script discussions. None of the script discussions were short and high-quality 416or lengthy and low-quality. This study focused on 20 collaborative situations of which nine 417 situations were regarded as more active script situations, and 11 situations were characterised 418as less active script situations ($M_{duration} = 0:07:31$, SD 0:02:57). 419

As this study is strongly exploratory, the qualitative examples were described in detail to 420illustrate and broaden the perspective of the quantified analysis. The qualitative examples were 421 selected from the data to show what types of discussions were activated with scripted 422 423discussion and what kinds of qualitative differences could be seen in different learning 424 situations. The case examples were selected based on the following selection criteria. At first, the most active group working session in terms of the script use was selected (namely, the 425426 second task of group 5, where the duration of the script discussion was 13 min). Second, the parallel but least active group session was selected (namely, second task of group 3, with a 427 script discussion duration of 5 min). The two extremes were selected as case examples, 428 because they clearly illustrate the differences between situations with more and less active 429script use. On average, the script discussion length in the whole dataset was 7 min per task. All 430the groups had more and less active script discussions (see Table 4 for the overall minimum 431and maximum script discussion durations in different groups). 432

Results

Preliminary analysis: Macro script use

The average overall duration of the groups' scripted discussions per session was 0:07:31 (*SD* 435 0:01:29, *min* = 0:01:59 and *max* = 0:13:00). On average, the groups used more time for the 436

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A Um 142 ARD 259 Prov# 1 21/08/2017

T-LL 2 Outline forming diamonic

49.1

	Active	Less active
General description	Multiple themes for discussion are presented, and prompted questions are considered from several points of view. Students are not in a hurry but rather concentrate on each prompted question.	Students say the prompted question al but do not engage in adiscussion ov
Orientation-phase	Students recognize the main aim of the task and have a discussion over it.	Students repeat the task from the instructions but do not negotiate over task aims.
	Students discuss their task interests (or lack thereof).	Students may express their task intere lack thereof) but do not engage in discussion over it.
	Students recognize the challenges of the task and have discussion over them.	Students may evaluate the task as challenging/easy but do not engage any discussion over it.
	Students consider the strengths of the group members thoroughly and realistically.	Students may express group's strengt randomly or in a joking manner.
	Students set goals for the task and for the group work.	The goal is simple – for example: to g work done.
Intermediate-phase	Realistic evaluation of the group's progress.	Unrealistic evaluation of the group's progress.
	Discussing about their feelings about the task and about the group work.	Students may share their feelings but of engage in any discussion over ther
	Considering the different responsibilities, roles, and interactions in the group.	Students do not evaluate their responsibilities, roles, and interacti
	Progress evaluation: what have they done, what is missing, and what needs to be done.	No evaluation of the progress or very limited or unrealistic evaluation of progress.
	Time management.	Students may point out the lack of tim they do not show any planning of management.
Reflection-phase	Realistic evaluation of the group's performance.	Unrealistic evaluation of the group's performance.
	Sharing and discussing about the feelings.	Students may share their feelings, bu do not engage in any discussion or them.
	Evaluating working and communication within the group. Discussing about the possible challenges and	No evaluation of the group work or communication styles in the group Students may recognize their challen
	evaluating how did they overcome the challenges.	but do not engage in any discussion them.

orientation-phase (M = 0.03:03, SD = 0.01:14, 4.50% of their total group working time) than for the intermediate-phase (M = 0.02:16, SD 0.01:29, 3.32% of total group working time) or the reflection-phase (M = 0.02:12, SD 0.01:12, 3.17% of total group working time) (Table 5). 439

14.1 Table 4 Script discussion durations among the conaborative learning gro	t4.1	Table 4	Script discussion	durations an	nong the collab	porative learning grou
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t4.2	Group	Script use duration	
t4.3		Min duration	Max duration
t4.4	1	0:09:27	0:12:46
t4.5	2	0:05:19	0:10:38
4.6	3	0:01:58	0:05:22
.7	4	0:05:25	0:08:00
8	5	0:05:31	0:13:00

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	Sum	М	Std
Orientation-phase	1:00:58,7	0:03:02,9	0:01:14,3
Intermediate-phase	0:45:15,1	0:02:15,8	0:01:29,0
Reflection-phase	0:44:02,3	0:02:12,1	0:01:11,9

This shows that the groups spent more time orienting themselves to the group work than for
coordinating their progress within the task or reflecting on their learning and group work in the
end of their task work.440
441

The results show that the type of monitoring varied during the scripted phases (Table 6). 443 The Kruskal-Wallis test showed that the amount of groups' monitoring of socio-emotional 444 experiences (as a sub-category for socio-emotional monitoring) differed significantly in the 445 different script phases (H(2) = 14,18, p < .01), with a mean rank of 42.30 for the orientation 446 phase, 25.50 for the intermediate phase, and 23.70 for the reflection phase. Pairwise compar-447 isons (post-hoc tests) showed significant differences between orientation and intermediate 448 phase and between orientation and reflection phase (p < .01, respectively). A Kruskal-Wallis 449 test also showed that the groups' monitoring task understanding (as a sub-category for socio-450cognitive monitoring) differed significantly in the script phases (H(2) = 24,88, p < .01), with a 451mean rank of 45.98 for the orientation phase, 23.28 for intermediate phase, and 22.25 for the 452reflection phase. Pairwise comparisons (post-hoc tests) showed significant differences between 453the orientation and intermediate-phase and between the orientation and reflection-phase 454(p < .01, respectively). As expected, the script directed the groups to focus on monitoring 455task progress more in the intermediate-phase than in the other scripted phases. There were no 456 significant differences between phases in other categories. However, it is notable that the 457socio-emotional activity of "providing socio-emotional support" was the only type of moni-458toring activity that was frequently present in all script phases, and the amount of it slightly 459increased from the orientation phase to the reflection phase. 460

How do socio-cognitive and socio-emotional monitoring emerge in the situations461where the provided script is used more actively and less actively?462

The more active and less active script discussions were explored in terms of different types of 463 monitoring activities that were stimulated. When the mean durations of monitoring were 464 compared, the results showed that there were differences between the amount of monitoring 465 activities that active script discussion stimulated compared to the less active script discussions. 466

t6.1 Table 6 The mean durations of monitoring activities in the different scripted p	hases
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t6.2 t6.3		Orientation script <i>M</i> dur	Intermediate script Mdur	Reflection script <i>M</i> dur
t6.4	Monitoring task understanding	0:01:26	0:00:25	0:00:20
t6.5	Monitoring content understanding	0:00:59	0:00:30	0:00:15
t6.6	Monitoring task progress	0:00:16	0:01:27	0:00:10
t6.7	Monitoring socio-cognitive challenge	0:00:45	0:00:36	0:00:13
t6.8	Monitoring socio-emotional experience	0:01:23	0:00:44	0:00:37
t6.9	Monitoring socio-emotional challenge	0:00:10	0:00:11	0:00:12
t6.10	Monitoring socio-emotional support	0:01:02	0:01:00	0:01:16

The overall difference among all the group situations was highest in terms of monitoring socio-
emotional support, where the mean duration in the more active script discussions was4674.33 min, while the mean duration in the less active script discussions was 2.09 min
(Table 7). However, smaller differences were also seen across all types of monitoring.467

To explore in more detail the monitoring processes that the script stimulated, the most 471 active script discussion was selected (Group 5, task 2) and compared with the least active script 472 discussion during the parallel task (Group 3, task 2). The groups' actions for socio-cognitive 473 and socio-emotional monitoring in different script phases are elaborated through the transcribed examples. Figure 1 gives an example of two case groups' orientation, intermediate and 475 reflection script discussions. Case 1 shows an active script discussion and Case 2, in contrast, shows a group situation where the short script discussion involves few monitoring activities.

In the first transcribed example, the case groups are discussing the orientation script 478questions. The left column in Table 8 shows an active script discussion during a collaborative 479task about forest ecosystems, whereas the right column shows the same question prompt in the 480 same task in a less active script discussion. The example shows how the Case 1 group was 481 engaged in socio-cognitive and socio-emotional monitoring when discussing their strengths as 482 a group. This example highlights what type of norms the group members created for their 483 group work. For example, the group discussed how important it is to share ideas, to state their 484opinions, to give space for everyone to contribute, and to have a mindset of learning from each 485 other's' ideas and points of view. They also started to monitor their content understanding with 486 Anna (note that all the names are pseudonyms to protect students' privacy) explicitly 487 emphasising the pursuit to gain a better understanding of their topic through collaboration 488 (line 8): "We want to learn from each other. For me it is important to learn from you, because I 489don't have a lot of previous knowledge of these things". Niina continued by highlighting the 490opportunity for shared learning by saying (line 9): "Maybe together we can find new things. I 491hope that we can put our knowledge together, and we can all learn from it'. This discussion 492shows how the group members explicated interdependency and built a safe socio-emotional 493atmosphere for collaboration. Particularly important from a socio-emotional point of view is 494that they explicitly state that they want to learn from one another. These are regarded as 495valuable discussion acts for developing a socio-emotionally well-balanced group situation. In 496 other words, these group members show that they value each other's contributions and that 497 they also see this group situation's learning value. The second example on the right-hand 498column in Table 5 shows how the Case 2 group discussed the same script question. Even 499though they also explicated a good socio-emotional atmosphere, their discussion was short, 500and it stayed on the surface level. They did not, for example, engage in discussions where they 501would build group norms or values. 502

Type of monitoring	Active script Mdur	Less-active script Mdur	Mdur
Monitoring socio-emotional support	0:04:33	0:02:09	0:03:19
Monitoring socio-emotional experiences	0:03:33	0:02:00	0:02:45
Monitoring task understanding	0:03:06	0:01:45	0:02:13
Monitoring content understanding	0:02:30	0:01:18	0:01:44
Monitoring task progress	0:02:22	0:01:45	0:01:54
Monitoring socio-cognitive challenges	0:02:06	0:01:18	0:01:35
Monitoring socio-emotional challenges	0:00:66	0:00:48	0:00:34

t7.1 **Table 7** The mean duration of monitoring activities during active and less active script discussions

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SOCIO-COGNITIVE MONITORING				_
SOCIO-EMOTIONAL MONITORING SOCIO-EMOTIONAL SUPPORT				
ORIENTATION SCRIPT [4:08-8:57]	INTERMEDIATE SCRIPT [32:30-38:45]			REFLECTION SCRIPT [1:11:30-1:12:56]
SE 2: LESS-ACTIVE SOCIO-COGNITIVE MONITORING SOCIO-EMOTIONAL MONITORING SOCIO-EMOTIONAL SUPPORT GRIENTATION SCRIPT [4:30-6:35]	INTERMEDIATE SCRIPT [33:08-34:14]		REFLECTION SCRIPT [1:05:45-1:06:50]	
:00 9:00	32:00	39:00	1:05:00	1:13

Fig. 1 Socio-cognitive and socio-emotional monitoring during more active and less active script phases

The second pair of examples (Table 9) is from the groups' intermediate script discussion that 503was conducted about half-way through the group task. The Case 1 group focused first on the 504socio-cognitive monitoring of their progress by summarising what content they had covered so 505far. They also monitored their content understanding and specified in which parts they lacked 506understanding. The continued discussion shows their socio-emotional monitoring in terms of 507expressing the value of group work in situations where they lack understanding or where they 508have different types of understanding. Niina explicitly highlights the importance of group 509interaction (line 8): "I think it is a good thing in group work that we have different opinions, 510but we also need to justify those opinions, so we need to really think what our understanding is 511and why we think something is important". Iida says (line 10) that she thinks that they were 512having challenges in the beginning, but now she feels that the task is clearer. Niina continues (line 513

	Orientation, Script Question 3. What kind of strengths does your group have?		
	Case 1: Active script discussion	Case 2: Less-active script discussion	
1	Alex: So, what kinds of strengths do we have?	Alisa: We have Elias.	
2	Iida: We are very outgoing; I'm sure that everyone will say what they think.	Elias: Good team spirit.	
3	Anna: I agree.	Sara: That's a lot.	
4	Iida: Or shares their own ideas with everyone.	Elias: And, and. All are smart people, what could go wrong?	
5	Anna: And I'm sure that everyone can state their opinions; we will give space for everyone's thoughts.		
6	Niina: Yes, and everyone has of course a little bit different types of knowledge, so if someone knows more than the others, then someone else can also bring a new point of view to the discussion.		
7	Iida: Yes, and we are open to new ideas.		
8	Anna: And we want to learn from each other; for me it is important to learn from you, because I don't have a lot of knowledge of these things.		
9	Niina: Maybe we can find new things together. I hope that we can put our knowledge together and that we all will learn from it.		
1	J lida: Yes, and I hope that after this work everybody knows what a forest ecosystem is and knows how to teach it to pupils.		
1	1 Alex: And I hope that our group will function well.		

A Umin 142 ARD 259 Prov# 0 21/082017

	Intermediate, Script Question 6. How has your work progressed	?
	Case 1: Active script discussion	Case 2: Less-active script discussion
1	Niina: How have we progressed?	Alisa: Well, this is quite tiring work. It is because of these early mornings
2	Anna: Well pretty good	no no.
3	Ida: Pretty well ves it'll be alright	
4	Niina: Well if you think so; we have now thought about those content areas, those goals, so we are kind of half way now.	
5	Iida: Yes, the only thing that bothers me is this lack of understanding. I cannot get a hold of this. I understand quite well those main concepts and such, but what is concerning me is that I can't really teach these if I don't understand them well enough.	001
6	Niina: Yes and I think that we all have a little bit different ways of seeing these, like what we consider to be important, and	
7	Ida: Yes I'm sure that is also, yes, but it is just pity that I don't have enough previous knowledge. (laughs)	Q
8	Niina: but I think it is good thing in group work that we have a different opinions but we also need to justify those opinions, so we need to really think what is our understanding and why we think something is important.	
9	Alex: vea-veah.	
10	Iida: I think in the beginning we had challenges in understanding the task; now it is getting clearer what we need to do	
11	Niina: And this has a huge meaning for our future, for real. Very seldom do we get to think this thoroughly, and when we are teachers we need to know how to do this	
12	lida: Yes, and it is better that we are doing this now as a group	
13	Niina: Yes, exactly, this way we have three other opinions and not only own thoughts.	

11) by showing how she values the task and sees it as important for their future work as classroom 514teachers. Iida specifies (line 4) that she feels good about working on this task together as a group. 515This example shows how, and particularly how often, the scripted working phase afforded the 516group socio-emotional monitoring in terms of discussing the task value as well as their progress as 517a group. This discussion demonstrates that the group members were aware that they had different 518understandings and opinions, and they understood that they were needed to justify their opinions. 519They regarded their group work as valuable especially because of the opportunity to have more 520opinions and suggestions than only one's own. This example highlights a deep-level understand-521ing of group interaction and illustrates how cognitive aspects (developing understanding) are 522intertwined with socio-emotional aspects (interdependency, value of group work). In contrast, the 523Case 2 group replied to the same script question briefly by Alisa saying: "This is quite tiring work. 524It is because of these early mornings". This shows a surface-level approach to the monitoring of 525the group's progress, on both a socio-cognitive as well as a socio-emotional level. 526

The last scripted-phase, reflection, requested the groups to engage in an evaluation of how they succeeded in the task as a group, what types of challenges they experienced, and how they overcame the possible challenges (Table 10). The Case 1 group considered time management as a challenge for them. However, their discussion also implies that they needed to make compromises in their work, and they discuss why compromises are important in the group interaction as well as in teachers' work. This example shows a proficient type of monitoring, where group members are

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	Reflection Script Question 12. How did you overcome your possible challenges?		
	Case 1: Active script discussion	Case 2: Less-active script discussion	
1	Anna: How did we overcome challenges? Well, we hurried ourselves.	Elias: Well our challenge was that we were so tired, and we didn't really solve it.	
2	Iida: We didn't have major challenges, just the time.	Alisa: Sucking the mint. (laughs)	
3	Niina: Yes, and like everyone were able to make compromises and could take into consideration what the others are thinking. Like it is not only that I know what I want.	Sara: We should have had a huge pot of coffee or caffeine pills.	
4	lida: Yes, exactly.	Elias: I would have been like (tapping the table) because I don't drink coffee.	
5	Niina: And I think that is the most important, like similar thing is in one's working life, like even though you are alone in the classroom, and you can basically yourself decide all your class' things as a teacher, you need to consider other people in the school and class also.	Sara: Me either. (laughs)	
6		Alisa: I also don't drink coffee; we would all have our stomachs hurting.	

able to reflect on what types of behaviour were successful within the group interaction (line 3), but 533they also extend their thinking towards future work as classroom teachers (line 5). For the Case 1 534group, the most visible aspect that supported their group work was their ability to make 535compromises but also that they were aware of their need for compromises. This last example is 536shown in their reflection-script discussion, where they again point out that they were able to make 537compromises and take others' thinking into consideration. This shows an example of the socio-538emotional support provided in this group as well as their group working values. In contrast, the 539Case 2 group with less active script discussion felt that their group work was challenged, because 540they were tired, and they were not able to overcome that challenge during their work. Thus, the 541discussion stayed on a superficial level and lacked true reflection and evaluation. 542

How do socio-cognitive and socio-emotional monitoring activities transfer543to the subsequent task work after the more active and less active script discussions?544

The results indicated the differences between the group situations in terms of socio-cognitive and 545socio-emotional monitoring during scripted discussions. Further analysis aimed to explore 546whether there were also differences in groups' socio-cognitive and socio-emotional monitoring 547after more active and less active script discussions. In other words, we examined how the 548supported monitoring activities were transferred to the task work phases. This was done to 549evaluate whether the active script use also contributed beneficially to the groups' task work. 550Based on a Mann-Whitney test, the situations in which the groups were actively and less-actively 551using the script for their group work differed significantly from each other in the task work phase. 552The difference was significant in regard to how the groups provided socio-emotional support (as a 553subcategory for socio-emotional monitoring) during the task work (U = 79.50, p = .020) with a 554mean rank of 7.77 (for less active script use) and 13.83 (for more active script use). In other words, 555socio-emotional monitoring in the form of providing socio-emotional support was more often 556transferred to task work after more active script discussion than after less active script discussion 557 (Fig. 2). Other types of activities, including main and sub-categories, were not significantly 558different in the learning situations where groups were more active or less active in their script use. 559

A UmbH42 Rd 259 Pro 21/052017



Fig. 2 Transfer of socio-emotional support to task working after more active and less active script discussions

The Case 1 group was engaged during the script discussions in building up a sound socio-560emotional atmosphere, which was explained in detail during the previous section. The Case 1 561group also put forth effort to keep up the socio-emotionally balanced atmosphere by providing 562socio-emotional support during their task work (i.e. by giving attention to each other's contribu-563tions, by being aware of the need for compromises, and by being able to make compromises). 564This was visible when they verbalised their arguments and made joint decisions, such as: "it is 565true what you said earlier" and "you can do what you consider is the best". These were also 566present in this group's scripted discussions when the group members highlighted the importance 567of interaction and the meaning of compromises. The Case 2 group, in contrast, did not explicate 568the meaning of a group's socio-emotional support in their script discussions nor during their task 569work. There were a few attempts to provide socio-emotional support during their task work, but 570 there were short compliments, such as: "good point" and "it's quite well written". 571

The following transcribed examples show the observed differences in the case groups' inter-572action and the types of socio-emotional support provided after the more active and less active script 573discussions. The first transcribed example is from the task work phase where the Case 1 group is 574coming to a solution in their task. Earlier, this group had some differing opinions about the topic, 575and this episode shows how they came to a shared solution and how they provided socio-emotional 576support to each other. Interestingly, a clear connection can also be seen in this conversation to their 577scripted phase discussions. The most visible theme in this group's scripted discussions was how 578they were first building a safe socio-emotional climate for their group work and how they valued 579their group's ability to make compromises. This transcribed example shows socio-emotional 580support and how particularly Niina (line 7) acknowledges an earlier contribution by another 581student, Anna, by saying: "...but it is true what you said earlier (looking at and waving her hand 582towards Anna) that we are planning this class session for the 4th graders, so it could be more 583challenging". This selected example shows that this group has been negotiating their understanding 584and also making compromises. In this example, it becomes clear that Niina is trying to smooth the 585conversation by explicitly stating to Anna that her point was also correct, even though they as a 586group decided not to follow her opinion. A small amount of emotional arousal in terms of 587 frustration can be seen from Anna's behaviour and her wording when she says (line 4): "No no 588that's not what I meant' and (line 13) "Ok, sorry [for asking]". However, it can be concluded that in 589this group situation Niina pointed out that she values Anna's point of view and it worked as a socio-590emotional support for the whole group, but particularly for Anna (Table 11).

The second example from the Case 1 group (Table 12) is at the end of their task work. In this pisode, Anna is giving a suggestion for their group work (line 1): "Should we write examples of 593

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591<mark>Q1</mark>
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_	21:30-22:30
1	Alex: The main content could be and then place in the brackets that plants are examples of the producers and animals are consumers.
2	Anna: Yeah, that is what I was earlier suggesting also, that we place them in the brackets.
3	Alex: But not anything too detailed, like
4	Anna: noo, noo, that is not what I meant.
5	Iida: It can be that complementary knowledge that consumers are for example
6	Alex: Animals are consumers.
7	Niina: It is a pity that we haven't had the lecture about the analysis of core knowledge and differentiated instruction yet. But it is true what you said earlier (looking at and waving her hand towards Anna) that we are planning this class session for the 4th graders, so it could be a more challenging. [Anna glances toward Niina, but the others are not following what Niina is saying.]
8	Iida: I now write here that the main content includes
9	Alex: hmm yeah.
10	Anna: What about those producers, did you mention those?
11	Alex: Yes.
12	Niina: It was in the beginning.
13	Anna: ah ok, sorry [for asking].

organic and inorganic?" Niina replies and shows a different opinion - that of not wanting to write 594more detailed information. She reasons her suggestion by saying that they do not need to be so 595specific. Anna points out that she disagrees (line 6): "but I think we should write down all we 596know". The accompanying smile makes the disagreement less direct. At this point, Niina laughs 597and moves closer to see what Iida has written. Niina says (line 7): "You can write it down". 598However, Anna withdraws her suggestion by saying (line 8): "No you don't need to write it 599because of me, no problem". After Anna has withdrawn her suggestion, she turns her gaze away 600 from the group for a moment. Iida summarises what she has written. Anna says (line 10): "You 601 can write what you consider is the best solution". Niina shows socio-emotional support by saying 602 (line 11) that she understands Anna's point of view but also feels that it is challenging for them to 603 progress the way Anna is suggesting, since they are now in a hurry to finalise their task. At the end 604 of this episode, the group members decide not to include the examples (lines 12-13). 605

t12.1	Table 12	Transcribed	example of socio	o-emotional support
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	46:00-48:00
1	Anna: Should we write examples about organic and inorganic?
2	Niina: Those come later. I don't know, do we need to be so specific? We can always say that inorganic is, for example (tries to think of an example, and laughs), you say what could be an example of inorganic.
3	Anna: Yeah, that's what I was thinking also, so what is inorganic? (laughs)
4	Alex: Well, for example, rocks and lifeless soil.
5	Niina: Yeah, I don't think that we need to explain everything. Because these are quite concise.
6	Anna: But I think we should write down all we know. Just write anything. (rocks herself and smiles)
7	(Niina laughs, moves closer to see what Iida has written, and says) You can write it.
8	Anna: No you don't need to write it because of me, no problem. (turns her gaze away)
9	(lida tells what she has written): Here in complementary knowledge we have
10	Anna: You can write it or leave it, do what you consider is the best.
11	Niina: I understand, but this is very difficult to try to think of these, as we are in a hurry.
12	Alex: Just leave it.
13	Anna: Leave it.

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The Case 2 group did not challenge each other's thinking in any of the phases of their group 606 work like the Case 1 group did. They also had fewer instances where they provided socio-607 emotional support for each other (see Fig. 2). The selected transcribed example (Table 13) offers a 608 discussion typical of this group. In the example, Sara explains her content understanding of the 609 forest ecosystem. Alisa acknowledges Sara's point by saying (line 2): "That is a good point, 610 definitely that is valuable to notice". The short episode continues by Elias summarising what he 611 had written down, and Alisa shows nonverbal socio-emotional support by showing a thumbs up. 612 Elias is not very keen toward this nonverbal support and says (line 5): "This is just bullshit". Alisa 613 replies by praising Elias (line 6): "no, I think that is quite well written". It can be concluded that, in 614 this case example, the socio-emotional support was targeted directly at the group members' 615 current activities, for example, at what they were saving or writing about the content. Further-616 more, no specific transfer can be seen in this group's scripted discussion and task discussion, 617 where they would have been elaborating their work and providing socio-emotional support. 618

Summary of the selected case examples

The transcribed case examples described above show the situational differences of the socio-620 emotional support given in each case group. It can be summarised that in the Case 1 group, the 621 group members challenged their own and each other's thinking more and thus also needed 622 different types of socio-emotional support to keep their group work well-balanced. The Case 1 623 group's interaction also showed the transfer between scripted phases and task work phases. 624 Their scripted discussions included themes like valuing group work, valuing each other's 625 contributions, and valuing the ability to make compromises. These themes also became visible 626 in their task work phase through the socio-emotional support they provided. On the other hand, 627 the Case 2 group's socio-emotional support was more directly targeting the current activities in 628 the group – for example, by praising the contributions of the other group members. No 629 thematic connection could be found between this group's script and task work phases. 630

Discussion

This study explored collaborative learning in terms of groups' socio-cognitive and socio-632emotional monitoring. A regulation macro script was implemented to support groups' interaction633and working processes. The study focused on monitoring activities during more and less active634scripted interaction in three phases of collaborative learning (orientation, intermediate, and635reflection phase) as well as the near transfer of socio-cognitive and socio-emotional monitoring636activities in the subsequent task work.637

t13.1
 Table 13
 Transcribed example of socio-emotional support
 16:30-17:00 t13.2 t13.3 1 (Sara explains her content understanding about the forest ecosystem.) t13.4 2 Alisa: That is a good point, definitely that is valuable to notice t13.5 3 Elias: I wrote it here that a student learns to search information to combine new information with previous knowledge. 4 t13.6 (Alisa replies by showing a thumps up and laughs.) t13.7 5 Elias: This is just bullshit. t13.8 6 Alisa: No, I think that is quite well written

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The preliminary analysis showed how the groups used the provided script in their group work 638 and how the script stimulated monitoring activities. In general, the students used the external 639 support more thoroughly at the beginning of their group activities for orienting themselves to the 640 group and to the task than for coordinating their progress or evaluating and reflecting on their 641 performance. These results are promising in terms of stimulated orientation discussion, since prior 642 research has shown that well conducted orientation contributes to students' proactive engagement 643 in the task (Eby and Dobbins 1997; Salas et al. 2005). Orientation provides foundational 644 metacognitive knowledge on which groups can set goals and make plans for approaching the 645task as well as to create standards against which to monitor and coordinate their progress and 646 products (Miller and Hadwin 2015). However, as this study also indicated, not all the groups in all 647 situations achieved a high-level orientation discussion, which is worrisome since a lack of group 648 orientation can debilitate team performance (Hillyard et al. 2010). Furthermore, even with the 649 prompted support of the macro script, the groups were generally less engaged in the intermediate 650 or reflecting phases than in the orientation phase. This observation connects to other studies that 651 have shown that monitoring and reflection can be challenging for student groups (Järvelä et al. 6522016b). Reflection, in particular, was very weak, despite its importance for learning and for 653 learning transfer to new situations (Zimmerman 1989). To be constructively reflective, learners 654 should be reflective about their own performance, their learning experience, and their methods or 655 strategies of learning (Schunk and Zimmerman 1998). 656

In the preliminary analyses, we further observed differences in the types of monitoring the 657 script phases activated. The orientation phase activated significantly more monitoring of task 658 understanding and of socio-emotional experiences than did the two latter script phases. The 659 intermediate phase stimulated the groups to monitor the task progress compared to the other 660 two phases. These findings are somewhat expected, as they reflect the questions given in the 661 script. Interestingly, providing socio-emotional support was the only type of group activity that 662 was actively present in all of the script phases, even though the script prompted only the 663 awareness of emotions, not providing support. It may be possible that the script discussion was 664 beneficial for group members to open up their feelings toward the task and group work, and 665 thus it increased their group-level awareness and made the positive socio-emotional expres-666 sions more salient (Baker et al. 2013). In practice, the time spent in the scripted discussions 667 supported the groups in more clearly communicating their personal emotional experiences 668 such as lack of interest, exhaustion, frustration and cognitive challenges in understanding the 669 task. This, further, activated them to encourage each other or boost their team spirit. 670

Even though the preliminary analyses indicate that the regulation macro script supported 671 collaborative learning by introducing the reason for interaction, the script did not guarantee high-672 level regulation interaction. We could clearly differentiate between more active and less active 673 script discussions where both the length and the quality of scripted interaction differed. Our results 674 showed that the more active and the less active script discussions differed in terms of the 675 frequency of monitoring activities that the interaction involved, especially in terms of providing 676 socio-emotional support. The differences between monitoring activities was explored in depth 677 with qualitative examples from the two case groups' orientation, intermediate and reflection script 678 discussions. The Case 1 Group members were showing interdependency and explicitly building a 679 safe socio-emotional atmosphere for collaborative learning by highlighting the value of sharing 680 ideas, stating opinions, giving explicitly a space for everyone to contribute, and having a general 681 mind-set to learn from each other's ideas and points of view. Thus, a variety of both socio-682 emotional and socio-cognitive monitoring activities were observed during the scripted discus-683 sions. The Case 2 Group also explicated a positive socio-emotional atmosphere, but their script 684 discussions were short and lacked details. In other words, neither productive socio-emotional nor socio-cognitive monitoring was especially activated in this group. 685

The observed differences reflect the study by Hämäläinen and Häkkinen (2010), who 687 examined the difference between ideal script use and actual script use. Their study indicated 688 that different groups act differently despite using a similar script. Our results also connect to 689 the findings by Rogat and Linnenbrink-Garcia (2011), who observed differences in social 690 regulation in elementary school students working in groups on a series of three mathematics 691 tasks. Their findings indicated that while some groups demonstrated in-depth interpretation of 692 693 the task while planning, others simply read the instructions and started the task with little discussion of what the task meant. The authors further suggested that this type of low-quality 694working disrupted group progress by undermining engagement and interfering with monitor-695 ing (Rogat and Linnenbrink-Garcia 2011). 696

Our observation of the frequency of both socio-cognitive and socio-emotional monitoring in 697 the more active script discussion links to the prior research that has highlighted the connection 698 between groups' positive socio-emotional interactions and high-level cognitive functioning 699 (Barron 2003; Mullins et al. 2013; Van den Bossche et al. 2006). For example, Lajoie et al. 700 (2015) found that positive socio-emotional interaction created space for cognitive interaction 701 towards problem solving. Also, Polo et al. (2016) argue that research needs to see emotions as part 702 of the ongoing cognitive efforts and make participants aware of how social roles are affected by 703 emotion and how participants need scaffolds to help regulate the collaborative efforts. 704

The second research question moved the focus to the task work phase between the scripted 705phases and evaluated how the groups' socio-cognitive and socio-emotional monitoring were 706 transferred to the task activities after more active and less active script phases. The results 707 showed that the group work after the active script discussion included more attempts to 708 provide socio-emotional support within the group than did the group work after the less active 709script discussion. Prior research has shown that positive social interactions are often formed at 710the early stages of the collaboration but that it also needs to be maintained throughout the 711 collaboration (Rogat and Linnenbrink-Garcia 2011). The scripted phases in this study gave 712 groups time and space to consider their emotional experiences and to trigger their strategic 713 714 evaluations to consider if they needed to make some changes to their group work. Further-715more, once socio-emotional support was stimulated during the script discussions, it tended to continue during the task working. The in-depth analysis of the task work showed differences 716between groups in terms of how often and in which ways they offered socio-emotional support 717 within their group. The Case 1 Group members challenged their own and each other's thinking 718 more often than did the Case 2 Group students, and that was also reflected in the types of 719socio-emotional support they provided. What was particularly visible in the Case 1 Group 720 interaction was their tendency to give positive attention to each other's contributions and also 721their ability to be aware of their need for compromises. It can be summarised that the same 722 themes that were present in their scripted discussions, namely valuing the group work, valuing 723each other's contributions and valuing the ability to make compromises, also occurred in their 724task work phases in terms of the socio-emotional support they provided. In contrast, the Case 2 725Group's socio-emotional support was more directly targeting the current activities in the group, 726like complimenting the task work. The students were not explicating the values of their group 727 work in their script discussion nor during the task work. One explanation for this can be that 728the discussions on the socio-emotional experiences increased awareness of the overall socio-729emotional atmosphere in the group, and thus the students also paid more attention to it during 730 their unscripted task working. 731

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The question of how scripted activities are actually enacted in different learning situations, or 732 how students and groups appropriate the script in their group working is current topic in the CSCL 733 scripting research (i.e. Noroozi et al. 2017; Stegmann et al. 2016; Tchounikine 2016). Our study 734explored the issue by examining how scripted activities were actually enacted. Noroozi et al. 735 (2017), in turn, emphasise second-order scaffolding in terms of exploring whether designed 736 scaffolds can help students to acquire competences that can be transferred by the students 737 themselves to various learning tasks. Our study is connected with transfer issues in evaluating 738 how scripted interactions were thematically transferred to discussions that were not directly 739 scripted. This study contributes to the current CSCL script discussion by offering an empirical 740 example of how groups make use of the external support (cognitive and emotional) offered to them 741 in authentic teacher education course environment during an extended period of time (six weeks). 742

Our contribution extends this prior work by directly offering scripting elements to support 743 socio-emotional aspects within collaborative interaction. Even though several authors (e.g. 744Tchounikine 2016) have highlighted the meaning of emotional and relational processes, to the 745 best of our knowledge there is no previous work that has explicitly supported socio-emotional 746 processes with scripts. However, Järvelä et al. (2016a) as well as Miller and Hadwin (2015) 747 designed a technological support for collaborative learning that also acknowledges the emo-748 tional aspects of group work. In detail, their approach aimed to increase learners' awareness of 749their own and others' learning processes by prompting learners to evaluate their ongoing group 750activities (Järvelä et al. 2016a). Whereas their study used technology as an individual reflection 751instrument, our approach used technology to prompt the students' face-to-face discussions on a 752group level. In other words, scripting was used as a pedagogical method for framing effective 753learning activities to create opportunities for group members to become aware of their own and 754each other's thinking, understanding, and feelings so that together they could monitor and 755 control their shared learning activities. 756

Limitations

This study, like other similar studies implementing an exploratory and observational approach, can 758 be criticised due to its lack of generalisability of the results. As observational methods afford details 759 and context specificity on how the certain phenomenon is activated under certain circumstances, 760 the possibility to draw general conclusions of how, for example, the socio-cognitive and socio-761emotional monitoring generally appears, is limited (Järvelä et al. 2013). A clear limitation of the 762study is a lack of control group, and thus, the real effects of the designed regulation macro script 763 cannot be determined. As there is no control group, there is no way to rule out the possibilities of 764 group related and situation specific factors that may have affected to groups to be sometimes more 765 engaged in script discussions and to transfer the regulation activities also to unscripted task phases. 766 However, this study actually is about how different groups enact the same script in different ways 767 in authentic learning situations. Some groups seem to welcome certain kinds of prompts (like Case 768 1 Group did regarding the socio-emotional monitoring prompts) and to even transfer the prompts 769 to phases in which the script is not presented, while others do not (Case 2 Group). 770

Several methodological decisions that were made during the data analysis need to be 771 discussed. In this study, the unit of the analysis was focused on the group level, as we 772 did not account for group members' individual regulation activities. This decision 773 naturally limits our power to elaborate on whether there were differences between 774 situations because some members were more active than the others. However, the same 775 decision was also made in Sinha et al. (2015), and they also pointed out that studying a 776

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group level phenomenon also means that it is inextricable from the individual, highlight-777 ing how interactions within the group context influence its quality (Rogat and Adams-778 Wiggins 2015; Rogat and Linnenbrink-Garcia 2011, 2013). The second methodological 779 780 solution of this study was to use the time interval as the unit of the analysis. Sinha et al. (2015) used a similar approach. However, whereas Sinha et al. (2015) implemented a 781 five-minute interval, our approach was used in 30-s intervals. These types of occurrence 782 ratings afforded capturing how the monitoring strategies were used for that time period 783 and allowed us to observe each group situation in a structured manner and to detect 784overall variations in monitoring patterns within and between groups. Furthermore, this 785 level of detail did not lose information regarding the moment-to-moment nature and 786 fluctuations in collaborative interaction. 787

Future research directions

As research of regulation of collaborative learning is emergent, a key direction for future 789research is how and when regulation processes are activated in groups, how individual and 790 social aspects of regulation intertwine, and how regulation can be supported. This study gives 791 interesting research questions and reasoned hypothesis based on our observations to be 792 explored in the future studies. For example, situational differences between groups and tasks 793 found in this study requires more detailed further analysis. Further studies are needed to 794explore why some groups are more engaged in script use and use it for orienting, coordinating 795 and evaluating their group learning, whereas others use the script less effectively. Future 796 studies could aim for answering the following research questions: What makes groups adopt or 797 ignore certain script prompts? What are prerequisites that determine compliance to the script 798 prompts? Which group characteristics are problematic in that respect? 799

Furthermore, much remains to be understood regarding the types and configurations of 800 support that best promote regulation of collaboration. Are there other ways in which groups 801 who do not comply with the script can be supported during their learning? Do they need more or 802 other kinds of script prompts? For instance, it is unclear how much support learners require at the 803 individual or group level, in what kinds of tasks or learning situations, and whether too much 804 support may impinge on interaction and groups' processes (Dillenbourg 2002). It also remains to 805 be investigated to what extent the effects of scripts translate into the long-term impacts of such 806 scripts on individual outcomes. Therefore we suggest that follow up research could be aimed at 807 this question. This could have consequences not only for the design principles of such scripts, but 808 also for the transfer of learning from group to individuals in the long-term. 809

It would be insightful to evaluate with a quasi-experimental setting if the regulation macro 810 script would have for example a near- and/or far-transfer effect. This would give more 811 comparable information to see to what extent students can transfer their acquired regulation 812 skills for application in similar collaborative learning situations. However, having said how 813 transfer could be tested, one needs to keep in mind that group situations are always unique 814 constitutions of its members' prior experiences and situational characteristics. As members 815 collaborate, they encode, interpret, and recall information together, and in so doing they create 816 knowledge that becomes embedded in a group's structures and processes. Therefore, research 817 should also value groups as collective ecosystems that create their own working cultures and 818 norms, and no situation is entirely replicable to another. This makes also group interaction 819 analysis unique, by its methodological approach and by the information that can be gained by 820 the groups without too much controlling their interactions. 821

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Conclusion

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This study developed a detailed regulation macro script to support collaborative learning and 823 analysed socio-cognitive and socio-emotional monitoring in more and less active scripted 824 discussions in three scripted phases, and how the monitoring activities were transferred to the 825 task work that followed active and less active script discussions. We agree with Tchounikine 826 (2016) that in a learning situation the script itself is not important; rather it is what learners' 827 construct in relation to the script - that is, how learners have perceived, understood, and made 828 the script their own. Furthermore, we also agree with Stegmann et al. (2016) that group-level 829 negotiations of the script are crucial for how a group of learners interacts and makes use of the 830 script. Our claim is that social regulation of learning is not an outcome but rather a process of 831 socio-cognitive and socio-emotional monitoring that sets the stage for better collaboration 832 (Hadwin et al. 2011). Successful collaborative learning includes learners' meta-level knowl-833 edge about cognition, motivation, and emotion, which are manifested through the monitoring, 834 negotiating, and aligning of understandings (Järvelä et al. 2016a). This process can be 835 supported through scripting, but more evidence is needed about the contribution of such 836 approaches and tools to the quality of collaborative learning. Collaborative learning can be 837 challenging for groups, and often social regulation activities are lacking or they are weakly 838 conducted. Thus, the knowledge of and the ability to implement monitoring practices can 839 provide direction for students to move towards more productive collaboration. The findings of 840 the study can be used to design and provide support for small group collaboration. Based on 841 the findings of this study, it can be concluded that future studies are needed for evaluating the 842 different phases of group interaction, and particularly to design pedagogical support for groups 843 to also engage actively in the intermediate and reflection phases during collaborative learning. 844

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