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Shifting Patterns in Co-regulation, Feedback Perception, and Motivation During Research Supervision Meetings

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ABSTRACT

Supervision meetings give teachers and students opportunities to interact with each other and to co-regulate students' learning processes. Co-regulation refers to the transitional process of a student who is becoming a self-regulated learner by interacting with a more capable other such as a teacher. During a task, teachers are expected to pull back their support and give opportunities to students to take responsibility. This study aims to explore the shifting patterns of co-regulation, feedback perception, and motivation during a 5-month research project. Participants were 20 students conducting research in pairs and six teachers who supervised these students. Two videotaped supervision meetings at the beginning and end of the research process and questionnaires on feedback perception and motivation were analysed. Results on co-regulation showed a constant and comparable level of regulation at the start and at the end of students' research projects. Feedback perception did not change, but motivation decreased significantly.

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KEYWORDS
Co-regulation; motivation; feedback perception; teacher-student interaction

Supervision meetings in which teachers and students interact give teachers an opportunity to scaffold their students' learning (Allal, 2016; Ruiz-Primo, 2011). The concept of scaffolding can be defined as teachers who adapt their support to students' level of understanding and is based on two rules: (1) when the student fails, the teacher increases control; (2) when the students succeeds, the teacher decreases control (Van de Pol, Volman, Oort, & Beishuizen, 2014; Wood, Wood, & Middleton, 1978). Scaffolding can be seen as support that is adapted, is slowly decreased over time, and is aimed at transferring the responsibility of the task to the student (Van de Pol & Elbers, 2013). Within scaffolding, teachers adapt their support to students' level of independence in order to support them to be active participants during meetings (Rasku-Puttonen, Eteläpelto, Arvaja, & Häkkinen, 2003).

Co-regulation relies on scaffolding and refers to the transitional process of a student who is becoming a self-regulated learner by interacting with a more capable other such as a teacher (Hadwin & Oshige, 2011). Co-regulation of learning refers to social regulation of learning in which students temporarily regulate their cognition, behaviour, motivation, and emotions with their teacher (Räisänen, Postareff, & Lindblom-Ylänne, 2016). Supervision meetings give teachers and students opportunities to interact with each other and to co-regulate students' learning processes. Teachers apply regulation that is more direct and use instruction and explanation when the student's level of independent

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functioning is low; they apply regulation that is more indirect and use questions and prompts when the student's level of independent learning increases (Salonen, Vauras, & Efklides, 2005). Co-regulation occurs with teacher's indirect regulation; students can take on their responsibility because of teachers who are decreasing their support (Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013).

In higher education, students are supported in their research projects during supervision meetings with their teacher. The goal of these research projects is that students develop research skills by applying their knowledge about research in practice (Wisker, 2009). During these meetings, students discuss the process and outcome of their research individually or in a small group. Although students can adopt a more active role and take initiative when they interact with their teacher, they often show passive behaviour (Prins & Mainhard, 2009, August) and still misunderstand and misinterpret teacher feedback (Higgins, Hartley, & Skelton, 2002; Hyatt, 2005). The meetings give teachers the opportunity to evaluate students' research skills and to adapt their support to the students' needs (de Kleijn, Meijer, Brekelmans, & Pilot, 2015). However, teachers tend to intervene and provide feedback without diagnosing students' learning needs (Agricola, Prins, Van der Schaaf, & van Tartwijk, 2018). Agricola et al. (2018) showed that teachers apply a lot of direct regulation in the context of research supervision, and as a result, co-regulation does not occur very often, even if students might be ready for it.

Co-regulation can occur as the result of successful scaffolding: when teachers slowly decrease their support during the meetings, students gradually take on more responsibility (Salonen et al., 2005). Then, students adopt an active role; they can ask questions about and verify their interpretation of the feedback (Prins, Sluijsmans, & Kirschner, 2006). Previous research concerning co-regulation shows that students and teachers are able to co-regulate students' learning (Hadwin, Wozney, & Pontin, 2005; Karasavvidis, Pieters, & Plomp, 2000) and that co-regulation plays an important role in the development of students' self-regulation (Salonen et al., 2005). However, teachers have trouble in decreasing their guidance; relinquishing control might be more difficult than increasing control (Van de Pol & Elbers, 2013). Students in their turn have difficulty taking on the responsibility and show passive behaviour (Prins & Mainhard, 2009, August). The aim of this study is twofold; first, we want to test the theory of co-regulation in the context of research supervision; we aimed to provide insight into how teachers and undergraduate students co-regulated students' learning. Second, we want to add to the existing knowledge about how students perceive teacher feedback, and how motivated they are for their research task.

Co-regulation within Successful Scaffolding

In this study, *co-regulation* is defined as teachers and students who share in the regulation of students' learning; through dialogue and interaction, the student learns with the support of a more capable teacher (Hadwin & Oshige, 2011; McCaslin & Hickey, 2001). Teachers and students co-regulate students' learning by asking questions and requesting information from each other. Co-regulation occurs within successful scaffolding. Wood, Bruner, and Ross (1976) defined *scaffolding* as the adult who controls those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate on those elements that are within his range of competence (p. 90). In successful scaffolding, teachers are expected to dominate the teacher-student interactions at the start of a new task with their teacher support. When time passes and student competence increases, teachers can decrease their support and shift more responsibility to the student. In this study, we focus on diminishing teacher support and its relationship to students' assumption of responsibility. Figure 1 shows this transitional process of co-regulation for teachers and students based on a model of scaffolding adapted from Van de Pol, Volman, and Beishuizen (2010).

Empirical research on co-regulation between teachers and students is limited; some small-scale studies showed that teachers provided opportunities for active student behaviour and that students took on responsibility (Hadwin et al., 2005; Karasavvidis et al., 2000). Another study showed teachers and students had difficulties in decreasing support and taking on responsibility, respectively (Rasku-

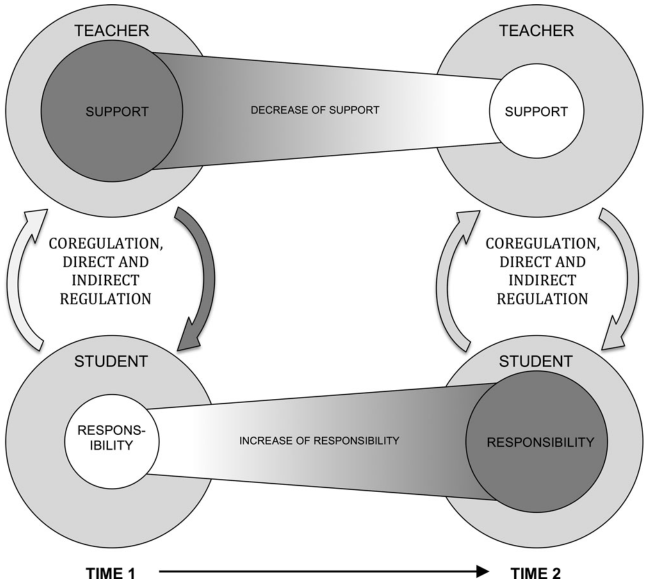

Figure 1. Transitional process to co-regulation adapted from (Van de Pol et al., 2010).

Puttonen et al., 2003). These researchers focused on secondary school students (Karasavvidis et al., 2000; Rasku-Puttonen et al., 2003) or graduate students (Hadwin et al., 2005) in different domains. Co-regulation was investigated during teacher-student interactions using the concept of scaffolding; they determined if teachers decreased their support, students took more responsibility between the beginning and the end of a task, and co-regulation occurred.

Hadwin et al. (2005) studied the teacher-student transition of dialogue regulation during a six-credit yearlong research task. Ten graduate students participated and had to develop a research portfolio that demonstrated their research skills. Students met individually with an instructor to review their portfolio. The qualitative discourse analysis did indeed show the hypothesised shift in domination of the dialogue. The researchers concluded that students were merely listening and observing at the start of the research task while teachers dominated the teacher-student interactions. As time passed, teacher support decreased and, consequently, students took on responsibility and self-regulated their learning. Karasavvidis et al. (2000) studied tutorial sessions between a geography teacher and ten secondary school students (grade ten; fifteen years old) on a three-hour correlational reasoning task and found that teachers decreased their support. Rasku-Puttonen et al. (2003), however, did not find a shift towards more student regulation. They observed two history teachers who did not decrease their support, but rather increased their controlling activities at the end of a five-month learning task. Therefore, their 34 secondary school students (thirteen years old) did not take on more responsibility. These three studies show most teachers decreased their regulation, the teacher-student meetings differed in terms of co-regulation, but the scaffolding principle did not always hold as expected.

Co-regulation and Scaffolding in Research Supervision

Undergraduate research supervisors who are scaffolding research projects should apply strong teacher support in the early phase of a project; the result of gradually decreasing this support will lead to more student independence (Shanahan, Ackley-Holbrook, Hall, Stewart, & Walkington, 2015 as cited in Moore, Dueweke, Newton, & Stevens-Russ). Manathunga (2005) described in her study a research supervisor who gave constructive written and verbal feedback for the first months and then the amount of feedback gradually decreased. Shanahan et al. (2015) argue in the initial stages of research often more hands-on supervision is needed than at later points (p. 363). At the beginning, students need to know what good research looks like, and then the supervisor tries to move to a point of independence for their students (Lee, 2008). Once research is underway research supervisors should be sensitive to how much guidance each student requires (Malachowski, 1996). Opportunities for co-regulation of learning occur when teachers and students are sharing their responsibility. Hosein and Rao (2017) recommend a combination of a teacher-directed and student-directed approach to develop undergraduate students' knowledge of research methods and to provide space for students and becoming a researcher. However, teachers find research supervision difficult as they are balancing between directive interventions and allowing students to find their own way (Vehviläinen & Löfström, 2016). PhD supervisors also experience this tension when they are trying to move towards student independence; failure to move to this point causes anxiety (Lee, 2008). Vehviläinen and Löfström (2016) showed that their research supervisors were concerned with when should one intervene and when to refrain from intervening; they dealt with the problem of ownership and the sharing of responsibility with their students. This study tries to test the theory of co-regulation in research supervision, by determining how it differs at the beginning of the supervision process versus and at the end of it.

Feedback Perception

Feedback is closely associated with the co-regulation of learning, as co-regulation results from teacher-student interactions and daily feedback activities (Allal, 2016). Adaptive support has proven to be useful in encouraging students' self-regulation as an outcome of feedback conversations (Carless, 2006; Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001). When students receive teacher feedback, they must first perceive the feedback before they can accept or act upon it (de Kleijn, Mainhard, Meijer, Brekelmans, & Pilot, 2013). For example, when students have positive perceptions about the feedback, that feedback has a positive effect on student learning (Harks, Rakoczy, Hattie, Besser, & Klieme, 2014). Harks et al. (2014) argued when students perceive feedback as useful, they feel competent, and a positive change in interest occurs. Then, students actually use the feedback, which leads to better performances. Directive feedback will be most helpful during the early stages of learning, when teacher support gradually decreased as students gain knowledge (Shute, 2008). When teacher feedback encourages students' active role, students get the opportunity to take on responsibility, and this makes co-regulation of learning possible. In this study, we focus on the differing feedback perceptions of students when they are interacting with their teacher.

Motivation

According to the self-determination theory (SDT) all students possess inner motivational resources that can potentially allow them to engage constructively and proactively during learning activities (Reeve, Ryan, Deci, & Jang, 2012). Motivated students are better regulators of learning, and good regulators of learning stay motivated for the task they are doing (Zimmerman & Schunk, 2012). Motivated students are expected to actively contribute to the co-regulation of their learning with their teachers. Within SDT, three levels of motivation are distinguished: the lowest level is amotivation, followed by extrinsic motivation, and intrinsic motivation (Deci & Ryan, 1985). However, many educational activities are not designed to be intrinsically interesting and do not automatically motivate students to carry them out on their own. Students have to regulate their behaviour and transform the regulation into their own. Ryan and Deci (2000) have ordered the different types of motivation and regulation in terms of the extent to which motivation for one's one behaviour emerges from one's self (p. 61). Amotivation, for example, refers to students who feel no intention to act. External regulation refers to students who satisfy an external demand or obtain a reward. Identified regulation refers to students who have identified with the value of the learning activity. At the far right is intrinsic motivation. The different types of motivation and regulation are placed on a continuum, but students do not necessarily progress through every stage. A student can adopt a new behavioural regulation at any point, depending on their experience or the situation.

The motivational resources that students possess are more or less activated and can be influenced by teachers' actions. Within educational environments, student motivation is generally most positive when students experience high autonomy (Reeve & Jang, 2006). Reeve and Jang (2006) define autonomy as the experience that students' actions originate from themselves (p. 209). Teachers cannot directly give students the experience of autonomy, but they can encourage and support this experience by creating learning opportunities (Reeve & Jang, 2006). Reeve et al. (2012) and Reeve and Jang (2006) investigated the instructional behaviours of autonomy-supportive teachers and identified examples of this behaviour: listening and asking what students want and need; creating independent work time; and offering praise and encouragement. These teaching behaviours fit the scaffolding principle of adaptive teaching and offer opportunities for co-regulation of learning.

Present Study

Undergraduate research has been defined as "an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline" (Council of Undergraduate Research, 2018). Experiences with undergraduate research are important to improve for example students' communicating skills, critical thinking skills, and problem solving skills (Seymour, Hunter, Laursen, & DeAntoni, 2004). An undergraduate thesis is a first step in research, demanding the development of research and writing skills (Wisker, 2012). Teachers should encourage students' self-regulation by decreasing their support when students' understanding increases. We expected our teachers to decrease their support, and our students to take on responsibility. We measured this at two different moments in the research process: in the starting phase, when the research plan was written, and towards the end of the project, when the final draft version of the thesis is discussed. Therefore, the following research questions were addressed:

- How does the *co-regulation* between teachers and students during research supervision meetings shift in the course of a five-month research project?
- How does students' *feedback perception* and *motivation for their research task* shift in the course of a five-month research project?

Methods

Design

In this exploratory study, a mixed methods study design was used (Creswell & Clark, 2011; Luck, Jackson, & Usher, 2006). The quantitative and qualitative data were used to paint a more complete picture of co-regulation, feedback perception, and motivation in research supervision (Bazeley, 2018). Using the qualitative data, we tested the theory of co-regulation within research supervision. Using the quantitative data, we tried to add new knowledge about feedback perception and motivation. We used a concurrent embedded strategy. Concurrent meant that the qualitative and quantitative data were collected at the same time; embedded meant the qualitative method addressed a different question (about co-regulation) than the quantitative method did (about feedback perception and motivation) (Creswell & Clark, 2011). In this study, we focused on triangulation by data source as we collected data from different students and teachers, at two different times. We also applied triangulation by method and by data type, as we quantitatively analyzed the questionnaire data and qualitatively analyzed the video observations (Meijer, Verloop, & Beijaard, 2002).

Context

This study was conducted within the context of the writing of an undergraduate thesis and face-to-face research supervision meetings in higher education. Students were in the final year of their bachelor of health programme at a Dutch university. The students wrote their thesis alone or in pairs and had 20 weeks to conduct their research project and write their thesis (30 ECTS; 840 h). During the course, the students had approximately eight supervision meetings with their teacher; two of these meetings were selected for data gathering.

Two supervision meetings in the research process were used to collect the data. The first supervision meeting was observed during week 3; this meeting was selected because students were working on the draft version of their research plan, they had not handed in their final version, and they still needed help from their teacher. The second supervision meeting was observed during week 18; this meeting was selected because students were working on the draft version of their final thesis. The third week was called Time 1 and the eighteenth week was called Time 2.

Research Course

Students worked on a research plan in which they wrote a theoretical framework, their research questions, and a methods section. Before students could start data gathering, an independent assessor (not the teacher) determined if their research plan was of sufficient quality. Most students worked on their plan for five weeks before handing in their final version. After the approval of their research plan, students continued with their research project. They gathered and analysed data, and wrote a results and discussion section. At the end, students wrote a final draft version of the thesis and sent it to their teacher. Teachers read the final draft version of the students' thesis and provided feedback during the last supervision meeting. Based on the received feedback, students finalised their thesis. Again, an independent assessor assessed the final version of their thesis. Figure 2 shows an overview of the undergraduate research course.

Participants

A total population of 87 students and 10 teachers were part of the research course and agreed to participate in the study. Teachers and students were informed that the researchers were investigating the interaction between teachers and students. All participants gave informed consent before data collection started. The supervision meetings of 85 students and ten teachers were observed and videotaped in week 3. Questionnaire data of these 85 students were collected in week 3, and used for reliability and factor analyses.

The supervision meetings of 28 students and six teachers were observed and videotaped in week 18. Questionnaire data of these 28 students were collected in week 18. Most students carried out their research project in pairs. Because we were interested in teacher-student interactions over time, we wanted the interaction opportunities to be similar for all participants in this study. For that reason, we decided to exclude students who worked on their thesis alone or who had their supervision meetings alone. This case selection led to 20 students (ten pairs) (*M* age = 22.7; 90% female) and six teachers. Each teacher with two students was defined as a triad. The data of these ten triads were used for further testing on differences between week 3 and 18.

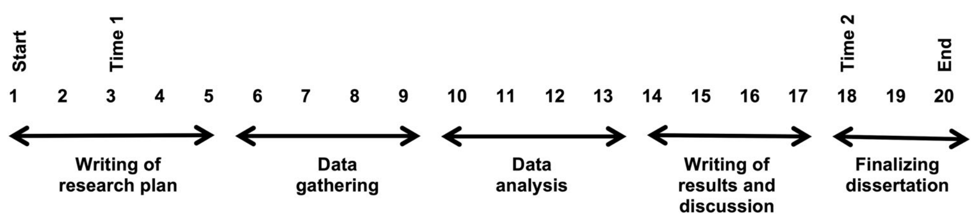

Figure 2. Overview of the twenty-week undergraduate research course.

Measures

Co-regulation

The degree of regulation of learning processes for teachers and for students can be represented as a continuum ranging from very low to very high (Vermunt & Verloop, 1999). We used a continuum of regulation of learning for students and teachers and distinguished four different levels as Hadwin et al. (2005) did: (1) teacher direct regulation; (2) teacher indirect regulation; (3) student indirect regulation; and (4) student direct regulation. Co-regulation was measured with teachers and students' indirect regulation; indirect regulation occurs when teachers and students are questioning and requesting information from each other, when they are sharing thoughts and ideas, and regulating together. As a result, teacher direct regulation and student direct regulation are not considered to be co-regulation.

Hadwin et al. (2005), Karasavvidis et al. (2000), and Rasku-Puttonen et al. (2003) determined teacher and student regulation of learning based on the function of speech and communication. They coded teacher and student utterances on direct and indirect regulation. As language users, teachers and students signal their intended meaning and interpretation of their utterances by using characteristic words. With these characteristic words, they signal the communicative function of a phrase. Within studies on collaborative learning, the function of communication is also researched as *dialogue acts* (Erkens & Janssen, 2008; Van der Schaaf, Baartman, & Prins, 2012). Erkens and Janssen (2008) distinguished five different communicative functions: (1) *argumentative* utterances indicate a line of argumentation or reasoning; (2) *elicitative* utterances indicate questions or proposals requiring a response; (3) *imperative* utterances indicate commands; (4) *informative* utterances indicate transfer of information and; (5) *responsive* utterances indicate confirmation, denial, or answer.

In this study, we combined the coding of the function of speech from co-regulation research with the dialogue act coding from collaborative learning research. Instruction, demonstration, and explanation were defined as argumentatives and imperatives (direct regulation), while prompting and asking questions were defined as elicitatives (indirect regulation)(Erkens & Janssen, 2008; Hadwin et al., 2005; Karasavvidis et al., 2000). The supervision meetings of ten triads were observed at Time 1 (week 3) and Time 2 (week 18) to determine the shift in co-regulation.

Feedback Perception

To determine a shift in students' perception of feedback, the Feedback Perception Questionnaire (FPQ) was used at Time 1 and Time 2 (Strijbos, Narciss, & Dünnebier, 2010). The FPQ consists of 18 items that use a five-point Likert scale ranging from 1 (fully disagree) to 5 (fully agree). The 18 items were divided into six scales of three items. The six scales measured *Fairness* (e.g., I would consider this feedback justified), *Usefulness* (e.g., I would consider this feedback helpful), *Acceptance* (e.g., I accept this feedback), *Willingness to Improve* (e.g., I shall improve my work), *Affect Positive* (e.g., I feel satisfied receiving this feedback on my work) and *Affect Negative* (e.g., I feel frustrated receiving this feedback on my work).

Reliability analysis and factor analysis were conducted with the questionnaire data of the 85 students who filled out the questionnaire at Time 1. Exploratory factor analysis was conducted to empirically explore the underlying structure of the eighteen items of the feedback perception questionnaire of Strijbos et al. (2010). As we anticipated the scales to be correlated, a principle component analysis with oblique (oblimin) rotation was applied. The pattern matrix and scree plot were used to determine the number of components, and factor loadings were used to interpret and label the components (Costello & Osborne, 2005). The non-fixed principle component analysis provided a four-component structure. For this four-component model, sampling appeared to be adequate (*Kaiser-Meyer-Olkin* measure of sampling adequacy = .87; individual item values ranging from .52 to .83), and inter-item correlations appeared to be sufficiently large (Bartlett's test of sphericity χ^2 (153) = 908.35, $p < .001$). Based on these results, and the factor solution of Strijbos et al. (2010), we chose to use the four-component solution. This solution accounted for 69.1% of the total variance. The Eigenvalues (after rotation) showed that the factor Willingness to Improve explained the most variance (43.5%) in the data structure and contributed most to the factor solution. Following the outcome of this analysis, we decided to use the four scales that Strijbos et al. (2010) described with two exceptions; we did not apply the merged Affect scale, and the two items of the Acceptance scale that loaded on factor 2 were added to the Affect Negative scale (see Appendix). This resulted in four scales: *Willingness to Improve, Affect Negative, Affect Positive,* and *Adequacy of Feedback*. Cronbach's alpha and item-rest correlations were analysed for each scale. All feedback perception scales were considered reliable (Cronbach's alpha > .70).

After the factor analysis, four reliable scales were determined, and the four scales — Willingness to Improve (n = 3 items; Cronbach's alpha = .71), Affect Negative (n = 5 items; Alpha = .83), Affect Positive (n = 3 items; Alpha = .80) and Adequacy of Feedback (n = 7 items; Alpha = .90) — were used in further analyses on the data of the 20 selected students.

Motivation

To determine a shift in students' motivation, the Situational Motivation Scale (SIMS) was used at Time 1 and Time 2 (Guay, Vallerand, & Blanchard, 2000). The SIMS consisted of 16 items, which used a seven-point Likert scale ranging from 1 (does not correspond at all) to 7 (corresponds exactly); the 16 items were divided into four scales of four items. The scales measured *Intrinsic Motivation* (e.g., Because research is fun), *Identified Regulation* (e.g., Because I am doing it for my own good), *External Regulation* (e.g., Because it is something I am supposed to do) and *Amotivation* (e.g., There may be good reasons to do this, but personally, I don't see any).

Reliability analysis and factor analysis were conducted with the data of the 85 students who filled out the questionnaire at Time 1. Exploratory factor analysis was conducted on the 18 items. As we anticipated the scales to be correlated, a principle component analysis with oblique (oblimin) rotation was applied. The pattern matrix and scree plot were used to determine the number of components; factor loadings were used to interpret and label the components (Costello & Osborne, 2005). The non-fixed principle component analysis provided a four-component structure. For this four-component model, sampling appeared to be adequate (*Kaiser-Meyer-Olkin* measure of sampling adequacy = .77; individual item values ranging from .46 to .85) and inter-item correlations appeared to be sufficiently large (Bartlett's test of sphericity χ^2 (120) = 648.49, $p < .001$). Based on these results, we chose to use the four-component solution as Guay et al. (2000) did. This four-component solution explained 66.6% of the total variance. The Eigenvalues (after rotation) showed that the factor Intrinsic Motivation explained the most variance (32.5%) in the data structure and contributed most to the factor solution. Following the outcome of this analysis, it was decided to use the four scales that Guay et al. (2000) described: a scale *Amotivation,* a scale *External Regulation,* a scale *Identified Regulation,* and a scale *Intrinsic Motivation*. Cronbach's alpha and item-rest correlations were analysed for each scale. All motivation scales were found to be reliable (Cronbach's alpha > .70).

After the factor analysis four reliable scales were determined, and the four scales Intrinsic Motivation (Alpha = .82), Amotivation (Alpha = .86), Identified Regulation (Alpha = .79), and External Regulation (Alpha = .70) were used in further analyses on the data of the 20 selected students. See Figure 3 for an overview of the study.

Materials and Procedure

Video Camera

The supervision meetings were videotaped with a fixed camera. On the day of observation, the first author installed and started the video camera, but was not present in the observation room during the videotaping of the meeting. Students were used to cameras being present because they often videotaped their own conversations for self-reflection. Teachers reported that they were aware of the camera for the first few minutes, but after that, forgot its presence.

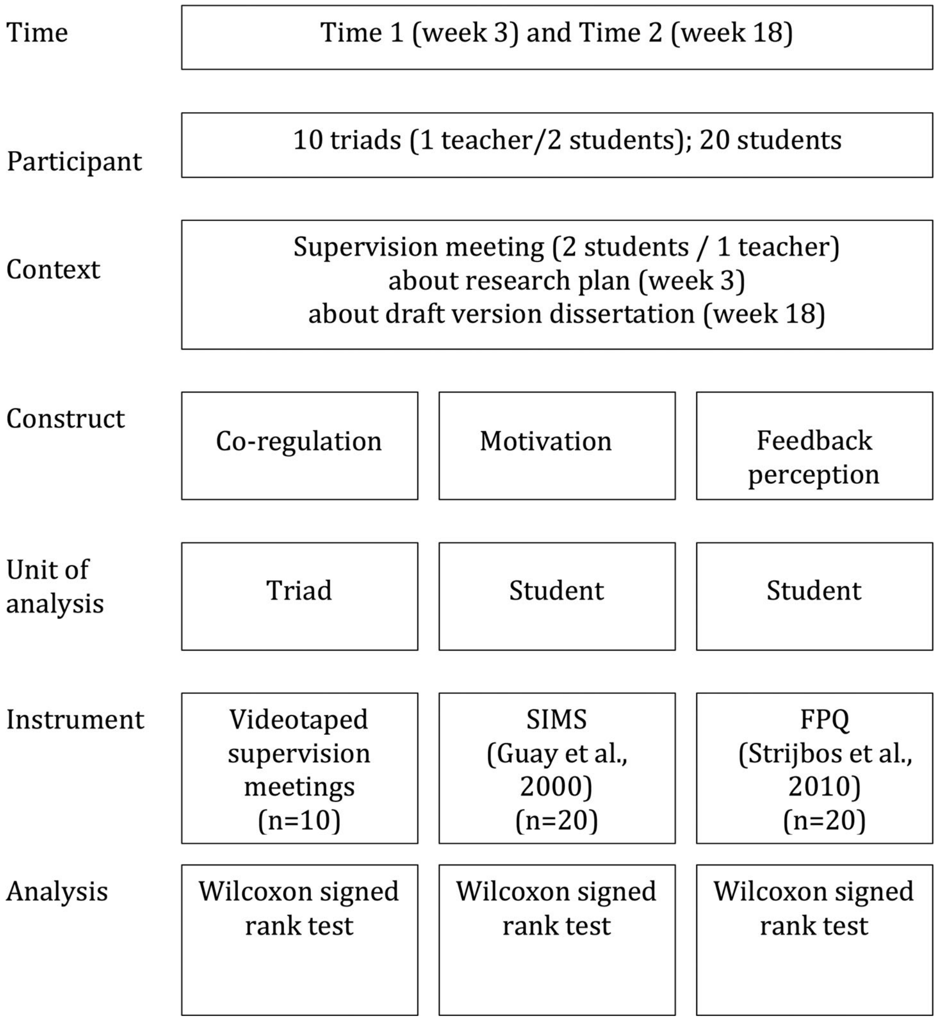

Figure 3. Overview of the study.

Questionnaires

Directly after the supervision meeting, students were asked to fill out the Feedback Perception Questionnaire (FPQ) (Strijbos et al., 2010) and the Situational Motivation Scale (SIMS) (Guay et al., 2000). Students filled out the questionnaires in a different room than the one the supervision meeting took place in.

Video Transcription

All 20 videotaped supervision meetings (n = 10 at Time 1; n = 10 at Time 2) were transcribed verbatim into simple transcripts. Videos were transcribed literally, with punctuation, pauses, continuers (e.g., hm, yeah) and turn taking, but without intonation or non-verbal behaviour. During transcription speech turn taking was used as the first segmentation criterion, because it fits the natural course of the conversation (Chi, 1997). Thus, a speaker got his/her own paragraph and a blank line was used between speakers. As each meeting consisted of a triad, this resulted in three different speakers' turns of the teacher, student 1, and student 2.

Data Analysis

Co-regulation

Co-regulation was analysed in two steps. First, dialogue act coding was used to code teachers' and students' utterances on five communicative functions. The unit of analysis consisted of each teacher's turn and student's turn. Second, teacher's and student's communicative functions were used to determine direct and indirect regulation with each triad as the unit of analysis. Both steps are described in detail in the next paragraph.

Dialogue act Coding. All transcripts were imported in the programme Multi Episode Protocol Analysis (MEPA). MEPA is a computer programme that is used for the analysis and coding of discussions (Erkens, 2005). MEPA offered facilities for automatic coding based on a rule system that automatically categorised utterances into dialogue acts (Erkens & Janssen, 2008). This rule system used if-then rules for pattern matching, i.e., to look for typical words or phrases. For example, the segmentation filter of MEPA used 300 rules to scan for punctuation characters (i.e., "?", "!", "."), connectives ("however", "so") and starting-discourse markers (i.e., "well"). The utterances were segmented before and after the marker. This so-called Dialogue Act Coding (DAC) filter coded the segmented utterances based on recognition of words and phrases. The DAC filter recognised words and phrases that signified the communicative function of the message. Five different communicative functions and twenty-nine dialogue acts were distinguished (see Table 1). All utterances (both students and teacher) were coded on the five communicative functions and on the 29 dialogue acts with the programme MEPA. Frequencies of the communicative function codes were computed for each supervision meeting.

Direct and Indirect Regulation. To determine the regulation of learning during the supervision meetings, the communicative functions were transformed to direct and indirect regulation for teachers as well as students.

Teacher direct regulation (TDR) occurred when the teacher initiated action and regulated student learning (e.g., by evaluating the student's research questions). When the teacher used an argument, the DAC filter coded this segment as an argumentative. When the teacher used a directive or commanding utterance, the DAC filter coded this segment as an imperative. The argumentative and imperative segments were summed and TDR was assigned.

Teacher indirect regulation (TIR) occurred when the teacher invited the students to regulate their learning (e.g., by posing a question like "What are your strong points?"). When the teacher asked a question, the DAC filter coded this segment as an elicitative and TIR was assigned.

Student indirect regulation (SIR) occurred when the students requested help from the teacher to regulate their learning (e.g., by posing a question "How can I do better on this task?"). When the students asked a question, the segment was coded as an elicitative. The segments were summed for both students and SIR was assigned.

Student direct regulation (SDR) occurred when the student initiated and completed the regulation of learning alone (e.g., by explaining how s/he carried out a certain task, or indicating a certain difficulty). When the student used an argument, the DAC filter coded this segment as an argumentative. When the student used a directive or commanding utterance, the DAC filter coded this segment as an imperative. The two segments were summed for both students and SDR was assigned.

Shifts in co-regulation, Feedback Perception, and Motivation

For the analysis of co-regulation, the raw frequencies of the twenty supervision meetings were not comparable across time and across triads because the duration of supervision meetings differed. To account for that fact, the raw frequencies of TDR, TIR, SIR, and SDR were converted to percentages. A within-triad analysis was done on the co-regulation, feedback perception, and motivation data. Because these data were not normally distributed, we applied the non-parametric Wilcoxon

Table 1 Description of categories for analysis of regulation of learning with dialogue act coding.

Segment	Regulation	Communicative function	Dialogue act	Code	Description	Discourse marker, i.e.,
Teacher /Student	Direct regulation	Argumentatives	Reason	ArgRsn	Reason, ground	"Because … "
			Contra	ArgCnt	Counterargument	"However, … "
			Conditional	ArgCon	Condition	"If … "
			Then	ArgThn	Consequence	"Then … "
			Disjunctive	ArgDis	Disjunctive	"Or … "
			Conclusion	ArgCcl	Conclusion	"So, … "
			Elaboration	ArgEla	Continuation	"Furthermore, … "
		Imperatives	Action	ImpAct	Order for action	"W8!"
			Focus	ImpFoc	Order group member to focus	"Hey!"
Teacher /Student	Indirect regulation	Elicitatives	Question Verify	EliQstVer	Yes/no question	"Agree?"
			Question Set	EliQstSet	Set question/multiple choice	" … or … .?"
			Question Open	EliQstOpn	Open question	"Why?"
			Proposal Action	EliPrpAct	Proposal for action	"Let's change … "
Teacher /Student	Other regulation	Responsives	Confirmation	ResCfm	Confirmation of info	"Right"
			Deny	ResDen	Refutation of info	"No"
			Acceptation	ResAcc	Acceptance of info	"Oh"
			Reply Confirm	ResRplCfm	Affirmative reply	"Sure"
			Reply Deny	ResRplDen	Negative reply	"No way"
			Reply Accept	ResRplAcc	Accepting reply	"Okay"
			Reply Statement	ResRplStm	Statement reply	" … "
		Informatives	Performative	InfPer	Action performed by saying it	"Hello"
			Evaluation Neutral	InfEvlNeu	Neutral evaluation	" … easy … "
			Evaluation Positive	InfEvlPos	Positive evaluation	"Nice!"
			Statement	InfStm	Task information	" … "
			Action	InfStmAct	Announcement of actions	"I'll do … "
			Social	InfStmSoc	Social statement	"Love you … "

signed rank tests. We tested for differences between Time 1 and 2 on the median percentages of TDR, TIR, SIR, and SDR; on the four perception scales; and on the four motivation scales that were found to be reliable. For these analyses, the completed questionnaire data for the 20 students at Time 1 and 2 were used. Exploratory correlation analysis was done between the feedback perception scales and motivation scales.

Co-regulation Excerpts

A between-triad analysis was done on co-regulation to explore triad patterns. We defined consistent regulation of learning when triads had a high TDR and low SDR at Time 1 and 2, and when triads had a balanced TDR and SDR at Time 1 and 2. To apply this label of consistent regulation, we used the group means of TDR at Time 1 ($M = 47.08\%$) and at Time 2 ($M = 47.31\%$) and the group means of SDR at Time 1 ($M = 28.39\%$) and at Time 2 ($M = 29.33\%$). For each triad, we determined if the TDR and SDR score was higher or lower than the mean score at Time 1 and 2.

Results

Descriptives of Dialogue Act Coding

In total, 12 h and 15 min of supervision meetings were transcribed and 25.968 dialogue acts were coded, with 6.856 argumentatives, 332 imperatives, 2.261 elicitatives, 7.699 informatives, and 8.827 responsives.

Shifts in Co-regulation

The within-triad analysis with the Wilcoxon signed rank tests showed no differences between Time 1 and 2 for triads' TDR, TIR, SIR, and SDR and thus no differences for triads' co-regulation (TIR and SIR) (see Table 2).

The between-triad analysis of the coded results in Table 3 showed huge differences between triads. Many triads showed high levels of teacher direct regulation (TDR) and moderate levels of student direct regulation (SDR). These high levels of direct regulation lead to quite low levels of co-regulation; teacher indirect regulation (TIR) and student indirect regulation (SIR) were very low compared to their direct regulation. Other triads seemed to show more of a balance in their co-regulation of learning. Over time, triads showed a very consistent regulation of learning pattern. Two different patterns were distinguished for six of the ten triads. Three triads (3, 8 and 9) showed consistent low co-regulation over time with low indirect regulation (TIR and SIR) and high direct regulation (TDR and SDR). Three other triads (5, 6 and 7) showed consistent moderate to high co-regulation over time with moderate to high levels of indirect regulation (TIR and SIR) between students and teacher (see Figure 4).

Patterns of Co-regulation

To illustrate the pattern of low co-regulation, we provide an excerpt of the observation of triad 8 at Time 2. In this excerpt the high direct regulation of teacher 8 is shown; teacher's utterances are frequently coded with argumentatives and informatives (see Table 4).

To illustrate the pattern of high co-regulation, we provide another excerpt of the observation of triad 5 at Time 1. In this excerpt the high direct regulation of the students is shown; students' utterances are frequently coded with argumentatives and informatives (see Table 5).

Table 2. Wilcoxon signed rank-test results comparing Time 1 and 2 on co-regulation, feedback perception and motivation.

	Time 1			Time 2			Difference			
	Mdn	Min	Max	Mdn	Min	Max	T	*z*	*p*	*r*
Co-regulation										
Teacher direct regulation	.43	.32	.62	.47	.35	.62	25.00	−.26	.80	.06
Teacher indirect regulation	.17	.08	.27	.16	.09	.26	19.00	−.87	.39	.19
Student indirect regulation	.08	.03	.15	.07	.04	.16	27.00	−.05	.96	.01
Student direct regulation	.29	.13	.44	.27	.13	.44	22.00	−.56	.58	.13
Feedback perception										
Willingness to Improve	5.00	3.33	5.00	5.00	4.00	5.00	23.50	−.412	.68	.07
Affect Negative	1.00	1.00	2.60	1.40	1.00	3.00	21.50	−1.03	.30	.16
Affect Positive	3.33	2.00	4.33	3.83	1.00	4.67	71.50	−.96	.34	.15
Adequacy of Feedback	4.57	3.00	5.00	4.29	2.71	5.00	33.50	−.84	.40	.13
Motivation										
Intrinsic Motivation	5.25	4.00	6.25	4.75	2.25	5.75	25.00	−2.83	.005**	.45#
Amotivation	1.63	1.00	4.00	3.38	1.00	5.75	30.50	−2.19	.03*	.35#
External Regulation	4.13	1.75	6.00	4.75	2.25	5.75	56.00	−1.57	.12	.25
Identified Regulation	5.63	4.00	6.75	4.75	2.25	5.75	23.50	−2.09	.04*	.33#

$^*p < .05$; $^{**}p < .01$; $^{\#}r \geq .30$.

Table 3. Descriptive results of dialogue act coding for teacher-student regulation per triad at Time 1 and Time 2.

		Teacher direct regulation				Teacher Indirect Regulation				Student Indirect Regulation				Student Direct Regulation			
		Time 1		Time 2		Time 1		Time 2		Time 1		Time 2		Time 1		Time 2	
Triad	T	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
8	8	248	62.31	341	61.78	84	21.11	106	19.20	14	3.52	31	5.62	52	13.07	74	13.41
9	8	298	60.82	233	52.13	88	17.96	65	14.54	22	4.49	29	6.49	82	16.73	120	26.85
3	3	175	56.82	245	47.76	50	16.23	94	18.32	22	7.14	35	6.82	61	19.81	139	27.10
2	2	162	46.02	388	47.03	66	18.75	187	22.67	27	7.67	46	5.58	97	27.56	204	24.73
10	9	161	43.40	192	45.07	58	15.63	39	9.15	41	11.05	47	11.03	111	29.92	148	34.74
5	4	263	43.33	208	38.31	74	12.19	49	9.02	13	2.14	31	5.71	257	42.34	255	46.96
6	7	144	43.11	151	40.27	26	7.78	38	10.13	18	5.39	35	9.33	146	43.71	151	40.27
4	3	109	41.76	338	51.37	44	16.86	115	17.48	26	9.96	44	6.69	82	31.42	161	24.47
1	2	97	41.63	475	54.47	62	26.61	229	26.26	19	8.15	32	3.67	55	23.61	136	15.60
7	7	121	31.59	175	34.93	64	16.71	48	9.58	61	15.93	82	16.37	137	35.77	196	39.12

Note. *f* = frequency of utterances coded within one supervision meeting in that week; % = relative frequency of utterances coded as proportion of total amount of utterances within one supervision meeting in that week; T = teacher.

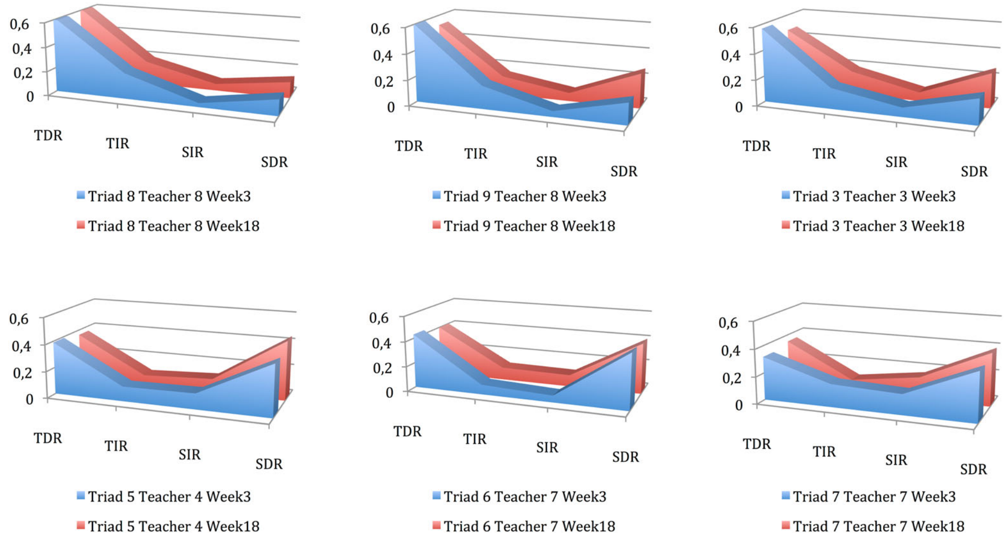

Figure 4. Triads with a consistent co-regulation of learning pattern over time.

Shifts in Feedback Perception and Motivation

The Wilcoxon signed rank tests also showed no differences between Time 1 and 2 for students' feedback perceptions. The Wilcoxon signed rank tests did show significant differences between Time 1 and 2 for students' motivation. After the supervision meeting at Time 2, students' Intrinsic Motivation and Identified Regulation were significantly lower and students' Amotivation was significantly higher than after the supervision meeting at Time 1 (see Table 2). No differences were found for External Regulation. Medium effect sizes were found for Intrinsic Motivation, Amotivation and Identified Regulation.

Correlation Between Feedback Perception and Motivation

Correlation analyses were performed between the scale scores of the FPQ and the SIMS (see Table 6). All feedback perception scales correlated significantly with each other, and almost all motivation scales correlated significantly with each other. The scores on the Amotivation scale correlated significantly with scores on all feedback perception scales. The Identified Regulation scale correlated

Table 4. Excerpt of low co-regulation (Triad 8; Teacher 8; Time 2; Lines 925–939).

Line	Speaker	Utterance	Code
925	Teacher8	Actually, your main research question is more descriptive …	InfStm
926	Teacher8	… what is the effect? …	EliQstOpn
927	Teacher8	… what are the strategies?	EliQstVer
928	Teacher8	And it is not … one group has more than the other.	ArgThn
929	Teacher8	Because, you did not pose a research question about that at all.	ArgRsn
930	Teacher8	And when it becomes obvious there are differences between males and females …	ArgCon
931	Teacher8	… well then you zoom in to it.	ArgThn
932	Student1	Yes	ResCfm
933	Teacher8	It is tempting to test these differences when you have the data.	ArgThn
934	Student1	Yes	ResCfm
935	Student2	Yes	ResCfm
936	Teacher8	But it is actually …	ArgCnt
937	Teacher8	… it is actually not necessary …	InfStm
938	Teacher8	… because you haven't got a research question about it …	ArgRsn
939	Teacher8	… thus, you are doing something you are not asking.	ArgCcl

Table 5. Excerpt of high co-regulation (Triad 5; Teacher 4; Time 1; Lines 422-438).

Line	Speaker	Utterance	Code
422	Teacher4	Because, do you have any clue in which direction to do your literature review …	ArgRsn
423	Teacher4	… when you are talking about strategies …	ArgCon
424	Teacher4	… and how to define strategies.	InfStm
425	Student1	We have searched for coping strategies …	InfStm
426	Student1	… and found several studies …	InfStm
427	Student1	… and then we read what these researchers found …	InfStm
428	Student1	… but many publications just described peoples' emotions, instead of the strategies they literally used …	ArgCnt
429	Student1	… so we have …	ArgCcl
430	Student2	… one publication.	InfStm
431	Student1	We found only one publication …	InfStm
432	Student2	… that really focused on strategies.	InfStm
433	Student1	Yes.	ResCfm
434	Teacher4	Uhum	InfStm
435	Student2	The other publications were about the difficulties people encounter …	ArgEla
436	Teacher4	Uhum	InfStm
437	Student2	… and which emotions they had.	EliQstOpn
438	Teacher4	And what kind of combinations of keyword are you using?	EliQstVer

Table 6. Correlation matrix between feedback perception scales and Situational Motivation Scales.

	WI	AN	AP	AF	IM	AM	ER	IR
Willingness to Improve (WI)	1.00							
Affect Negative (AN)	−.24*	1.00						
Affect Positive (AP)	.29**	−.46**	1.00					
Adequacy of Feedback (AF)	.49**	−.61**	.60**	1.00				
Intrinsic Motivation (IM)	.18	−.15	.16	.20	1.00			
Amotivation (AM)	−.38**	.34**	−.41**	−.53**	−.38**	1.00		
External Regulation (ER)	.09	−.08	.09	.22*	−.27*	.09	1.00	
Identified Regulation (IR)	.24*	−.09	.29**	.28**	.54**	−.48**	−.09	1.00

*$p < .05$; **$p < .01$.

significantly with the Willingness to Improve scale, the Affect Positive scale and the Adequacy of Feedback scale. The Intrinsic Motivation scale did not correlate with any of the feedback perception scales.

Discussion

Consistent Co-regulation from the Beginning to the End

The first aim of this study was to test the theory of co-regulation in the context of research supervision; we aimed to provide insight into how teachers and undergraduate students co-regulated students' learning. We answered the research question "How does the co-regulation between teachers and students during research supervision meetings shift in the course of a five-month research project?" We expected an increase in co-regulation; teachers and students who are sharing thoughts and ideas about the research project they were working on, instead of teachers telling their students what to do. However, the within-triad analysis showed no significant differences among the ten triads in their teacher-student regulation of learning between Time 1 and Time 2. Teacher and student indirect regulation (TIR and SIR) had the same regulation of learning pattern at Time 2 as they had at Time 1. It seemed teachers and students co-regulated their meetings identically at Time 1 and Time 2. The expected difference between the starting phase and final phase of writing and supervising the thesis was not found. A more closer look at the different triads did show two patterns, but not one triad showed a shift in co-regulation; direct regulation and indirect regulation were as high (or as low) on Time 2 as they were on Time 1.

Scaffolding: No Decreasing of Support or Taking on Responsibility

The scaffolding principle, with a decrease in teacher support and an increase in student responsibility, should have made more co-regulation possible. As this transition did not occur, co-regulation stayed the same. Within the low student and high teacher regulation triads (5, 6 and 7), the students asked some questions and rarely offered any argument. The teachers in these triads controlled the dialogue with their arguments. This low level of student regulation (students merely observing and being passive) makes sense given that students had just started working on their thesis research (Prins & Mainhard, 2009, August). The teachers showed very active behaviour, and these high levels of teacher direct regulation make sense, since at the beginning of a new task, teachers must engage in more explanation and instruction to increase students' understanding (Hadwin et al., 2005). At Time 2, these teachers had not decreased their support, and students were not able to or did not get any opportunities to take on more responsibility. These results were contrary to the conceptual model of Van de Pol et al. (2010) and the results of Hadwin et al. (2005). Teachers and students were showing the same behaviour in the final phase of the thesis. The unchanged high level of teacher direct regulation at Time 2 was not expected for a task on which students had worked on for 5 months; students were expected to be more active during these teacher-student interactions. Rasku-Puttonen et al. (2003) also found that teachers maintained control at the end of the task and that some teachers even increased their controlling activities.

The other three triads (3, 8 and 9) were regulating students' learning processes in a much more equal way. Within these triads, a more balanced regulation of learning occurred. At Time 1, teachers and students were already co-regulating and sharing their thoughts and arguments in an equal way. These teachers gave opportunities to their students for active participation during the supervision meetings, and the students were able to pick up that active role and accept more responsibility. These findings were contrary to the conceptual model of Van de Pol et al. (2010) and conflicted with the results that Hadwin et al. (2005) found, as teachers might have decreased their support even more, and students might have taken on more responsibility. Fortunately, the students who were active at Time 1 remained active at Time 2. Most importantly, this balance in regulation between teachers and students are considered authentic co-regulation; teachers and students shared their thoughts and arguments, prompted, and guided each other. An explanation for the findings above could be that students' autonomy cannot be influenced that easily; it is not just a matter of supporting students' autonomy more or less. Students' learning might not simply improve, but may be a non-linear process (Willison, Sabir, & Thomas, 2017). Teachers might be following their own script and objectives (Nathan & Kim, 2009) and not providing opportunities for their students to take on that active role.

Feedback Perception and Motivation

The second aim of this study was to add new knowledge to the existing one about how students perceive teacher feedback, and how motivated they are for their research task. We answered the second research question of "How does students' feedback perception and motivation for their research task shift in the course of a five-month research project?" Results showed no differences in feedback perception between Time 1 and 2. Apparently, the research phase seemed to have no impact on students' perception of feedback. It did not matter what kind of teacher regulation was used. Students perceived feedback as valuable whether it came from a teacher that used high direct regulation or from a teacher who used direct regulation more in balance with student regulation. It seems neither a high level nor a low level of autonomy support is valued more by students. The level of structure, support, and space that teachers provide might depend on context, student characteristics, and educator purpose (Willison et al., 2017). Our findings are in line with the results of Overall, Deane, and Peterson (2011) who found no association between the degree of teachers' support for students' autonomy and students' satisfaction with their supervision.

Results showed significant differences in motivation between Time 1 and 2. Intrinsic Motivation and identified Regulation decreased and Amotivation increased between Time 1 and Time 2. When students started conducting research, it seemed they were quite motivated, but when the work was done and the final feedback was given, motivation dropped. A possible explanation for this drop in motivation could be that students did not see the value of research skills for future life. Murtonen, Olkinuora, Tynjälä, and Lehtinen (2008) argued that when students do not see this value, they may have problems in their motivation to learn research skills. Another explanation could be that the supervisors did not pay enough attention to student's active participation and motivation; Mackiewicz and Thompson (2013) argued that supervisors can enhance student's motivation during supervision meetings by giving praise, encouragement, and statements of sympathy or empathy. Järvelä, Järvenoja, and Malmberg (2012) emphasised that especially students who are poorly motivated need support to become active regulators of their own learning; by reinforcing students' ownership supervisors can give students the responsibility for their writing (Mackiewicz & Thompson, 2013). The students who interacted with "high regulation teachers" might not have experienced a lot of autonomy support from their teachers, and this may have affected their motivation for research. Autonomy supportive teachers always seek students' initiative and support their intrinsic motivation (Reeve, Bolt, & Cai, 1999). Students who interacted with "low regulation teachers" might have experienced their teachers as autonomy supportive, but perhaps did not feel competent enough to finish their thesis.

Correlation analysis between feedback perception and motivation showed that Intrinsic Motivation did not correlate to any feedback perception scale. Apparently, it did not matter for their intrinsic motivation what kind of feedback a student received; when students are interested in doing their own research, negative feedback will not influence this. On the other hand, when students have low intrinsic motivation, positive feedback will not help either. The Adequacy of Feedback correlated positively with External Regulation and with Identified Regulation, but negatively with Amotivation. Apparently, the more adequate the feedback is, the more motivated a student will be for doing research.

Limitations and Future Research

This study is subject to some limitations. First, this study focused on a small sample of students and their teachers in a specific context in higher education. Therefore, we were not able to generalise any results to the broader population of students in higher education. In future larger scale studies, students' feedback perception and motivation could be investigated to determine differences between the beginning and the end of a task. Second, we did not focus on the reasons why students and teachers showed certain regulation throughout the supervision meetings and why students' motivation dropped. More research is needed to discover answers to these questions. This information could be used to develop interventions for students to better prepare themselves for these supervision meetings about undergraduate research, and for teachers to adapt their supervision. Information about how autonomy supportive teachers can increase or maintain students' motivation would be helpful.

Implications

In this study, we tried to unravel the research supervision process and to generalise to the theory of scaffolding and co-regulation. Teachers can encourage students' regulation of learning with their supervision; some teachers showed scaffolding behaviour in which they stimulated students' active roles by co-regulating students' learning. These teachers seemed to be sensitive, finding out how much guidance each student requires just as Malachowski (1996) described. Other teachers still seem to search for a balance between giving support and allowing students to find their own way just as the teachers of Vehviläinen and Löfström (2016) did. The results of this study do fit the modes of regulation, including co-regulation, as found in collaborative settings (Hadwin & Oshige, 2011). The reviewed studies on co-regulation by Panadero and Järvelä (2015) showed co-regulation to be an unbalanced regulation of learning, as its use has not been consistent. The results of this study add to that knowledge, as co-regulation did not correspond to the expected scaffolding process in time with teachers who decrease their support, and students who increase their responsibility.

Conclusion

It can be concluded that co-regulation between teachers and students in supervision meetings concerning undergraduate students' research projects does not vary significantly over the course of students' research projects. Our study showed a constant and comparable level of regulation during supervision meetings at the start and at the end of students' research projects. Analysis of these teacher-student interactions showed some supervisors were very eager to teach. These supervisors were willing and wanting students to learn as much as possible from their teaching. In their enthusiasm, they offered much feedback and many explanations, resulting in students acting quite passively. Other supervisors seemed to be more autonomy-supportive to the students; these supervisors' students took more responsibility in regulating their learning than other students did. Unfortunately, students' motivation dropped independent of the way their supervisors acted. This balance of collaboration between supervisors and students who were regulating students' learning processes together is considered to be true co-regulation. We argue co-regulation is not easy and so few supervisors can do it, even an experienced supervisor will struggle with this. We conclude that students' learning process cannot be easily influenced. It is a non-linear process; it accelerates and decelerates and supervisors cannot just readily increase or decrease their support for students. Several supervisors have to reach beyond their own repertoire: they should not simply follow their own scripts but should provide opportunities for students to take an active role.

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Appendix

Table A1. PCA component loadings (*N* = 85) of Feedback Perception Questionnaire with oblique (oblimin) rotation.

		Components			
Scale	Items	I	II	III	IV
Fairness	I am satisfied with this feedback	**.506**	−.297	−.231	.067
	I would consider this feedback fair	**.864**	−.094	.134	.003
	I would consider this feedback justified	**.790**	−.094	.197	−.001
Usefulness	I would consider this feedback useful	**.494**	−.234	−.166	.267
	I would consider this feedback helpful	**.644**	.072	−.341	−.044
	This feedback provides me a lot of support	**.682**	−.016	−.248	.050
Acceptance	I accept this feedback	**.538**	.021	−.226	.304
	I dispute this feedback	.141	**−.719**	.051	.199
	I reject this feedback	.009	**−.821**	−.059	.123
Willingness	I shall improve my work	.118	.111	−.111	**.663**
	I shall invest a lot of effort in my revision	.195	.058	−.061	**.819**
	I shall work on further revision of my work	−.166	−.170	.090	**.817**
Affect	I feel … receiving this feedback on my work				
Positive	Satisfied	.153	−.237	**−.610**	.057
	Confident	−.005	−.099	**−.813**	.054
	Successful	−.039	.030	**−.876**	−.002
Negative	Offended	.092	**−.751**	.134	−.043
	Angry	−.065	**−.874**	−.094	.053
	Frustrated	.055	**−.740**	−.239	−.260
Eigenvalues		7.84	1.93	1.57	1.10
% Of variance explained		43.53	10.72	8.74	6.12
I			.248	.190	.440
II				.263	.545
III					.449

Note. Loadings above .40 are boldface.

Table A2. PCA component loadings (*N* = 85) of Situational Motivation Scale with oblique (oblimin) rotation.

	Components			
Scale Items	I	II	III	IV
Intrinsic motivation				
Because I think research is interesting	**.571**	.177	.108	.242
Because I think research that research is pleasant	**.895**	.006	−.052	−.059
Because research is fun	**.940**	.077	−.022	−.112
Because I feel good when doing research	**.593**	−.077	−.014	.226
Identified regulation				
Because I am doing it for my own good	−.021	−.006	−.061	**.888**
Because I think that doing research is good for me	.348	−.168	.375	.282

(*Continued*)

Table A2. Continued.

Scale	Items	Components I	II	III	IV
By personal decision		.246	.213	.143	**.433**
Because I believe that doing research is important for me		.256	−.177	.313	**.500**
External regulation					
Because I am supposed to do it		.194	**.853**	−.124	.195
Because it is something I am supposed to do		.125	**.848**	−.063	−.065
Because I don't have any choice		.275	**.615**	.150	−.163
Because I feel that I have to do it		−.018	**.792**	.095	−.023
Amotivation					
There may be good reasons to do this, but personally I don't see any		−.040	.128	**.763**	.158
I do this but I am not sure if it is worth it		.087	−.046	**.877**	−.110
I don't know; I don't see what this brings me		.009	−.027	**.945**	−.163
I do this, but I am not sure it is a good thing		−.140	.009	**.777**	.082
Eigenvalues		5.21	2.69	1.64	1.11
% Of variance explained		32.54	16.82	10.29	6.93
Component correlations	I		.166	.375	.296
	II			.034	.001
	III				.276

Note. Loadings above .40 are boldface.