

Beyond the self

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BEYOND THE SELF

A NETWORK PERSPECTIVE ON REGULATION
OF WORKPLACE LEARNING

DERK BRANSEN

Beyond the self:

A network perspective on regulation of workplace learning

Derk Bransen

The research reported here was carried out at



Maastricht University



Maastricht UMC+

in the School of Health Professions Education



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Beyond the self:

A network perspective on regulation of workplace learning

PROEFSCHRIFT

Ter verkrijging van de graad van doctor aan de Universiteit Maastricht,

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Derk Bransen

Promotor

Prof. Dr. E.W. Driessen

Co-Promotoren

Dr. M.J.B. Govaerts

Dr. D.M.A. Sluijsmans, Rotterdam University of Applied Sciences

Beoordelingscommissie

Prof. Dr. A.B.H. de Bruin (chair)

Prof. Dr. F.W.J.M. Smeenk

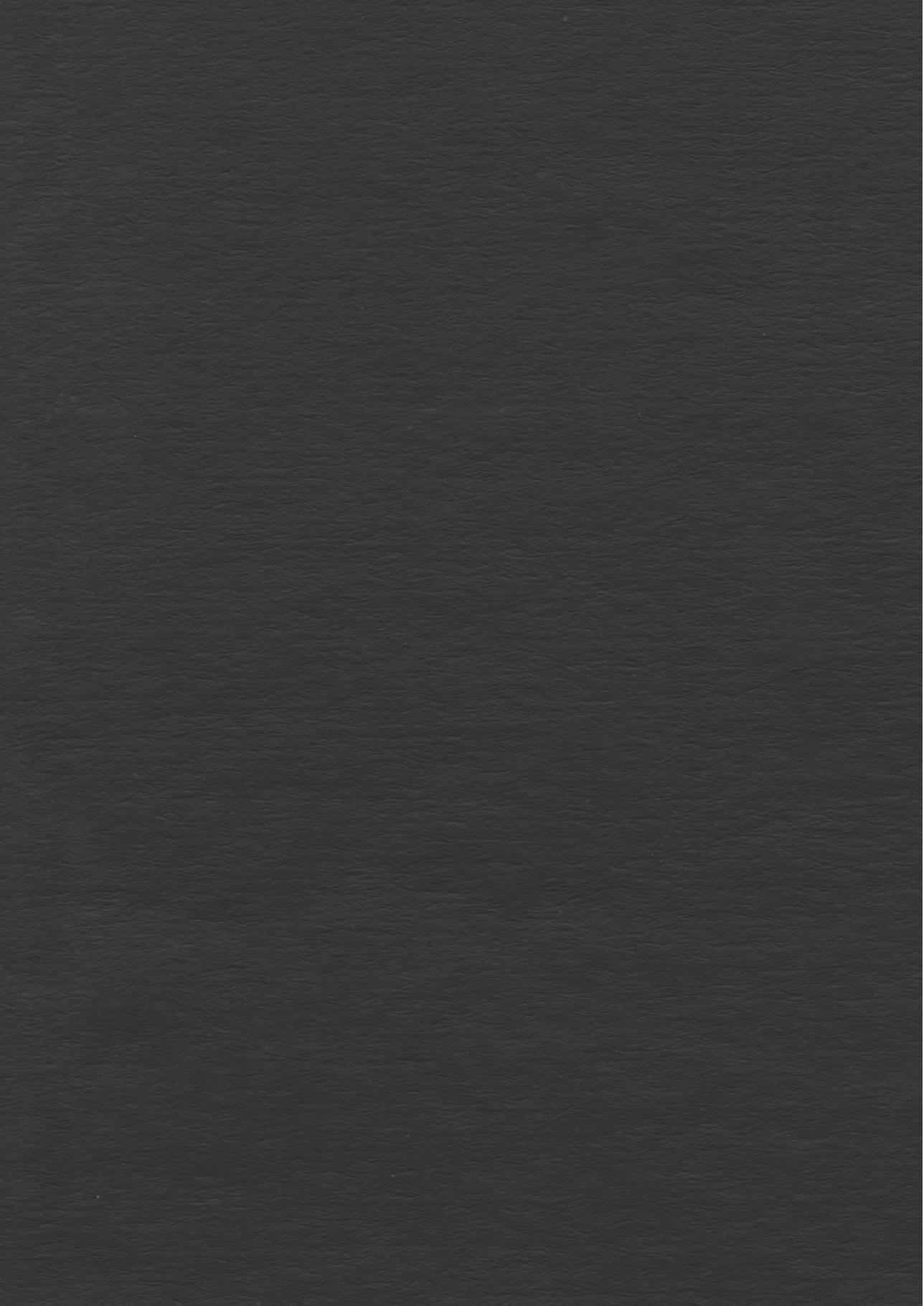
Prof. Dr. C.R.M.G. Fluit, Radboud University Medical Center

Dr. J. Berkhout, Heliomare Rehabilitation Center, Wijk aan Zee

Dr. S. Rovers

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CHAPTER 1

GENERAL INTRODUCTION

Introduction

Regulation of learning and development is widely considered an important competence for healthcare professionals as it is essential for (lifelong) learning throughout their professional careers.¹ For example, physicians are expected to monitor and quickly adapt to rapid and sometimes unpredictable developments within their respective fields of expertise and to seek or create learning opportunities in accordance with perceived gaps in their knowledge or skills.² Additionally, reflecting on learning processes, activities, and outcomes – which is considered a key component of self-regulated learning (SRL) – helps physicians to become aware of the extent to which learning goals are achieved, to pinpoint potential struggles during learning, and to gain input for identification of future learning needs.³ Because of its relevance for becoming and being a competent healthcare professional, many health professions education (HPE) curricula foster students' development of the complex skills underlying self-regulatory learning behaviours. For example, some curricula offer training sessions to help students learn how to formulate attainable and relevant learning goals,⁴ or how to reflect on learning processes and progress.⁵ To this end, HPE curricula increasingly implement portfolio-systems that assist students in monitoring their learning processes and activities.^{6–9} Notwithstanding these initiatives, research findings show that SRL remains challenging for medical students, especially in clinical clerkships.^{10,11}

In this introduction, I will elaborate on the concept of SRL and factors that may influence effectiveness of students' SRL in clinical clerkships. I will describe current challenges with regulation of learning, and I will point out problems that have yet to be overcome to help students meaningfully regulate their learning in the social and dynamic context of clinical learning environments. This chapter ends with stating this dissertation's research aims and an outline of the studies.

Regulation of learning

In research as well as educational practice, conceptualisations of regulatory learning tend to primarily focus on processes *within* the individual, thus focusing on the *self* within self-regulation of learning. Since its conception in the late 1980s, many SRL models have been developed, refined and expanded. Generally, all conceptual models consider self-regulated learners to be proactive participants in their own learning through (meta-)cognitive, motivational, behavioural, and/or emotional engagement.^{12–14} Processes such as strategic planning, organizing, and self-monitoring comprise the metacognitive component of SRL.^{12,15} Motivational aspects of SRL refer to, for example, learners' self-efficacy beliefs and learning

goal orientations.^{12,16} Behavioural aspects of SRL refer to learners' structuring, selecting, and creating environments that facilitate their learning.¹² Lastly, emotions may influence any of the abovementioned characteristics of regulation of learning.¹⁷

Although SRL models may differ in their specific focus – for example varying in their emphasis on either (meta-)cognitive, motivational, emotional, and/or behavioural aspects of regulatory learning – there seem to be several common underpinning assumptions. First, SRL refers to *active* engagement in learning processes.¹⁸ Second, SRL is characterized by *goal-directedness* and refers to learners' purposeful engagement during learning activities.^{12,15,18} Third, SRL is considered *context-dependent*, with different contexts and learning activities requiring different goals and strategies.^{19–21} Fourth, SRL models tend to integrate some form of *cyclicity*, incorporating different phases with the final phase of one SRL cycle providing input for the first phase of another SRL cycle.^{2,15}

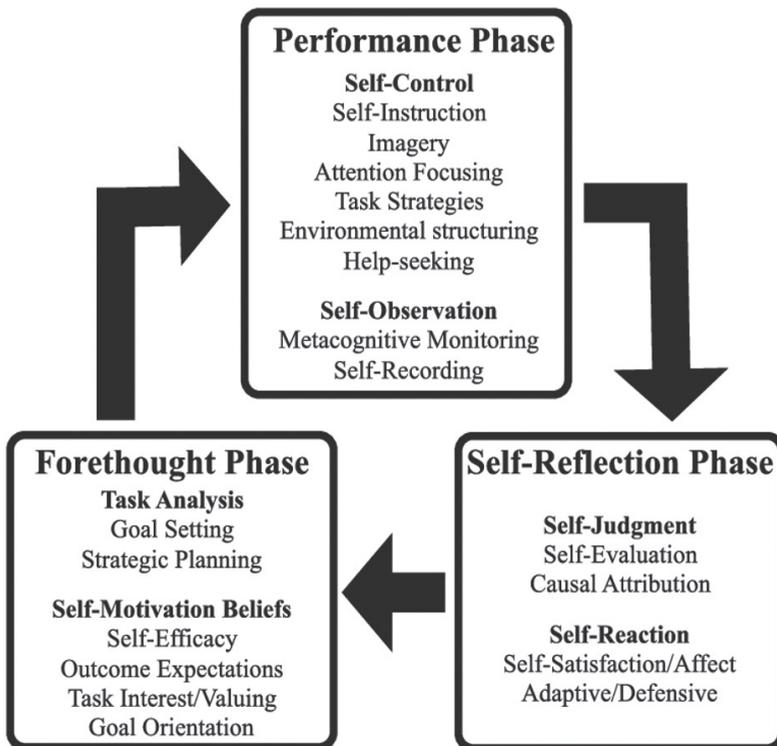


Figure 1.1 Phases and sub-processes of Zimmerman's model of self-regulated learning (Zimmerman BJ. *Becoming a self-regulated learner: An overview*. *Theory into Practice*. 2002;41(2):64-70).

A well-researched model is Zimmerman's model of self-regulated learning (figure 1.1),¹⁵ which encompasses three phases: a forethought phase, a performance phase, and a self-reflection phase. The forethought phase precedes actual engagement in learning or task performance and consists of formulating learning goals and strategic planning. Motivational beliefs (e.g., self-efficacy and learning goal orientation) influence processes and outcomes of this phase.¹⁵ The performance phase refers to processes during actual task performance, including processes such as performance monitoring and attention focusing. During the self-reflection phase, which follows actual task performance or learning activities, students reflect on their learning processes and activities and may engage in attributing causes to successes and/or failures.¹⁵ Emotions may influence several aspects of SRL, although they may be particularly salient during self-reflective processes after task performance or learning activities.¹⁷ Zimmerman's model is considered cyclical, because the output of the self-reflection phase may provide input for the forethought phase of a new SRL cycle.

Self-regulation of learning: A challenge

Although many HPE curricula aim to stimulate and facilitate students' engagement in regulation of learning, self-regulatory learning proves to be challenging for students in clinical settings¹⁰ – due to a multitude of factors. A broad range of contextual, personal, as well as social attributes interact and jointly influence how students regulate their learning in clinical learning environments.²¹ For example, students' personal beliefs about and motivation for learning may influence the nature and focus of their learning goals.²¹ Students who believe that communication skills cannot be learned, for instance, and who feel that “this is just something you have got or haven't got”, or “something you are born with”, may refrain from setting explicit learning goals within this competency domain.²² Additionally, students who transition from learning in classroom settings to clinical workplaces have to adapt their learning to learning environments that are dynamic, unstructured and often unpredictable. This transition forces students to abandon or adjust regulatory behaviours that were effective in the preclinical, well-structured curriculum and to find new ways to self-regulate their learning processes and activities.¹⁰ Students may feel uncertain about what is expected of them in the new learning environment, what learning affordances are offered, or how to create learning opportunities. As they may feel inadequately equipped to transfer previously acquired competencies to the new setting, they have to engage in new learning and new learning strategies, adding to their struggles with regulation of their learning.¹⁰ Social attributes such as relationships and familiarity with others in the environment may then provide further affordances and constraints to students' regulatory

learning.²¹ Driven by uncertainty about clerkship expectations, medical students may for instance help one another in understanding and navigating the new clinical learning environments.²³ Students may furthermore engage residents in formulation of realistic and attainable learning goals,²³ alike residents interact with their supervisors to pursue their learning goals.²⁴ Similarly, surgical residents may recruit their supervisors to help them monitor their performance during surgery.²⁵ However, the presence of peers and learners from other health care professions may also inhibit development of SRL. When learning opportunities are distributed among students, for example, some students may be left empty-handed and provided with fewer opportunities to develop SRL skills through active engagement in learning from and for work.¹⁸ These and other findings suggest that relationships and interactions with others in the clinical learning environment are key to the regulation of learning,^{2,20,26} and research increasingly acknowledges the relevance of the social context – and development of professional relationships within that social context – for SRL to be effective.²⁰

Challenging the self in regulation of learning

For many decades, our thinking about learning has been focused on the individual and socio-cognitive aspects of learning – heavily influenced by cognitive psychology. Learning is then typically considered a “thing” that is contained in the individual mind. In line with these conceptualisations of learning, researchers interested in regulation of learning tend to equally emphasize motivational, (meta-)cognitive, and/or emotional processes *within* the individual learner, primarily focusing on the *self* in self-regulatory learning and the individual as the unit of analysis.²⁷ Many SRL models – including Zimmerman’s model – therefore originate from socio-cognitive learning theories.²⁸ These models typically label processes within the individual as *modus operandi* of regulatory learning. Although such models acknowledge the influence of context on learners’ self-regulation, its influence is generally considered to affect regulation at the individual level, for example, when others in the learning environment support a student’s learning through task modelling or provision of feedback.^{27–29} In other words, although socio-cognitive perspectives acknowledge the influence of the social environment on regulatory learning processes and activities, its influence is positioned somewhat peripherally, rather than at the heart of (regulation of) learning.

A focus on the individual subsequently penetrates curriculum and assessment design and informs educational interventions.^{4,5} Building on research findings, educational interventions aimed at fostering students’ development of regulatory learning then typically emphasize

the need to optimize learning environments in order to better help individual students master relevant skills for planning, organizing, monitoring and evaluating their own learning and professional development.^{30–33} Increasingly, however, it is acknowledged that social interactions are key – even indispensable – for learning, and that learning is social as well as individual.^{20,23} Notions of social learning are, for instance, embedded in pedagogies such as problem-based learning, which rely on collaborative learning strategies.^{4,5} Similarly, learning in workplace settings is increasingly described and researched from a socio-cultural perspective, which emphasizes that learners are significantly influenced by their environment while simultaneously co-producing and co-creating the contextual surroundings in which they learn and work.^{34,35} In other words: learning and performance in workplace settings is shaped by continuous interactions between the individual and a broad range of social, organizational, cultural and other contextual factors in the environment.

Sociocultural learning theories thus emphasize the contextual and social embeddedness of processes and activities relevant for learning and – by extension – processes underlying regulation of learning.^{16,36–39} Learning – and arguably the regulation of learning – in clinical workplaces is grounded in social interactions with others in the clinical learning environment.³⁴ As a consequence, the shift towards sociocultural conceptualisations of learning may call for a change in the way we theorize regulatory learning, by putting context and the learners' interactions within social context at the heart of our thinking. Conceptualisations of regulatory learning with a focus on *self*-regulation and regulatory processes *within* the individual student may then be inadequately suited to capture and describe how regulation of learning occurs within the social, dynamic context of clinical practice. Likewise, an exclusive focus on the individual as unit of analysis no longer seems appropriate from a sociocultural perspective that considers learning and regulation of learning to be embedded in (social) contexts. Rather, theorizing regulatory learning from a sociocultural perspective may require a shift towards units of analysis that comprise the interactions between the learner and (others in) their learning environment.²⁷ Research on the social embeddedness of SRL is gaining momentum. However, we have yet to construct a comprehensive understanding of how medical students' regulatory learning is shaped by how they are socially embedded in the dynamic and unpredictable health care setting, and how they interact with others in their learning environment.

Research aims and questions

The research aim of this PhD thesis is twofold. First, I aim to explore conceptualisations of regulatory learning fitting a sociocultural perspective on workplace learning as well as the alignment of socio-cognitive perspectives on SRL with the social and interactive nature of clinical workplace learning. Second, I aim to investigate how medical students in clinical learning environments engage in regulation of their learning, using a sociocultural learning perspective. More specifically, I explore medical students' networks in clinical settings, and if and how interactions within these networks affect their regulation of learning. The research presented in this thesis therefore aims to address the following research questions:

- How are current conceptualisations of regulation of learning aligned with demands for collaboration in current healthcare, and how may expanding conceptualisations of regulation of learning add to our understanding and use of regulatory learning in healthcare settings?
- What are medical students' perceptions of network-based regulation of learning in clinical clerkships and its impact on their self-regulated learning behaviours?
- What are relationships between characteristics of medical students' networks for regulation of learning, characteristics of the learning environment, and self-regulated learning in clinical settings?
- What are reasons for students to select and engage others in their networks for regulation of their learning and (how) does the student's study year affect this?

Thesis outline

I designed a series of studies that provide insight into the overall research aims of this thesis. The first research aim is addressed in chapter 2 and chapter 6. In chapter 2, I explore different conceptualisations of regulation of learning (self-, co-, and socially shared regulation of learning), and elaborate on how the integration of these conceptualisations may add to our understanding and enhancement of regulatory learning in nowadays educational and healthcare settings. In chapter 6, I argue that SRL may best be considered as a socially grounded act and that measurement methods should be able to capture the social and contextual embeddedness of regulatory learning. The second research aim is addressed in chapters 3, 4 and 5. In these chapters, I present three empirical studies that aim to improve our understanding of how students in clinical clerkships regulate their learning through interacting with others in their networks.

Research presented in chapter 3 explores undergraduate medical students' perceptions of network-based regulation of learning in clinical clerkship environments. Drawing on constructivist grounded theory, I conducted semi-structured interviews with students of varying levels of experience to describe and theorize how students engage others in regulation of their learning. Chapters 4 and 5 present quantitative social network studies. In chapter 4, I explored and described relationships between characteristics of medical students' networks in clinical settings (network size, network diversity, and interaction frequency), students' perceptions of learning opportunities, and their self-reported self-regulated learning. Chapter 5 presents a study on how students use their networks in regulation of learning, and more specifically, the purposes for which medical students in different phases of their clinical training engage others in their co-regulatory networks. For both chapter 4 and chapter 5, I drew on the social network perspective and associated techniques to design, collect, analyse, and interpret the data. In chapter 7 – the discussion chapter – I reflect on the main research findings, relate them to existing literature and future research directions, and highlight the main messages of this dissertation. I furthermore describe this dissertation's implications for education and practice.

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CHAPTER 2

PUTTING SELF-REGULATED LEARNING IN CONTEXT: INTEGRATING SELF-, CO-, AND SOCIALY SHARED REGULATION OF LEARNING

Bransen D, Govaerts MJB, Panadero E, Sluijsmans DMA, Driessen EW.
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Abstract

Processes involved in the regulation of learning have been researched for decades, because of its impact on academic and workplace performance. In fact, self-regulated learning is the focus of countless studies in health professions education and higher education in general. While we will always need competent individuals who are able to regulate their own learning, developments in healthcare require a shift from a focus on the individual to the collective: collaboration within and between healthcare teams is at the heart of high-quality patient care. Concepts of collaborative learning and collective competence challenge commonly held conceptualisations of regulatory learning and call for a focus on the social embeddedness of regulatory learning and processes regulating the learning of the collective. Therefore, this article questions the alignment of current conceptualisations of regulation of learning with demands for collaboration in current healthcare. We explore different conceptualisations of regulation of learning (self-, co-, and socially shared regulation of learning), and elaborate on how the integration of these conceptualisations adds to our understanding of regulatory learning in healthcare settings. Building on these insights, we furthermore suggest ways forward for research and educational practice.

Introduction and problem statement

The necessity for healthcare professionals to regulate their learning is widely acknowledged due to positive associations with high-quality healthcare and lifelong learning.^{1,2} For example, safeguarding high standards in healthcare requires physicians to monitor relevant developments in continuously and rapidly changing healthcare practices and to align appropriate learning opportunities with personal learning needs and learning goals.³ Hence, physicians have to engage in self-regulated learning (SRL) to develop and maintain competence.⁴ Generally, self-regulated learners are considered to be “meta-cognitively, motivationally, and behaviourally active participants in their own learning”.⁵ In pursuit of and committed to their goals, they design and implement strategies aligned with these goals, monitor progression towards these goals, followed by reflection and – when applicable – formulation of new learning goals.^{6,7}

Because of its relevance for education and practice, and as SRL skills can be learnt and therefore taught, health professions curricula build in elements to support and facilitate the development of students’ SRL.^{8–10} For example, many curricula implement portfolio systems that stimulate or require students to reflect on progress and formulate personal learning plans,¹¹ or include problem-based learning principles to stimulate students’ self-directedness.^{12,13} Research findings consistently show that the ability to regulate one’s learning and professional development is associated with positive outcomes.¹⁴ For example, SRL has been related positively to medical students’ clinical skill performance,^{15,16} their overall academic achievement,¹⁷ and student well-being.¹⁸ However, we argue that there is a need and responsibility for health professions education and research to look beyond the self in order to adequately prepare students for practice, and to help professionals maintain and develop competence.

Health professions education (and healthcare practice, for that matter) has traditionally been characterised by a focus on the individual; education focuses on individual learners whom we licence individually after extensive individual assessment, and whom we teach to regulate their learning processes and activities on an individual level.¹⁹ One might argue that health professions education aims to move beyond the individual by including competency domains such as “Collaboration” in curriculum and assessment frameworks.²⁰ However, while described as ‘effectively working within a healthcare team to achieve optimal patient care’, learners’ proficiency as collaborators is still primarily based on their individual performance, even when evaluated in collaborative situations.²¹ Notwithstanding, present-day healthcare is increasingly team-based, delivered by healthcare teams, often consisting of healthcare

professionals collaborating across specialities and professions.^{22,23} As the main purpose of health professions education is to prepare students for this collaborative practice, it is essential that conceptualisations of regulation of learning align with the organisation and demands of learning and working in healthcare teams.

Geared to the growing reliance on healthcare teams for high-quality healthcare delivery, health professions education research has started to explore the concept of collective competence.^{22–24} The essence of collective competence is that the whole can be more (or less, for that matter) than the sum of its parts, and relates to the ‘dynamic, context-dependent, distributed capacity of a team, which is difficult to trace back to any one individual team member’.²⁵ In other words, ‘teams can be competent when one team member is incompetent, and competent individuals can form an incompetent team’.¹⁹ Although ensuring an individual physician’s competence is and remains essential, providing high-quality healthcare thus requires assurance of the healthcare team’s collective competence. To maintain and develop collective competence, it is essential that healthcare teams are able to engage in ongoing collaborative learning. Collaborative learning refers to learning that occurs when team members who have a collective goal interact about features of their shared tasks in order to attain their goals and by means of which they develop a set of integrated practices.^{26,27} As such, collaborative learning stretches beyond the individual and emphasises the interdependence among team members.²⁸ Collaborative learning may, for example, occur during trauma teams’ evaluation of healthcare delivery, when surgical teams start implementing new technology, or when students collaborate in performing learning tasks. Whenever collaborative learning is considered essential, the team’s ability to regulate their learning becomes of equal importance. In other words, if we agree that high-quality care hinges upon collaborative learning in healthcare teams, we should also focus on how to foster effective regulation of learning in order to develop and maintain collective competence. However, questions can be raised about the extent to which conceptualisations of regulation of learning in health professions education and research kept pace with the demands for collaborative learning and competence in healthcare practice.

Conceptualisations of regulation of learning

Self-regulated learning: focus on the individual

Chronologically, the first conceptualisations in the regulation of learning theory focussed on the self, that is, on how an individual student or professional regulates his or her individual learning. Some of the earliest attempts to conceptualise the regulation of learning were

made in the late 1980s by Zimmerman^{5,29} and by Boekaerts,^{30,31} with their SRL models having been adapted, expanded, and used for further research ever since.¹⁰ The first SRL models labelled processes within the individual – varying in their emphasis on either (meta) cognitive, motivational, or emotional aspects – as *modus operandi* of regulation of learning. Consequently, researchers interested in self-regulation of learning focussed on processes within the individual as the unit of analysis.³² Likewise, the majority of research (both within and outside the context of healthcare education) into SRL is conducted through collecting self-reported data.³³ Research on regulation of learning within healthcare (educational) settings with a strong focus on the individual is reflected in studies focussing on sub-components of SRL such as individualised learning plans,^{34–37} and self-monitoring of performance.^{38–40}

Co-regulated learning: Focus on interaction between individual and context

While early conceptualisations of regulation of learning (i.e. self-regulation of learning) emphasise processes within the individual learner, the term co-regulated learning (CRL) was coined in the late 1990s to capture the social and contextual influences on the regulation of learning.^{41–43} The concept of CRL emerged from sociocultural learning theories that focus on how learners' cognitions, emotions, and motivation for learning are mediated through social interactions with others in the environment.⁴¹ CRL thus builds on the notion that we need to go beyond regulatory processes within the individual in order to describe the regulation of learning satisfactorily, and the unit of analysis in CRL always is the interaction between the individual and (others in) the context.³² More specifically, CRL refers to non-reciprocal engagement in regulatory processes and activities, with the 'co-regulator' guiding the regulation of the 'co-regulated'. Conceptually, CRL is therefore considered an 'unevenly distributed' form of social regulation, in that a single or multiple group member(s) regulate(s) the learning activities of other individuals in the group.⁴⁴ Essential to CRL are social interactions between learners or professionals through which their learning processes, including processes relevant for the regulation of their learning, are mediated.^{45,46} Thus, through engaging in others' regulatory activities – such as goal setting, performance monitoring, and reflection – the 'co-regulator' mediates (i.e. co-regulates) the metacognitive and cognitive activities of the 'co-regulated', thereby influencing the regulation of his or her learning processes.^{41,45} Students or professionals can trigger CRL by summarising, requesting information, or giving explanations,⁴⁷ or through paraphrasing, requesting judgements of learning, giving prompts for thinking and reflection.⁴¹ Box 1 provides an example.

BOX 1 The co-regulation of learning how to close a wound after surgery

A student formulated a learning goal aimed at mastering basic techniques of wound closure. The supervising surgeon provides the student with the opportunity to pursue this goal by allowing the student to start the procedure of closing the wound. The role of the supervising surgeon consists of actively participating in the student's regulation of learning (i.e. co-regulation). Before the student starts, the surgeon may ask about the steps the student intends to take to close the wound successfully (co-regulation of strategic planning). Similarly, when the student is actively closing the wound, the surgeon may ask if the student is on the right track thus far (i.e. co-regulation of monitoring). After the student finishes closing the wound, the surgeon may ask about potential difficulties the student may have experienced and how he or she may improve future efforts (co-regulation of reflection and adaptation). After co-regulatory interactions with her supervisor, the student may then actively engage in and reflect on learning activities with the aim of transferring relevant skills for regulation of learning to other, unsupervised, learning tasks. Through engaging in the students' regulation of learning, the supervising surgeon helps to support the application and development of self-regulatory learning skills.

Importantly, CRL can take different forms, depending on the learning task, setting and/or relationships between co-regulator and learner. For example, power dynamics in hierarchical relationships or (perceived) differences in the level of expertise may influence the nature – and potentially effectiveness – of CRL. Co-regulation by peers may therefore differ substantially from supervisors' CRL in terms of goals and outcomes. Within health professions education, emergent research on co-regulation of learning is providing insight into the different manifestations and foci of CRL engagement. Research findings suggest that medical students differ in whom they engage as well as the purpose of engaging others' CRL. For instance, novice students seem to favour peers to discuss their learning goals, whereas experienced students favour more experienced healthcare professionals to reflect on professional identity formation.⁴⁸ Other studies into CRL adopted a social network perspective, and examined characteristics of the networks students' deploy when regulating their learning. Findings revealed that, in particular, the interaction frequency with which others are engaged in CRL positively relates to students' self-reported regulation of learning proficiency.⁴⁹

Socially shared regulation of learning: Focus on the team within context

At the start of the 21st century, fuelled by the increasing importance and need for collaborative learning, research started exploring how groups regulate their collective learning and performance in a distributed fashion. The term socially shared regulation of learning (SSRL) was coined to explain such regulatory actions. Generally, SSRL describes how teams regulate their collaborative learning and emphasises interdependency among members of a group or team. SSRL focuses on processes through which team members share the regulation of their collective learning activities, directed towards the pursuit of their jointly constructed goals.^{41,50} Similar to CRL, SSRL reflects a mode of regulatory learning in which the regulation is shared between individuals. The main difference, however, is that CRL involves one (or more) group members to guide the regulation of an individual learner (making it an 'unevenly distributed' form of social regulation), whereas SSRL is characterised by group members' reciprocal engagement in regulatory activities and processes. SSRL is therefore considered an 'evenly distributed' form of social regulation in which the regulation is shaped by and arises through the interactions between members of the group.⁴⁴ Therefore, the units of analysis in SSRL are the collective, the system, as well as the individual within the system.^{32,51}

Collaborative learning in medical practice may be prone to challenges. For example, fluid healthcare teams in which team members reshuffle constantly, time constraints, or hierarchy within healthcare teams may influence the extent to which collaborative learning is actually taking place. Collaborative regulation of such learning may subsequently be even more difficult. Hadwin, Järvelä, and Miller⁵² were among the first to describe a theoretical model SSRL. Their conceptualisation of collaborative regulation of learning includes four phases that jointly describe the modus operandi of SSRL.⁵² Notably, these phases roughly correspond to the four phases in Winne and Hadwin's SRL model.⁵³ In phase one, teams engage in the co-construction and negotiation of a shared understanding or perception of the (learning) task at hand. In phase two, teams co-construct shared goals to effectively complete the task and design a plan for how to tackle the task collectively. In phase three, the team monitors their progression towards the goal, to which collaboration is strategically coordinated. Perceptions and understanding of the task, their goal(s), strategies, or plans might be adjusted based on their collective monitoring of goal progression. Lastly, in phase four, teams evaluate the process, which might provide input for adaptation of future regulation, learning and performance. Drawing on Edmondson's work about how introducing new technology influences teamwork, Box 2 provides an example of how healthcare teams

may engage in socially shared regulation of learning.⁵⁴ We acknowledge that the example in Box 2 may not reflect common, day-to-day practice. However, the research the example is based on, lends itself well to explain how SSRL may occur in clinical workplaces. Although SSRL may be particularly relevant in cases of disruptive events that force healthcare teams to re-direct their learning endeavours (such as in the example in Box 2), SSRL is not exclusive to such events. Other examples in health professions education and practice that may appeal to teams' engagement in SSRL or components of SSRL include evaluation of corporate training systems, the building of collaborative communities of practice,⁵⁵ team reflection, or medical students collaborating in co-constructing a shared perception of their learning tasks.

BOX 2 SSRL when adopting new technologies

Adopting new technology may raise challenges to healthcare teams, as habitual routines may be disrupted. Teams then have to go through a learning process, which involves creating a shared willingness to start using the technology (motivation) as well as a shared mental model of what the new technology implies, not just in terms of new knowledge and skills but also in terms of potentially changing tasks and responsibilities of team members (SSRL phase 1). In her paper about implementation of a minimally invasive cardiac surgery innovation, Edmondson described how surgical teams engaged in learning to implement this technology. Her findings showed that teams who were effective in adapting to a new reality, spent time on engaging all team members in the team effort (both intellectually and emotionally) as well as creating a clear definition of the team's goals, roles, and responsibilities in the implementation process (SSRL phases 1 and 2). Successful OR teams then proceeded by jointly developing strategies for learning such as trial sessions and ongoing monitoring of the implementation process (SSRL phases 2 and 3). Then, OR teams continually engaged in monitoring of and reflection on their progress, through processes of attempting new behaviours and debriefing (reflection and debriefing) in order to learn (SSRL phase 4).

It is important to note that describing SSRL in terms of distinct phases refers to a theoretically ideal situation. In practice – especially in the unpredictable and dynamic context of healthcare practice – teams might not go through the phases in the abovementioned order, or might merge phases (as in the example in Box 2). However, research suggests that teams that go through these phases tend to be more successful in learning in and adapting to new situations.⁵⁴ Healthcare education research into SSRL is limited, although seemingly

similar concepts emerged from research on team learning (e.g. team reflexivity).^{56–58} Given that healthcare quality is associated with the quality of learning and working in healthcare teams,^{19,59} the conceptualisation of SSRL provides a valuable lens through which we might be better able to examine and understand how regulatory processes support collaborative learning.

Integrating self-, co-, and socially shared regulation of learning in education and healthcare

During collaborative learning situations, teams and team members may engage in self-, co-, as well as socially shared regulation of learning. The balance within collaborating teams regarding their engagement in regulatory processes and activities may shift across individuals and over time, based on characteristics of individual team members, the team composition and relationships between team members, social connectedness, as well as features of task and context. This shifting balance may subsequently result in varying levels of SRL, CRL or SSRL, depending on whether regulatory engagement is evenly (SSRL) or unevenly (CRL) distributed across team members. See Box 3 for an example.

To function productively as a collective, individual SRL geared towards collective goals is crucial.⁵² When teams engage in collaborative learning, individual team members will therefore engage in self-regulating their own learning processes and activities; even during collaborative learning, individual team members will activate strategies individually and monitor and regulate their individual efforts.⁶⁰ Team-level CRL may emerge during collaborative learning in cases when an individual team member takes control of or stimulates another team member's regulation processes or activities.⁶⁰ As such, CRL can play a mediational or transitional role towards productive self-regulation, yet also shared regulation of learning, depending on whether co-regulation is geared towards an individual team member's regulation (SRL) or the regulation of team as a collective (SSRL).⁵² The team member in Box 3 who expresses concerns about whether all of their collective goals are adequately evaluated, for example, serves as a co-regulatory mechanism through which the agency of regulation of learning shifts towards the collective. SSRL during collaboration may emerge when all team members regulate learning processes collectively, such as co-constructing goals or task perceptions. When teams engage in SSRL, team members collectively take metacognitive control of the team's tasks by means of adjusting behaviours, cognitions, and motivations, based on requirements for completion of their tasks.⁵²

In any collaborative learning, engagement in momentary coregulatory interactions may occur within episodes of both SSRL and SRL. Thus, learners may concurrently engage in different

forms of regulation. The three levels of regulatory learning (SRL, CRL, and SSRL) may therefore best be considered as embedded in one another during collaborative learning situations.^{41,44} During collaborative learning, teams may not always engage in either CRL or SSRL (or SRL for that matter). Whether a team will engage in either CRL or SSRL (or both) is context- and situation-specific. For example, if the team leader (Box 3) is highly directive, fully guiding the regulation of learning (i.e. CRL), learning will likely be regulated without engagement in SSRL. Therefore, whether CRL is transitional towards other modes of regulation depends on dynamics within the team and team leadership as well as requirements of the learning task.

BOX 3 Integrating self-, co-, and socially shared regulation of learning

To elucidate the integration of different levels of regulation of learning during collaborative learning, returning to the implementation of new technology in Box 2 might be helpful. Each individual team member of the surgical team activates individual regulatory processes such as effort regulation, individual monitoring of the task and his or her performance (SRL). Through negotiations and discussions, the team members co-construct a shared perception of the task as a team, and collectively formulate goals and strategies to accomplish the task (SSRL). During evaluation after the first attempts of using the new technology, one team member may notice that another team member is not picking up essential skills and helps him to adopt another learning strategy and to better monitor his performance throughout the procedure. (CRL aimed at other's SRL). Similarly, one team member may notice that the team is overlooking evaluating one of their collectively set goals and draws the team's attention to this goal (CRL aimed at the team's SSRL). As such, the team is able to regulate their collaborative learning efforts through concurrent engagement in SRL, CRL and SSRL.

A way forward

Implications for research

Importantly, conceptualisations of regulation of learning in the present article refer to an idealised and theoretical situation, which may differ from actual work settings. However, such models may provide useful frameworks for future research to disentangle how regulation of learning may occur in collaborative settings. While various levels of regulatory learning are increasingly explored in health professions education research,^{45,48,61–63} studies predominantly focus on processes within the individual or the individual in interaction and less on how teams regulate their collaborative learning. Given the demands for collaboration in current healthcare, it is important to widen our views of regulatory learning, and we propose that future research adopts a multi-level and integrated perspective, focussing on the levels of self-, co-, as well as socially shared regulation of learning in healthcare (education) settings.

This first and foremost implies that researchers interested in the regulation of learning should add SSRL to the equation that is currently dominated by SRL, and to a lesser extent, by CRL. The importance of focussing on social regulation to understand collaborative learning has recently been underlined in the context of health professions education.⁶⁴ Building on related concepts, such as team reflexivity,^{57,58} health professions education research could shift attention to team-level regulatory processes and activities, aiming to understand how teams – as well as individual team members – shape their regulation towards their collective goals. Furthermore, to improve our understanding of the regulation of learning, future studies could aim to disentangle the interrelatedness of SRL, CRL, and SSRL during collaborative learning. Specifically, researchers may want to explore the mediating role of CRL towards productive SRL and SSRL, and how regulatory interactions affect learning and performance. Because CRL can provide the affordances and constrains for other modes of regulation, a thorough understanding of the mechanisms by which it may exert its influence is essential.

Much of the SRL data in health professions education research (and CRL data for that matter) is collected through subjective self-reports,³³ exploring participants' perceptions of their regulatory activities. However, these perceptions often differ from their actual behaviour.⁶⁵ To overcome these limitations, recent trends draw on technological advancements and point to collecting multimodal data.^{52,66} This involves collecting data from different data channels (i.e. modalities),⁵² for example objective physiological and subjective self-report data, allowing researchers to examine features and phases of regulatory learning in complex collaborative

learning situations.⁶⁷ Through collecting objective data, we are able to make visible what otherwise remains invisible, such as effort regulation, increased attention, and confusion that may take place during episodes of SRL, CRL, and/or SSRL. For example, recent studies use data sources such as 360-degree cameras and electro-dermal measures to examine group members' shared monitoring of collaborative learning,⁶⁸ or collect physiological data such as heart rate and skin conductance measures (e.g. to measure emotional reactions) during collaborative learning situations.⁶⁶ Triangulating data from different sources (both objective and subjective data), may help us to better describe levels and outcomes of regulation of learning in various settings. To improve our understanding of the regulation of learning during collaboration, we can draw on simulation-based research, in particular,⁶⁹ as this more easily allows incorporation of technology. Simulation-based research settings seem therefore eminently suitable for helping scholars analyse and disentangle complex phenomena that are difficult to uncover,⁷⁰ such as regulatory learning processes.

Ethnographic research might offer unique and new opportunities to further our understanding of regulatory learning processes. Direct observation of healthcare teams, either in real-life settings or in simulation settings, may enable exploration of regulatory behaviour as it occurs during the performance of authentic tasks and how different regulatory forms may be embedded in one another. Additionally, observing regulatory behaviour allows for examination of the distinction of unevenly distributed CRL and evenly distributed SSRL. This distinction is theoretical and conceptual and may reflect theoretically ideal regulatory patterns. Investigating the extent to which regulation of learning is distributed across team members within clinical settings may help describe and improve real-world practices.

Implications for health professions education

When collaborative learning is considered important for healthcare professionals, regulation of collaborative learning becomes equally important. Therefore, elements that support, stimulate, and facilitate the regulation of collaborative learning should permeate healthcare professions curricula. First and foremost, increasing awareness of different regulatory levels is vital. Currently, most healthcare professions curricula seem to pay more attention to SRL than to CRL and SSRL. Increasing team members' awareness of each other's knowledge, activities, emotions, motivation, and views of the group's functioning as a collective is a crucial starting point to support development of CRL and SSRL.⁵⁰ To help make explicit what often remains implicit, discussions that focus on team members' awareness of own and other regulatory learning processes could be stimulated during debriefing sessions of simulation-based team training sessions, for example.^{71,72}

An important implication is that health professions education programmes create learning environments that fosters the development of individual as well as collective regulatory competence. If one of the aims of healthcare professions education is to promote collaborative learning, curricula must include learning tasks that require collaborative learning as well as regulation of that learning. These learning tasks should provide students with information that is relevant for developing such skills. It is then crucial that attention is paid to the provision of feedback that is explicitly aimed at specific self-, co-, and shared regulatory learning processes and activities.⁷³

Conclusion

Learning – and therefore regulation of learning – within the health professions domain takes place at different levels, with different levels of regulation of learning being embedded in one another. While the importance of collaboration and collective competence for healthcare professionals is increasingly recognised, attention to how healthcare teams regulate their collaborative learning has yet to gain momentum. We, therefore, may want to shift from an exclusive focus on how to optimise self-regulation of learning, to the broader perspective of how to most effectively regulate learning, depending on the level at which it takes place. Truly unravelling regulation of learning within the healthcare domain therefore means unravelling the levels of self-, co-, and socially shared regulation of learning. Only then are we able to help future healthcare professionals to develop the skills that are necessary to function productively within the complex, unpredictable, and collaborative context of healthcare delivery.

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CHAPTER 3

BEYOND THE SELF: THE ROLE OF CO-REGULATION IN MEDICAL STUDENTS' SELF-REGULATED LEARNING

Bransen D, Govaerts MJB, Sluijsmans DMA, Driessen EW.
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Abstract

Context: Medical students are expected to self-regulate their learning within complex and unpredictable clinical learning environments. Research increasingly focuses on the effects of social interactions on the development of self-regulation in workplace settings, a notion embodied within the concept of co-regulated learning (CRL). Creating workplace learning environments that effectively foster lifelong self-regulated learning (SRL) requires a deeper understanding of the relationship between CRL and SRL. The aim of this study was therefore to explore medical students' perceptions of CRL in clinical clerkships and its perceived impact on the development of their SRL.

Methods: We conducted semi-structured interviews with 11 purposively sampled medical students enrolled in clinical clerkships at one undergraduate competency-based medical school. Data collection and analysis were conducted iteratively, informed by principles of constructivist grounded theory. Data analysis followed stages of open, axial and selective coding, which enabled us to conceptualise how co-regulation influences the development of students' self-regulation.

Results: Data revealed three interrelated shifts in CRL and SRL as students progressed through clerkships. First, students' CRL shifted from a focus on peers to co-regulation with clinician role models. Second, self-regulated behaviour shifted from being externally driven to being internally driven. Last, self-regulation shifted from a task-oriented approach towards a more comprehensive approach focusing on professional competence and identity formation. Students indicated that if they felt able to confidently and proactively self-regulate their learning, the threshold for engaging others in meaningful CRL seemed to be lowered, enhancing further development of SRL skills.

Conclusions: Findings from the current study emphasise the notion that SRL and its development are grounded in CRL in clinical settings. To optimally support the development of students' SRL, we need to focus on facilitating and organising learners' engagement in CRL from the start of the medical curriculum.

Introduction

Self-regulated learning (SRL) is considered a core competence of physicians and one that is essential to the safeguarding of patient care.^{1,2} Many medical curricula therefore support medical students in developing SRL skills. Self-regulated learning is generally described as a cyclical process, often triggered by the formulating of goals and the subsequent employment of strategies to achieve and monitor advancement towards those goals, followed by engagement in reflection and the formulation of new learning goals.^{2,3} Research findings, however, indicate that students often struggle to regulate their learning in clinical learning environments as a result of the unpredictable, dynamic and messy nature of clinical workplace settings.^{4,5}

As early as 1989, the importance of environmental constraints and affordances to SRL was documented.⁶ Since then, the notion that medical students' SRL is context-dependent and socially derived has steadily gained momentum.^{7,8} Learning climates of hospital departments, available learning opportunities and social interactions with others seem to influence students' SRL,⁹ and medical trainees variably use SRL strategies, depending on social and contextual factors.¹⁰ A study by Berkhout and colleagues, for example, showed that novice students interact with peers and residents to help them formulate learning goals.¹¹ Elsewhere, paediatric residents have been found to benefit from interacting with supervisors when pursuing goals.¹² Similarly, surgical residents actively employ different strategies to engage their supervisors in the monitoring of performance during surgery.¹³

The potential impact of social interactions on medical students' SRL is embodied in the concept of co-regulated learning (CRL). In CRL, learners regulate their cognitions, motivation and behaviour together with other individuals in the environment.¹⁴ Essential to CRL are social interactions between students and others in their networks, through which learning processes, such as SRL development, are mediated or distributed.¹⁵ The concept of CRL reflects sociocultural learning theories that emphasise that learners are continuously influenced by their environment when simultaneously co-producing and co-creating the contextual surroundings in which they learn and work.¹⁶ By jointly engaging in learning activities, students and co-workers in health care settings mediate one another's metacognitive and cognitive activities, facilitating or constraining individuals' development and display of independent SRL behaviours.¹⁷ Findings from a recent study show that medical students' engagement in SRL changes over time and is influenced by their perceptions of the roles of, and interactions with, others in the workplace setting.¹¹ This illustrates that processes of CRL may influence the development of students' ability to self-regulate.

Examining how CRL, with social interactions as its main element, influences SRL development in workplace-based learning environments will contribute to a deeper understanding of how students actually develop SRL in clinical settings. This may help to create clinical learning environments that effectively foster SRL development, adequately equipping future physicians for lifelong learning. However, research focusing on the developmental aspect of SRL and how social interactions influence medical students' SRL development is still scarce. The present study aims to address this gap. Specifically, we aim to explore undergraduate medical students' perceptions of CRL in clinical clerkships and its perceived impact on the development of their SRL.

Methods

Methodology

We used a qualitative approach to explore medical students' perceptions of relationships between CRL and SRL in clinical clerkships. Data collection and data analysis were conducted iteratively, informed by principles of constructivist grounded theory.^{18,19} Using constructivist grounded theory, we acknowledged the research team's theoretical (DB, EWD, DMAS, MJBG) and practical (DB, EWD, DMAS, MJBG) backgrounds in SRL and CRL, and data collection and data analysis were informed by key concepts in SRL and CRL.

Setting

We conducted this study in the undergraduate programme (Master's degree) in medicine at Maastricht University, the Netherlands. The Masters programme comprises 3 years of clinical clerkships lasting between 12 and 22 weeks, in various hospital departments in an academic hospital and affiliated teaching hospitals. The Masters programme is designed according to the principles of competency-based medical education, using the roles of the Canadian Medical Education Directives for Specialists (CanMEDS) as its overarching framework.²⁰ Students' SRL is supported throughout the programme by a portfolio and a mentor. Daily workplace supervisors are assigned to support and guide student learning in various workplace settings. Before the start of each clerkship, students formulate a learning plan that describes their personal learning goals and discuss this with their mentor and the supervisors assigned for that clerkship. At the end of each clerkship, students collaborate with their mentors to reflect on their experiences and the feedback uploaded to the portfolio and formulate new learning goals for the next phase of training. Learning plans are included in students' portfolios, as are assessment data (e.g. feedback forms and test results), reflections on experiences, and any information students deem valuable for monitoring their personal and professional development.²¹

Participants and Sampling

Overall, 79% of students in the Masters programme are female. We purposively sampled medical students enrolled in the Masters programme to ensure variety in year of clinical training and gender (Table 3.1). Students were invited to participate via e-mail. Reminders were sent 2 weeks after the initial invitation. After 10 interviews, we considered that we had achieved data saturation and had gained an adequate understanding of the constructed themes and their relationships. Participants received a gift voucher for €10. This study was approved by the Dutch Society for Medical Education (Nederlandse Vereniging voor Medisch Onderwijs [NVMO]) Ethical Review Board (NVMO ERB ref. 970).

Table 3.1 Participant characteristics

Students, n(%)	
Gender	
male	2 (18%)
female	9 (82%)
Years of clinical training	
first year	2 (18%)
second year	5 (46%)
third year	4 (36%)
Age (year), mean (range)	23 (21-24)

Data Collection

Between February and June 2018, the first author (DB) conducted semi-structured interviews that lasted between 50 and 75 minutes. The research team developed an interview guide informed by key concepts of SRL, such as goal formulation and strategy design principles, monitoring and self-reflection processes, as well as CRL (relevant others with whom students engaged, as well as the nature of their interactions). After obtaining informed consent, first author (DB) provided students with a description of SRL. The first part of the interview then aimed to obtain the student's perspectives on how he or she engaged in SRL in the clinical setting; the second part focused on the student's perceptions of the impact of social interactions on the development of SRL skills. The final part of the interview focused on developmental aspects of SRL and CRL. The interview guide is included in the appendix of this chapter (page 58-59). During interviews, the interviewer prompted students to provide detailed examples and explanations of behaviours they described. The interview guide was updated iteratively between interviews, informed by concurrent data analysis. All interviews were tape-recorded and transcribed verbatim.

Data Analysis

Data collection and analysis followed an iterative process, allowing data collection and data analysis to inform each other. The first author (DB) and a research assistant (CN) independently read and coded transcripts 1-3 line by line to capture concepts related to CRL and students' development of SRL. In the initial coding scheme, codes described various SRL and CRL behaviours such as the formulation of learning goals, asking for feedback and feedback reception, and details of the significant others with whom students engaged in CRL processes. Also included were factors related to and influencing the development of SRL such as the phase of clinical training. Coding frameworks were compared and discussed until consensus was reached. DB used the coding scheme to code transcripts 4-11, continuously refining the coding framework through constant comparison and discussion of findings with the research team. The research team subsequently categorised codes and identified relationships between themes through axial coding. During the final stage of analysis, the research team used selective coding to develop theory about the influence of CRL on students' SRL development. To facilitate this process, DB constructed concept maps, presenting themes, sub-themes and their relationships, which were used during research team meetings to guide theory development. DB furthermore captured reflections, ideas and interpretations in memos throughout the data analysis. Data analysis was supported by the qualitative research software atlas.ti (ATLAS.ti Scientific Software Development GmbH, Berlin, Germany).

Reflexivity

Within our methodological approach, meaning is constructed through interactions with research participants, the data generated, and the interpretation by the research team. DB is a PhD candidate with an educational background in work and organisational psychology. MJBG and EWD are medical educators and researchers involved in the development of the assessment aspect of the Masters programme at Maastricht University. DMAS is an education researcher whose main areas of expertise are professional assessment, curriculum design and student involvement in assessment practices. Maastricht University is characterised by its problem-based learning (PBL) philosophy, in which collaborative and self-directed learning play pivotal roles. EWD and MJBG have worked within this setting for substantial lengths of time and DB has had formal education according to PBL principles; these backgrounds may have influenced their views on CRL and SRL and how these may be related. DB used memos and field notes to capture views and interpretations throughout data collection and analysis.

Results

From the data, we were able to construct three major shifts in students' SRL, which were simultaneously influenced by and exerted influence on students' engagement in CRL as they progressed through clerkships. Firstly, students expressed a shift with regard to whom they involved in CRL, bestowing an important role on peers at the start of clerkships and increasing their preferences for clinician role models towards the end of the programme. Secondly, novice students' SRL was mainly externally driven by cues in the environment, whereas experienced students' SRL was increasingly driven by intrinsic cues and self-motivation. Finally, regulatory behaviours shifted from a task-oriented approach towards a more comprehensive approach that focuses on professional competence and identity formation. We will detail these shifts and the influences of social interactions between students and relevant others that contribute to the shifts.

From interacting with peers to interacting with clinician role models

Students described a change with regard to whom they engaged with in CRL over the course of clerkships. At the start of the programme, interactions with peers played an important role, serving several goals. Novice students indicated being unsure of clerkship expectations and opportunities and thus relying on one another to develop an understanding of the new learning environment:

What I also really like when you're new to a place is that other interns [fellow students] always take you along, show you the way, and also point out how you can best tackle this here" (Student 2, Year 2).

Additionally, novice students tended to rely on one another to create a frame of reference in order to formulate learning goals, and to think about learning strategies and selection of learning opportunities:

You have a frame of reference, more or less. Like, you [fellow students] do it like this or think that is important or you already know it. Well, maybe I should know it too, so how do you do it? (Student 1, Year 2).

Interactions with peers thus exposed gaps in students' knowledge or skill proficiency, helping them to formulate goals and strategies to address these gaps.

Although peer interactions helped novice students to navigate and feel more comfortable in the new learning environment, students gained experience in adapting to new environments with each new clerkship. Over time, they participated increasingly in health care tasks,

which helped them to develop a firmer grasp of what they wanted or needed to learn. Experienced students reported that they then relied on other sources to help regulate their learning, referring to clinician role models such as attending physicians and residents. These role models influenced students' SRL behaviour through the provision of feedback, but especially through the stimulation of self-reflection based on interactions with and observations of these physicians:

In principle, the physician is your role model for 3 years, so you observe him and think, how would I do that and do I want to be this kind of doctor or do I want to be another kind? And through meeting all these different specialists, you create your own, let's say, [idea of the] physician you want to become (Student 9, Year 2).

From external regulatory drivers to internal regulatory drivers

At the start of the programme, students' SRL seemed to be largely externally driven. Novice students described complying with portfolio instructions and relying on input from others when formulating learning goals prior to a clerkship. Quite often, however, they also found that these learning goals were not well aligned with learning affordances in a specific setting, which led to feelings of detachment from their learning plans. During the first clerkships of the programme, students then depended on others in the actual workplace setting to help them reactively adjust learning goals and strategies. Residents and physicians, for example, helped students regulate their learning by providing clear and explicit directions on what they thought were important learning goals:

Yes, of course if a doctor says, 'Hey, this is fun to do' or 'You should be able to do this by the end of the clerkship,' then of course, you go along with it (Student 11, Year 1).

Workplace supervisors in particular seemed to play important roles in this respect:

You always chat with your workplace supervisor, and they say things like: 'We expect you to learn this and that, and get this and that out of your clerkship.' If you haven't already factored these [expectations] into your goals beforehand, then you think, okay, I'll take them into account [now] (Student 10, Year 1).

Self-regulated learning was also often grounded in situations in which a student and a physician were cooperating in a joint activity. Students reported that some physicians consistently posed questions about the activity, which uncovered gaps in knowledge or skill proficiency. This helped students to direct their learning activities and processes and bridge the gaps:

When you're in the operating room, and the surgeon asks six questions on anatomy and you can only answer one, then you sure know you have something to do at home (Student 9, Year 2).

Novice students' SRL thus seemed to be predominantly initiated by others in the learning environment. Over time, as students gained a better understanding of what was expected of them, they increasingly began to think about the type of physician they wanted to become and developed social sensors that helped them look for and select suitable others to provide input for their learning. Having experienced a variety of health care settings, and as they became increasingly aware of their developing professional identity, experienced students seemed better able to take the initiative in engaging others in CRL. They seemed increasingly willing and able to 'take charge' of regulatory activities. Appreciating their personal learning needs, they seemed more confident in actively asking relevant others to help them regulate their learning:

Then once I really did ask, on [the clerkship in] internal medicine, if there is a difficult conversation, or there's bad news to deliver, please let me do it because it's my learning goal (Student 6, Year 3).

Students reported that the extent to which they were able to engage in CRL to support their learning depended on whether they were willing and sufficiently confident to use SRL skills such as goal setting and the devising of strategies to achieve these goals. That is, students explained that when they took control of their learning based on a firm grasp of what they wanted to learn, they more readily found the courage to engage and mobilise others in the environment to select or create learning opportunities:

I do feel that I can control it [my own learning] a lot. By taking the initiative and showing that you want to learn. And also having the courage ... to ask questions and to ask for things to do, or to come up with suggestions (Student 1, Year 2).

From specific tasks to professional competence and professional development

Students indicated that the focus of the regulation of learning shifted over the course of clerkships. Novices described being task-oriented. That is, goal setting was characterised by high levels of granularity; novices focused strongly on attaining clearly demarcated learning goals (and on formulating learning goals):

I look at the framework plan for physicians [CanMEDS framework]. It's subdivided into competencies and those sub-competencies are divided into specific components (Student 10, Year 1).

For novices, CRL thus mainly entailed engaging others (peers and mentors) in formulating and reflecting on narrowly defined, task-specific learning goals. Consequently, self-reflection most often consisted of an evaluation of whether or not formulated learning goals were attained. Experienced students reported that, as they gained experience by progressing through clerkships, they not only became more capable of formulating realistic and feasible learning goals, but they also shifted the focus of their learning goals to more comprehensive aspects of medical expertise. That is, experienced students formulated learning goals that transcended the high level of granularity applied by their novice counterparts, and adopted a broader approach to goal setting and self-reflection. Thus, the learning goals of experienced students rose to the level of professional development and identity formation:

In your first clerkship, you are more concerned with specific learning goals, to improve things, and in your last clerkship you are more concerned with how do I become a good doctor in general. Then I'm no longer bothered by the specifics [...] I'm more concerned with the kind of doctor I want to be, what specialism I want to work in, and how I can direct my choices to achieving that (Student 6, Year 3).

Discussion

This study aimed to explore medical students' perceptions of CRL in clinical workplace settings and to investigate how interactions with others in the learning environment affect the development of students' SRL. Our findings show that students' engagement in CRL and SRL changes over time, and is influenced by changing perceptions and experiences of the learning environment and the development of a professional identity. Our findings suggest that three major shifts are key to students' development over time: (a) a shift in the selection of CRL partners, which moves from peers to clinician role models; (b) a shift in SRL behaviours, which tend to be externally driven in novice students and become internally driven and involving the deliberate, proactive engagement of others in more experienced students; and (c) a shift in regulatory focus as learners move from well-defined tasks and task requirements to a broader view of professional competence in relation to the developing of a professional identity.

The findings of our study corroborate those of previous research and stress the importance of social interactions in clinical settings for the development of medical students' SRL. Aligned with findings from the study by Berkhout and colleagues,¹¹ the current findings suggest that the influence of others on students' SRL differs between novice and experienced students. Whereas novice students mainly rely on peers to co-create a frame of reference to help

them navigate the learning environment, experienced students learn to take control, to interact with clinician role models as more experienced others and to increasingly engage these in co-regulatory activities to support their own learning. Participants furthermore reported that they could more readily engage others in their learning if they had developed a clear view about what they wanted to learn and how the achievement of these goals would contribute to the development of professional competence. These findings suggest relationships between SRL and CRL are reciprocal: SRL skills develop through interactions with others, whereas the mastery of SRL skills increasingly enables students to proactively engage in meaningful CRL to enhance their learning and competence development. Active participation in health care tasks, as well as reflection on the type of physician the individual wants to become, seem to be important facilitating factors, influencing students' development into learners who are increasingly able and willing to regulate their learning through interactions with others in the work and learning environments.

Participants in our study clearly indicated that the ability to regulate their own learning depended on their having a deep understanding of the clinical setting as a learning environment in which learning and work are intertwined. Students repeatedly reported being challenged as well as frustrated when tasked with setting learning goals if their understanding of the learning opportunities within clerkships was insufficient. In consequence, students felt they were then forced to continuously adjust and refine their goals based on observation of and negotiation with residents, physicians and peers, as well as on actual learning and work experiences. These findings are in line with those of previous studies which showed that goal setting in clinical contexts requires negotiation between students and supervisors and engagement from supervisors if goals are to be realistic and attainable.^{22,23}

Our findings also showed that the extent to which and the pace at which students are embedded in teams in clerkship environments influenced their ability to proactively engage others in the regulation of their learning through the solicitation of feedback or by negotiating their own active participation in health care tasks. This may suggest that we need to facilitate the prolonged inclusion of students into communities of practice (CoPs) to capitalise on the opportunities for CRL in specific work settings.²⁴ In CoPs, individuals typically engage in learning from and with each other by sharing goals and having conversations about how best to achieve these goals, and thereby continuously deepening one another's knowledge and skills.²⁵ Not only do CoPs create opportunities to engage peers and more experienced others in the regulation of learning, but they also offer opportunities to engage in discussions about the quality of work and health care, stimulating students'

reflections on what it takes to be and become a medical doctor and thereby supporting their professional identity formation and subsequent development of SRL. Based on the findings of our study, as well as findings from previous research,¹¹ peers seem to fulfil important roles in novice students' development of SRL because they can support students in goal setting and familiarise newcomers to opportunities within and expectations of the learning environment. Peer-assisted learning (PAL) has furthermore been shown to contribute to students' professional identity formation.^{26,27} We therefore may need to pay more attention to stimulating PAL within CoPs, by, for example, forming learning and working partnerships between novice and more experienced students. As PAL entails bidirectional support,²⁸ stimulating PAL within CoPs will deliver the added benefit of developing learners' coaching and teaching skills.²⁹

Overall, our findings support the notion of SRL as being embedded in CRL, an idea gaining momentum.³⁰ The current study highlights the need to look 'beyond the self' when examining and facilitating students' SRL development. Our findings reflect essential notions within sociocultural learning theories, indicating that workplace learning, including the development of SRL, always occurs in interactions with others, and that students' SRL always involves engagement in CRL. Rather than developing into students who learn 'autonomously' and 'independently' from others, students' transformation into self-regulated learners is reflected through significant changes in the way that they engage in CRL and their increasing ability to purposively and meaningfully engage others in their learning to support their development of competence. Although it is increasingly acknowledged that SRL is context-dependent, research often still emphasises and underscores learner independency and autonomy.^{31,32} The present study challenges this idea and instead advocates for considering SRL, as well as SRL development, as being embedded in social interactions in clinical workplace settings. Conceptualising the development of students' SRL as the development of students' ability to engage in CRL in CoPs has important implications for how we organise clinical clerkships and how we educate medical students to regulate their learning. For instance, we may need to reconsider current models of medical training in which students rotate through multiple short-block rotations. Rather, we should facilitate the development of safe and trusting longitudinal relationships within health care teams in longitudinal integrated clerkships,³³ for example to allow students to move towards the centre of the CoP and to fully capitalise on opportunities for CRL. Furthermore, in order to help students develop into learners who are able to regulate their learning in workplace settings, we may not only need to offer training and coaching in skills such as goal setting, self-assessment and reflection, but first and foremost to pay attention to the skills that enable students to

engage in CRL, such as feedback seeking and engaging others in learning conversations. Acknowledging from the outset of medical training that SRL is embedded in CRL may assist us in better preparing students to optimise their learning in workplace settings, and may help medical education and research to truly move beyond the self.

Limitations

This study was conducted with a limited sample of 11 participants. Most (nine students) were enrolled in the second or final years of clinical training. This means that these students were able to describe their behaviour and thoughts at the start of clinical training only retrospectively, which may have made them susceptible to memory bias. Co-regulated learning and SRL are abstract theoretical constructs, which students may have found difficult to talk about in practical terms. In constructing the interview guide, the research team attempted to formulate the questions as concretely as possible. It may be that CRL is more prevalent than students realise, and much of CRL may be hidden or implicit. For example, some students indicated after the interview had finished that they did not usually give very much thought to the concepts discussed in the interview. In a similar vein, participants were self-selected volunteers, which may imply that only students who actively thought about their learning agreed to participate.

Conclusions

Our study emphasises the idea that SRL and SRL development are embedded in social interactions and CRL in clinical workplace settings. We can support medical undergraduates' development of SRL when CRL is structurally embedded in clerkships, acknowledging that the ability to self-regulate implies the ability to engage in meaningful interactions with others to support learning processes. In order to facilitate medical students' transformation into lifelong learners, we therefore need to support and organise learners' engagement in CRL. For competency-based medical education, this means that we should reconsider the ways by which we include medical students in CoPs in order to encourage workplace partnerships between novice students and more experienced students and health care professionals. By capitalising on the opportunities for CRL in clinical settings, we may be able to better equip students with the learning skills they need to develop into health care professionals who are able to optimise their learning and provide high-quality care in rapidly changing health care systems throughout their professional careers.

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Appendix: Interview Guide

Demographics

- Name;
- Age;
- Which clerkship are you currently in?
- Which educational year are you currently in?

Learning

- Can you give a description of the way you learn in the workplace during clerkships?
- Which factors help and hinder your learning during clerkships?
 - How do these factors help and hinder?
- What role do others play in your learning during clerkships?
 - Who plays a role?
 - How do they play their role(s)?

Self-regulated learning

- To what extent do you have the idea that you are able to give direction to what you learn in the clerkships and how you learn that?
- How do you give direction to your learning (activities) in clerkships?
- What is the value to you of being able to give direction to and maintain control over what you want to learn and how you learn that?

Co-regulated learning

- How do others in clerkship environments help you in how you give direction to what you want to learn and how you learn that?
 - Who help you?
 - How do they help you?
 - With what do they help you?
- How do others in clerkship environments hinder you in how you give direction to what you want to learn and how you learn that?
 - Who hinder you?
 - How do they hinder you?
 - In what are you hindered by them?

- How do you seek help from others in clerkship environments with regard to giving direction to what you want to learn and how you learn that?
 - o Who do you seek help from?
 - o How do you look for help?
 - o What are you looking for help for?

Development

- Has the way in which you give direction to your learning changed during your clerkships?
 - o How?
 - o What do you think that caused this change?
- Has the way in which you seek help from others with regard to giving direction to your learning changed during your clerkships?
 - o Did you seek help from other people at the start of your clerkships than you do now?
 - o What do you think that caused this change?
- Has the way in which others help you in giving direction to your learning changed during clerkships?
 - o Do you receive help from other people now than you did at the start of your clerkships?
 - o How does the help you receive from others differ?
 - o What do you think that caused this change?



CHAPTER 4

RELATIONSHIPS BETWEEN MEDICAL STUDENTS' CO-REGULATORY NETWORK CHARACTERISTICS AND SELF-REGULATED LEARNING: A SOCIAL NETWORK STUDY

Bransen D, Govaerts MJB, Sluijsmans DMA, Donkers J, Van den Bossche P, Driessen EW.

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Abstract

Introduction Recent conceptualizations of self-regulated learning acknowledge the importance of co-regulation, i.e., students' interactions with others in their networks to support self-regulation. Using a social network approach, the aim of this study is to explore relationships between characteristics of medical students' co-regulatory networks, perceived learning opportunities, and self-regulated learning.

Methods The authors surveyed 403 undergraduate medical students during their clinical clerkships (response rate 65.5%). Using multiple regression analysis, structural equation modelling techniques, and analysis of variance, the authors explored relationships between co-regulatory network characteristics (network size, network diversity, and interaction frequency), students' perceptions of learning opportunities in the workplace setting, and self-reported self-regulated learning.

Results Across all clerkships, data showed positive relationships between tie strength and self-regulated learning ($\beta = 0.095$, $p < 0.05$) and between network size and tie strength ($\beta = 0.530$, $p < 0.001$), and a negative relationship between network diversity and tie strength ($\beta = -0.474$, $p < 0.001$). Students' perceptions of learning opportunities showed positive relationships with both self-regulated learning ($\beta = 0.295$, $p < 0.001$) and co-regulatory network size ($\beta = 0.134$, $p < 0.01$). Characteristics of clerkship contexts influenced both co-regulatory network characteristics (size and tie strength) and relationships between network characteristics, self-regulated learning, and students' perceptions of learning opportunities.

Discussion The present study reinforces the importance of co-regulatory networks for medical students' self-regulated learning during clinical clerkships. Findings imply that supporting development of strong networks aimed at frequent co-regulatory interactions may enhance medical students' self-regulated learning in challenging clinical learning environments. Social network approaches offer promising ways of further understanding and conceptualising self- and co-regulated learning in clinical workplaces.

Introduction

Clinical clerkships are challenging learning environments in which medical students often struggle to self-regulate their learning.¹ Self-regulated learning (SRL) involves formulating learning goals, planning, implementing and adjusting strategies to achieve goals while monitoring progression, followed by self-reflection and formulation of new learning goals.² Research increasingly acknowledges that personal, social, and contextual attributes interact to influence medical students' SRL in clinical workplace settings.³⁻⁶ SRL not only depends on an individual student's abilities and capacities, but also on available or perceived learning opportunities and opportunities to interact with others.⁷ The context-dependency and social embeddedness add to the complexity of SRL in the dynamic and unpredictable learning environments of healthcare settings. The notion that social interactions influence students' regulation of learning is captured in the concept of co-regulated learning (CRL). In CRL, students jointly regulate their learning processes together with peers, residents, or others present in the clinical learning environment.⁸⁻¹⁰ For example, conversations with supervising residents or physicians may help students to formulate realistic learning goals, develop and implement learning strategies, or reflect on professional competence development.¹¹

In clinical clerkships, SRL and CRL are thus inextricably linked, as SRL largely comes about through interactions in students' social networks. As interactions within these networks specifically focus on, influence, and contribute to students' SRL, they can be conceptualized as "co-regulatory networks". Given the importance of enhancing medical students' SRL in clinical settings, a better understanding of CRL and how co-regulatory networks impact medical students' SRL is essential. In alignment with shifting conceptualizations of SRL as socially embedded learning activities, adopting a social network approach seems eminently suitable to explore relationships between medical students' co-regulatory networks and their self-regulatory learning behaviours.¹²

Social networks are structures consisting of actors (individuals) and links between individuals (i.e., ties) that capture various features, such as communication patterns as well as the frequency and content of the communication.¹³ Networks are often described in terms of their characteristics. Quantitative approaches to social network analysis consider size, diversity, and tie strength key characteristics of social networks.¹⁴ Network size indicates the number of individuals with whom a person interacts within the network.¹⁴ Strength of ties indicates the frequency or duration of interactions between individuals in a network.¹⁵ Network diversity indicates the degree of variation among individuals within a network (e.g., differences in age, gender, or job level).¹⁶

Previous research findings suggest that how students interact with others in their networks and how they position themselves within networks influences how, what, and from whom they learn. For example, exchanging relevant information through informal social interactions within networks has been shown to be positively related to medical students' learning outcomes,¹⁷ and students' network sizes are positively associated with academic performance.¹⁸ Strong ties within networks appear to be particularly important when engaging in complex tasks, whereas weak ties seem to be more important for receiving unique information.¹⁹ Research within organizational contexts furthermore indicates that high performing individuals tend to have highly diverse networks.²⁰ Research into the relationship between SRL and social networks in virtual learning environments suggests that it is the 'good' self-regulators who position themselves in the centre of a network from the very start of engagement in the new environment, creating connections with many others in their network.²¹

These studies, conducted outside of clinical workplace settings, highlight the importance of focusing on networks for understanding relationships between networks, SRL, and learning. Although it is widely acknowledged that regulation of learning in clinical clerkships is socially grounded, research explicitly focusing on co-regulatory networks has yet to gain momentum. As SRL research in clinical settings has been largely conducted using, for example, interviews and focus groups, we aim to expand existing knowledge by examining relationships between SRL and students' co-regulatory networks through use of a quantitative social network approach that enables us to explore the structure of co-regulatory networks in a systematic way. More specifically, this study aims to explore and describe relationships between characteristics of medical students' co-regulatory networks in clinical settings (network size, network diversity, tie strength), students' perceptions of learning opportunities, and their self-reported self-regulated learning.

Method

Methodology

Our purpose with this cross-sectional questionnaire study is exploratory and descriptive. We were particularly interested in exploring networks of relations and interactions surrounding individual students rather than focusing on all relationships within the clinical learning environment as a whole. We administered a questionnaire to explore various aspects of students' SRL, students' perceptions of the workplace learning context, and their co-regulatory networks during clinical clerkships. To collect our data, we drew on previous research indicating that self-reports are often used to study SRL,^{22,23} and social networks.^{12,14,17}

Setting

We conducted this study in the undergraduate master's in medicine programme at Maastricht University, the Netherlands. The programme is designed according to principles of competency-based medical education.²⁴ Students complete three years of clinical clerkships in an academic hospital and affiliated teaching hospitals (five regular clerkships, two electives, one healthcare participation clerkship [HELP], and one scientific research participation clerkship). Students rotate through clerkships in a fixed order, starting with internal medicine or surgery and finishing with HELP. Clerkships last between 8 and 18 weeks and predominantly consist of workplace learning; mandatory educational meetings are scheduled at regular intervals. The programme supports SRL through an e-portfolio, mentors, and assigned workplace supervisors. Students formulate learning goals and plans, discussing these with their mentor and the assigned workplace supervisor at the start of every clerkship.²⁵

Participants and data collection

Students were eligible if they, at the time of our study, were enrolled in one of the following clerkships: internal medicine, surgery, neurosciences, mother and child, family and social medicine, or HELP (N= 615). Between November 2019 and February 2020, DB recruited students during 41 educational meetings that were spread across all clerkships. After a short explanation of the study, DB handed out QR codes and URL links that provided access to the questionnaire. The Ethical Review Board of the Dutch Society for Medical Education approved this study (ref. 2019.2.3).

Instrument

We administered a two-part questionnaire. The first part focused on SRL behaviours and students' perceptions of the extent to which the workplace learning context entailed opportunities for learning and SRL; the second part focused on students' co-regulatory networks. Acknowledging the notion that networks and student behaviours within particular networks may vary across contexts, we requested participants to keep in mind their current clerkship when completing the questionnaire. Prior to administration, the complete questionnaire was pilot tested with 10 respondents. After the pilot, we made minor adjustments to several items to improve comprehensibility. Additionally, we based response options for the co-regulatory network questionnaire on pilot respondents' input,²⁶ which provided initial estimates of network sizes and interaction frequencies as well as relevant others with whom students in clerkships interact.

Self-regulated learning at work questionnaire

We used an adapted version of the Self-Regulated Learning at Work Questionnaire (SRLW-Q), which was constructed and validated in workplace settings.⁷ We included the subscales appropriate for our context, i.e., the forethought, performance, and self-reflection scales, henceforward referred to as the SRL scale, and the workplace learning context scale, henceforward referred to as the WLC scale, as a measure of perceived learning opportunities in a particular clerkship setting. Using principles of collaborative and iterative translation,²⁷ we translated and adapted both scales to the study setting. DB translated the items and, in collaboration with SRL experts, clinical workplace learning experts, and questionnaire design experts, iteratively refined items until the expert panel perceived the match with clinical workplaces to be appropriate.

Co-regulatory network questionnaire

The second part of the questionnaire focused on students' co-regulatory networks. Participants indicated whom they engaged with to discuss SRL activities as described in the SRL scale. Participants could select one or more groups out of eight options (e.g., peers, residents, physicians). After identifying relevant relationships, participants indicated from a fixed number of options how many individuals within each selected group they engaged with (providing measures of network size and diversity) and the interaction frequency with members of that particular group (providing a measure of tie strength). Of note: based on the pilot we learned that the cognitive load required to complete the original questionnaire was high. Thus, we decided to measure interaction frequency for groups as a whole rather than for each separate individual in the student's network. The complete survey is included in the appendix of Chapter 5 (page 104 ff) of this dissertation.

Network measures and data analysis

We calculated the variable 'network size' by counting the total number of individuals in a student's network, and the variable 'network diversity' by counting the number of different groups present within a student's network. We calculated the variable 'tie strength' by adding interaction frequencies with groups within a student's network and dividing this sum by the number of groups present in the network, providing a measure of mean tie strength. To provide a measure of tie strength for each clerkship as well as across clerkships, mean tie strengths were calculated by averaging means across the various groups. We computed the internal consistency for the SRL and WLC scales. Structural equation modelling (SEM) was used to investigate relationships between the variables included in this study. We first

conducted several multiple regression analyses to explore relationships between network size, network diversity, tie strength, WLC, and SRL. Results from these regressions provided input for constructing the investigated model. We checked the distributions of the variables in the SEMs for normality and correlations and measured the quality of fit for the SEMs by comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). We conducted a multiple group analysis of the relationships, in which we included students' current clerkships. Since multiple group-invariance analysis on clerkship revealed differences between clinical clerkships regarding relationships within the model, we conducted analysis of variance (ANOVA) to compare co-regulatory network characteristics between clerkships. We performed analyses using R 3.6.3, and R-package Lavaan 0.6–5 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Of the 615 students invited to participate, 403 (65.5%) students completed the questionnaire. Of those who completed the questionnaire, 145 (36%) were first year students, 142 (35%) were second-year students, and 116 (29%) were third-year students. The sample consisted of 284 women (70.5%) and 117 men, which is representative of the student population in the programme (69% women). Table 4.1 presents descriptive statistics for network size, tie strength, network diversity, and the SRL and WLC scales for each clerkship and across clerkships. The Cronbach's α of the SRL and WLC scales was 0.893 and 0.693, respectively.

Figure 4.1 presents the structural equation model and relationships between students' co-regulatory network characteristics, SRL, and WLC. First, we analysed relationships between variables across all clerkships. Fit parameters for the analysis across clerkships were good (CFI = 0.923; TLI = 0.826; RMSEA = 0.065). Fit parameters for the multiple group analysis were slightly better (CFI = 0.985; TLI = 0.967 RMSEA= 0.029). The multiple group analysis indicated configural variance of the model between clinical clerkships, which shows that students' current clerkship contexts moderated relationships in the model.

Table 4.1 Descriptive statistics for co-regulatory network characteristics, self-regulated learning scale, and workplace learning context scale (N=403).

	N	Network Size		Network Diversity		Tie Strength		SRL		WLC	
		M (1-27)	SD	M (1-8)	SD	M (1-5)	SD	M (1-5)	SD	M (1-5)	SD
IM	75	8.37	3.56	4.09	1.63	3.23	0.73	3.51	0.33	3.55	0.40
SC	70	9.23	4.30	3.97	1.79	3.57	0.83	3.44	0.37	3.71	0.43
NS	81	7.59	3.62	4.28	1.57	2.91	0.76	3.48	0.41	3.29	0.48
MC	56	7.52	4.07	4.05	1.75	3.05	0.85	3.63	0.44	3.43	0.57
FSM	83	7.29	3.77	4.12	1.69	3.14	0.82	3.45	0.41	3.40	0.49
HELP	38	8.61	3.52	4.74	1.43	2.64	0.62	3.55	0.40	3.60	0.38
Total	403	8.04	3.86	4.17	1.66	3.13	0.82	3.50	0.39	3.48	0.48

Abbreviations: Means (M), Standard Deviations (SD) for network size, network diversity, tie strength, self-regulated learning scale (SRL), and workplace learning context scale (WLC) within six clinical clerkships (IM=Internal Medicine, SC=Surgery Clerkship, NS=Neurosciences, MC=Mother and Child, FSM=Family and Social Medicine, HELP=Healthcare Participation Clerkship) and for all students (total). Mean tie strengths were calculated by averaging means across the various groups both within clerkships and across clerkships (total).

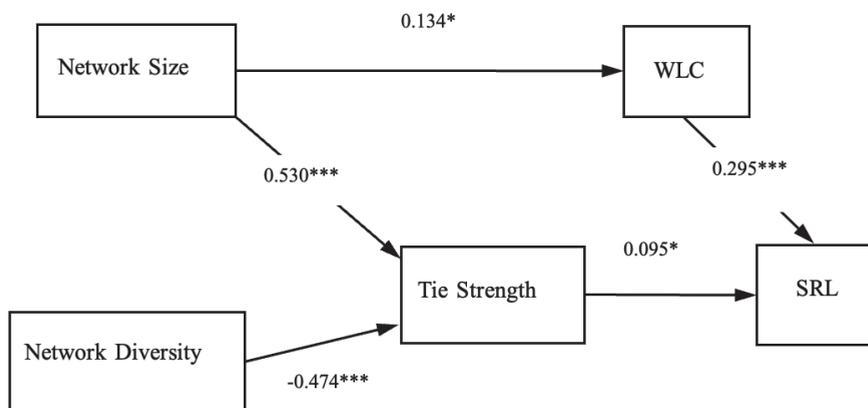
**Figure 4.1** Model of relationships among co-regulatory network characteristics, workplace learning context scale, and self-regulated learning

Fig. 4.1: Structural equation model informed by multiple regressions for the variables network size, network diversity, workplace learning context scale (WLC), and self-regulated learning scale (SRL). We present the standardized coefficients. (*= $p < 0.05$, **= $p < 0.01$, ***= $p < 0.001$).

Table 4.2 presents results from analysing relationships within the SEM, both across (overall) and for each clerkship. When analysing relationships across clerkships, all direct relationships within the model were significant. We found a positive relationship between tie strength within co-regulatory networks and SRL ($\beta = 0.095$, $p < 0.05$), indicating that an increase in interaction frequency is associated with an increase in self-reported SRL. Although we found no significant relationships between network size and SRL, nor between network diversity and SRL, we found that network size related positively to tie strength ($\beta = 0.530$, $p < 0.001$), whereas network diversity related negatively to tie strength ($\beta = -0.474$, $p < 0.001$). We found positive relationships between WLC and SRL ($\beta = 0.295$, $p < 0.001$) and between network size and WLC ($\beta = 0.134$, $p \leq 0.05$). As table 4.2 shows, multiple group analysis revealed differences between clinical clerkships regarding relationships within the model. This moderation is evidenced by positive relationships between SRL and tie strength in some but negative relationships in other clerkships. Relationships between WLC and SRL were more robust, evidenced by consistent positive relationships.

Table 4.2 Structural equation model results (N=403).

	Overall (N=403)	IM (N=75)	SC (N=70)	NS (N=81)	MC (N=56)	FSM (N=83)	HELP (N=38)
TS-SRL	0.045* ($\beta = 0.095$)	0.009 $\beta = 0.018$	-0.053 $\beta = -0.110$	0.038 $\beta = 0.080$	0.162* $\beta = 0.337$	0.194*** $\beta = 0.403$	-0.009 $\beta = -0.019$
ND-TS	-0.234*** $\beta = -0.474$	-0.060 $\beta = -0.122$	-0.471*** $\beta = -0.954$	-0.066 $\beta = -0.133$	-0.221 $\beta = -0.448$	-0.045 $\beta = -0.092$	-0.155 $\beta = -0.314$
NS-TS	0.113*** $\beta = 0.530$	0.014 $\beta = 0.066$	0.196*** $\beta = 0.923$	0.065 $\beta = 0.304$	0.102 $\beta = 0.479$	0.042 $\beta = 0.196$	0.101* $\beta = 0.476$
WLC-SRL	0.241*** $\beta = 0.295$	0.381*** $\beta = 0.467$	0.373*** $\beta = 0.457$	0.212* $\beta = 0.260$	0.192* $\beta = 0.235$	0.257* $\beta = 0.315$	0.314 $\beta = 0.385$
NS-WLC	0.017** $\beta = 0.134$	0.030 $\beta = 0.241$	0.001 $\beta = 0.010$	0.005 $\beta = 0.039$	0.029 $\beta = 0.232$	-0.003 $\beta = -0.028$	0.014 $\beta = 0.113$

Table 4.2: Structural equation model results across clerkships (overall) and within clerkships
Abbreviations: (IM=Internal Medicine, SC=Surgical Clerkship, NS=Neurosciences, MC=Mother and Child, FSM=Family and Social Medicine, HELP=Healthcare Participation Clerkship). We mention unstandardized estimates and standardized estimates (β) for relationships within the structural equation model (ND=network diversity, NS=Network Size, TS=Tie Strength, SRL=Self-Regulated Learning Scale, WLC=Workplace Learning Scale). * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Figure 4.2 provides an overview of students' co-regulatory network characteristics in six different clerkships. For each clerkship, it presents students' co-regulatory networks, depicting whom students include in their networks, the number of individuals within each group, and the interaction frequency with each group. Although co-workers, and particularly peers and residents, fulfil a prominent role in students' co-regulatory networks, Figure 4.2

Figure 4.2: Medical students' co-regulatory networks within six clinical clerkships

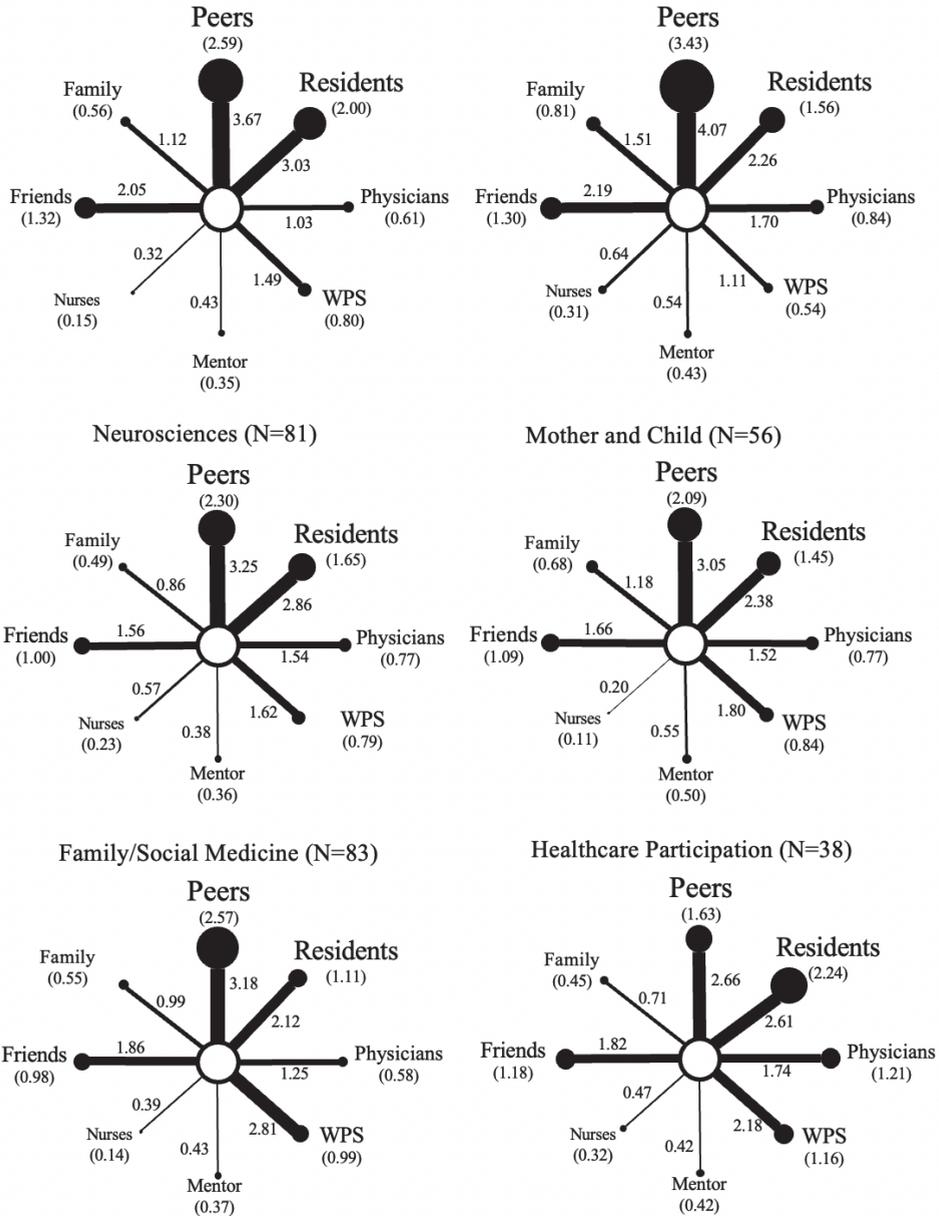


Fig. 4.2: Medical students' co-regulatory networks for six clerkships. The figure presents mean number of peers, residents, physicians, workplace supervisors (WPS), mentor, nurses, friends, and family between parentheses (the larger the line end, the larger the number of individuals within that group), and mean tie strength with each group next to the spokes that connect the student to the various groups (the thicker the lines, the higher the interaction frequency). Mean tie strengths were calculated by averaging means across the various groups both within clerkships and across clerkships.

shows that, throughout the programme, students seem to also engage friends and family in efforts to regulate their learning. Figure 4.2 furthermore shows that mentors are among the least frequently engaged across all clerkships as reflected by their relatively low tie strengths. Table 4.3 presents ANOVA results, comparing co-regulatory network characteristics between clerkships. We found significant differences in network size and tie strength, but not in network diversity. As shown, tie strength was strongest in surgery clerkships ($M= 3.57$) and weakest in HELP clerkships ($M= 2.64$). Co-regulatory network size was largest in surgery clerkships ($M= 9.23$) and smallest in family and social medicine clerkships ($M= 7.29$).

Table 4.3 Means, Standard Deviations, ANOVA tests comparing network characteristics of six clinical clerkships, (N=403).

	Overall	IM	SC	NS	MC	FSM	HELP
Network Size	8.05 (3.86)	8.37 (3.56)	9.23 (4.30)	7.59 (3.62)	7.52 (4.07)	7.29 (3.77)	8.61 (3.52)
ANOVA	F=2.71*		FSM		SC		
Tie Strength	3.13 (0.82)	3.23 (0.73)	3.57 (0.83)	2.91 (0.76)	3.05 (0.85)	3.14 (0.82)	2.64 (0.62)
ANOVA	F=9.05***		HELP		NS, MC, SC		FSM, HELP
Network Diversity	4.17 (1.66)	4.09 (1.63)	3.97 (1.79)	4.28 (1.57)	4.05 (1.75)	4.12 (1.69)	4.74(1.43)
ANOVA	F=1.265						

Table 4.3: Results from ANOVA tests comparing network size, tie strength and network diversity between clinical clerkships (IM=Internal Medicine, SC=Surgical Clerkship, NS=Neurosciences, MC=Mother and Child, FSM=Family and Social Medicine, HELP=Healthcare Participation Clerkship). We mention means and standard deviations (between parentheses). Mean tie strengths were calculated by averaging means across the various groups both within clerkships and across clerkships. For one-way ANOVA's we mention the $F(5,397)$ value, for post-hoc tests we mention only those rotations that differ significantly following the pairwise t-test.

** = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$ ”.*

Discussion

This exploratory study aimed to describe relationships between students' co-regulatory network characteristics (size, diversity, tie strength), students' perceptions of learning opportunities in clinical learning contexts, and self-reported SRL. We found positive and significant relationships between tie strength and SRL and between perceived learning opportunities and SRL. The clerkship context influenced both co-regulatory network characteristics as well as relationships between co-regulatory network characteristics, SRL, and perceived learning opportunities.

Overall, our findings confirm the importance of relationships and interactions in co-regulatory networks for medical students' SRL in clinical settings. By elucidating the scope of co-regulation in clinical workplaces, this study builds on, contributes to, and reinforces

changing conceptualizations of SRL as socially embedded learning activities.^{11,23} Medical education research into SRL has shown that formulating learning goals in clinical settings requires learners and engaged supervisors to interact and negotiate for goals to be realistic and achievable,^{28–30} as well as to monitor performance.³¹ We expanded this research by adopting a social network approach to CRL and SRL, allowing our data to show the extent to which students engage in CRL, and more specifically with whom, with how many others, and how often students co-regulate their learning during clerkships. We found that strong ties within co-regulatory networks in particular seem to benefit students' self-reported SRL. This finding seems to corroborate research that highlights the importance of social interactions for self-regulation in clinical contexts,^{5,6,11,30–33} but refines this notion by suggesting that coregulatory interaction frequency might be an important characteristic requiring further investigation. Our findings also suggest that being embedded in large coregulatory networks might facilitate interaction frequency, further enhancing medical students' SRL.

Our results furthermore suggest that students' ability to recognize learning opportunities within a particular context is essential for SRL, thus confirming previous research findings highlighting students' ability to align learning opportunities with learning plans.³⁴ Interactions within co-regulatory networks may support such recognition processes, especially if they are targeted at helping students to become aware of learning opportunities. Our findings regarding differences between clerkships in co-regulatory network characteristics and their relationships with SRL further highlight the context-dependency of SRL and CRL in clinical learning environments. These differences may reflect clerkships' context-specific features affecting co-regulatory network sizes, such as the number of supervisory staff present, with fewer staff at general practices compared to surgical departments at hospitals, for example. Similarly, one possible explanation for the variations in tie strength is that they may reflect differences in availability and approachability of supervisors in different clerkship settings,³⁵ influencing students' tendency to include multiple others in their co-regulatory network to support their learning and SRL. Self-evidently, there may be multiple explanations for differences between clerkships in coregulatory network characteristics and their relationships with SRL, such as differences inherent to the clerkship specialty, instructional support, or the structure of the clerkship itself.

An interesting nuance is our finding that tie strength was weakest in HELP clerkships. Given these clerkships are at the end of the master's programme, preceding transition towards residency training, lower co-regulatory interaction frequency may reflect students' pull toward acting autonomously and independently.³⁶ Autonomy and independence are core values within the culture of medicine, and students competing for positions in residency

training may feel pressured to conform to perceived or explicit expectations to act independently.^{37,38} The prevailing culture within medical education regarding progressive independence may thus inhibit students' willingness to engage others in their learning, even if they endorse the value of CRL. Additionally, students' CRL goals may change over time, potentially affecting interaction frequency as well. A recent study, for example, showed that experienced students, compared to novices, focused less on task-specific aspects of medical practice and more on professional identity development when engaging others in their learning.¹¹ Students' increasing confidence or competence in task performance and increasingly urgent considerations about the kind of physician they want to become may thus result in differently oriented, yet less frequent CRL.

Practical implications

Clinical contexts should provide students opportunities to build networks in which frequent co-regulatory interaction is stimulated. One approach is to stimulate partnerships among students, as well as between students and staff, for example, in prolonged clerkships, in which students are provided opportunities to build longitudinal relationships with others. Students and supervisors may then be encouraged and facilitated to establish learning needs and goals collaboratively, and to frequently interact regarding how to achieve shared goals in healthcare as well as in student's competence development.³⁹

Aligned with our finding that co-regulatory network size contributes to tie strength, mentors and supervisors can help students develop large co-regulatory networks that provide opportunities for frequent coregulatory interaction. We recommend that faculty development programmes pay attention to development of relevant skills to coach students in development of CRL skills and network building, as well as help students recognize and use available learning opportunities in various workplace settings. Additionally, rather than focusing students' SRL training on individual skills (e.g., goal setting, self-assessment, and reflection), medical education programmes might focus attention on development of skills that enable students to engage in CRL, such as feedback seeking and engaging others in learning conversations. This should include activities to make students aware of the benefits of co-regulatory networks and foster their ability to act on these benefits intentionally. Research in teacher education, for example, shows that network training sessions can be effective in developing quality networks.⁴⁰ These findings might provide a framework for designing training programmes targeting medical students' network building skills.

Limitations and future directions

First, we captured complex regulatory constructs using a questionnaire, reducing reality to response options within the questionnaire. Second, we based our conclusions on students' self-reports about complex SRL and CRL behaviour. Students may have varied in understanding questionnaire items or might not have been able to assess themselves or their networks accurately. However, self-reports are commonly used to study both SRL,^{22,23} and networks.^{12,14,17} Third, we focused on student-initiated interaction. Overall network size, diversity, and tie strength might have been larger had we included interaction initiated by others in clinical workplaces. Fourth, participants indicated the number of individuals within their co-regulatory networks from a fixed number of options. Therefore, network sizes may be larger than our data reflect. Fifth, we focused on only one characteristic of the individuals present in students' networks. That is, we only explored to which group they belonged (e.g., whether they belonged to the group of peers or physicians). We attempted to reduce these limitations by rigorous pilot testing of the questionnaire. Notwithstanding these limitations, our study was a first exploratory, quantitative attempt to explore co-regulatory networks in clerkships.

Our findings uncover future research directions to further disentangle SRL and CRL in clinical settings. First, researchers could focus on CRL initiated by persons other than students, to capture the mutuality of CRL in clinical settings. Second, future research might want to consider building on recent trends in network research that point to using mixed method social network analysis, which combines qualitative and quantitative approaches to analyse networks and allows for investigating both structural characteristics of networks and the meaning of interactions.⁴¹ Drawing on mixed method designs allows us to improve our understanding of the full complexity of interactions in co-regulatory networks. Third, future research could also focus on other characteristics of individuals in students' networks, such as experience (both as a healthcare professional and clinical teacher), gender, and age. Examining multiple characteristics helps create a more detailed understanding of the individuals with whom students engage in the regulation of their learning. A method for generating these data might be the use of predefined recall lists (or rosters) which present names of individuals, asking participants to indicate with whom on the roster they maintain specific relationships for regulation of their learning.¹²

Conclusions

This study highlights and reinforces the social and contextual embeddedness of SRL and CRL. Results provide insight into relationships among co-regulatory network characteristics, SRL, and clinical learning contexts, accentuating the importance of frequent interactions with meaningful others and making students aware of available learning opportunities. With its social network orientation, this study offers methods for operationalizing SRL and CRL in clinical workplaces, thereby paving a way along which medical education research can continue to disentangle social, relational, and contextual factors influencing SRL.

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CHAPTER 5

HOW MEDICAL STUDENTS CO-REGULATE THEIR LEARNING IN CLINICAL CLERKSHIPS: A SOCIAL NETWORK STUDY

Bransen D, Driessen EW, Sluijsmans DMA, Govaerts MJB
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Abstract

Background Self-regulated learning is a key competence to engage in lifelong learning. Research increasingly acknowledges that medical students in clerkships need others to regulate their learning. The concept of “co-regulated learning” captures this act of regulating one’s learning by interacting with others. To effectively cultivate such skills in students, we need to increase our understanding of co-regulated learning. This study aimed to identify the purposes for which students in different phases of clinical training engage others in their networks to regulate their learning.

Methods In this social network study, we administered a questionnaire to 403 medical students during clinical clerkships (65.5% response rate). The questionnaire probed into the composition of students’ co-regulatory networks and the purpose for which they engaged others in specified self-regulated learning activities. We calculated the proportion of students that engaged others in their networks for each regulatory activity. Additionally, we conducted ANOVAs to examine whether first-, second-, and third-year students differed in how they used their networks to support self-regulation.

Results Students used others within their co-regulatory networks to support a range of self-regulated learning activities. Whom students engaged, and the purpose of engagement, seemed to shift as students progressed through clinical training. Over time, the proportion of students engaging workplace supervisors to discuss learning goals, learning strategies, self-reflections and self-evaluations increased, whereas the proportion of students engaging peers to discuss learning strategies and how to work on learning goals in the workplace decreased. Of all purposes for which students engaged others measured, discussing self-reflections and self-evaluations were consistently among the ones most frequently mentioned.

Conclusions Results reinforce the notion that medical students’ regulation of learning is grounded in social interactions within co-regulatory networks students construct during clerkships. Findings elucidate the extent to which students enact self-regulatory learning within their co-regulatory networks and how their co-regulatory learning behaviors develop over time. Explicating the relevance of interactions within co-regulatory networks might help students and supervisors to purposefully engage in meaningful co-regulatory interactions. Additionally, co-regulatory interactions may assist students in regulating their learning in clinical workplaces as well as in honing their self-regulated learning skills.

Background

Self-regulated learning (SRL) is a key competence that physicians need to be able to engage in lifelong learning for high-quality care.¹ Although many medical curricula aim to foster the development of SRL skills, students often struggle to regulate their learning in the complex and dynamic clinical workplace.² Medical education research increasingly conceptualizes SRL as socially embedded activities, acknowledging that learners' regulatory learning processes and activities are influenced by interactions with others within a particular setting.³⁻⁵ As such, the notion of SRL is inextricably linked and intertwined with the concept of co-regulated learning (CRL), which specifies that learners' social interactions with others in their environment mediate how they regulate their cognitions, behaviours, and motivation.⁶⁻⁸ In clinical settings, CRL takes shape when medical students interact with peers, residents, physicians, or any other individual within their network to address activities, struggles, and considerations regarding the regulation of their learning. The networks in which interactions with meaningful others concern, influence, and contribute to students' self-regulation can be conceptualized as *co-regulatory networks* that may pose obstacles to students' regulatory learning, while also providing affordances.⁹

Previous research has suggested that learners can have different reasons for engaging others in their co-regulatory networks. Paediatric residents, for instance, may interact with their supervisors with the aim to pursue learning goals,¹⁰ whereas surgical residents may enlist the help of supervisors to monitor their performance during surgery.¹¹ Moreover, such co-regulatory learning behaviours and activities seem to evolve as learners progress through training, with junior medical students mostly engaging their peers in co-regulatory endeavours and their more advanced counterparts preferring to involve residents and physicians.^{5,12} Although the importance of interactions with others to students' regulation of learning is well-understood, network theories may offer more elaborated insights into the role learners' co-regulatory networks play in regulating their learning in clinical settings. According to social network theory, the way individuals are embedded in their social connections influences their behavior.¹³ Moreover, networks are structures consisting of actors (individuals) and links between these actors (ties) that capture, for example, the focus and patterns of communication.¹⁴ To understand the importance of relationships in medical education and their influence on educational processes and outcomes, social network analysis (SNA) has proven crucial. Indeed, previous SNAs have revealed that the relationships medical students maintained predicted their learning outcomes,¹⁵ that medical students tend to select friends of the same sex and ethnicity,¹⁶ and that residents who were close to others in their networks tended to have higher degrees of personal

accomplishment.¹⁷ These findings highlight the potential of social network perspectives to investigate how students' regulation of learning is embedded in the relationships they build and maintain during their clerkships.

Notwithstanding this, studies that have explored students' networks for CRL have only rarely adopted a social network perspective. In our recent study, however, we did focus on the relationships between students' co-regulatory network characteristics and their SRL and found that the frequency with which students engaged others in their co-regulatory networks and their self-reported SRL proficiency were positively and significantly related.¹⁸ Yet, we did not clarify the specific regulatory purposes for which students engaged others in their networks. Hence, there is at present a paucity of information on medical students' co-regulatory networks and how they use these networks to regulate their learning. In a bid to fill this gap, this study investigated students' co-regulatory networks in clinical settings. More specifically, we aimed to examine the purposes for which medical students in different phases of clinical training engaged others in their co-regulatory networks to regulate their learning.

Method

We conducted a cross-sectional questionnaire study involving medical students in clinical clerkships in the period between November 2019 and February 2020. We collected data on both the structure of students' co-regulatory networks and the focus of their interactions within these networks. We were particularly interested in the purposes for which students engaged others in their efforts to co-regulate learning during clerkships. We drew on social network analysis techniques, because it allowed us to examine whom students' engage with, and what the communication focuses on. As such, the social network perspective and associated techniques are suited to provide information about our research aim. We provide a more detailed description of how we drew on SNA in the remainder of this method section.

Setting

This study was set in the master's program in medicine at Maastricht University. Underpinned by the principles of competency-based medical education, this program has the roles of the Canadian Medical Education Directives for Specialists (CanMEDS) as its overarching assessment framework.¹⁹ In the course of the program which spans three years of clinical training, students rotate through 8- to 18-week clerkships in an academic hospital and affiliated teaching hospitals. As such, their learning is mainly workplace-based. To support

their SRL, students are assigned a mentor and workplace supervisor, and are required to compose an e-portfolio. For each clerkship, they set learning goals and formulate learning plans, which they consequently discuss with their supervisor and mentor.²⁰ After each clerkship, they evaluate and reflect on their learning together with their mentor, based on which they formulate new learning goals. These and other assessment requirements, including regular educational meetings, encourage students to follow the SRL cycle systematically.

Participants and Data Collection

Students who were in one of the following mandatory clerkships were considered eligible for participation in our study: healthcare participation (HELP), surgery, internal medicine, mother and child, neurosciences, family and social medicine (N=615). We approached students during educational meetings and invited them to participate in the study. To this end, the first author (DB) visited 41 educational meetings across the aforementioned clerkships, in collaboration with the course coordinators. After briefly clarifying the study, DB distributed URL links and QR codes, which gave students access to the questionnaire using their mobile devices. Before starting the questionnaire, participants signed an informed consent form. This study was approved by the Ethical Review Board of the Netherlands Association for Medical Education (ref. no. 2019.2.3).

Instrument

We developed a questionnaire to explore students' self-reported proficiency in SRL, their perceptions of the workplace learning context and its opportunities for learning and SRL, and students' co-regulatory network characteristics. The complete version of the questionnaire is included in the appendix of this chapter (page 104 ff). For the present study, we only used the data on the composition of students' co-regulatory networks (whom they engaged with to help regulate their learning) as well as on the purposes for which they engaged others in their co-regulatory networks. More specifically, we asked participants whom they would engage with when they wanted to discuss the regulation of their learning. Participants could select multiple responses from among the following eight options, hereinafter referred to as "actor groups" or "others": peers, residents, physicians, workplace supervisor, nurses, mentor, friends, and family. For each actor group they selected, participants then indicated the specific focus of their interactions. They could select multiple responses from among five regulatory purposes, namely to discuss: 1) *learning goals*; 2) *learning strategies*; 3) *how to use suitable learning opportunities*; 4) *working on learning goals in the workplace*; and

5) *self-reflection and self-evaluation*. We based these response options on Zimmerman's SRL model, which assumes that SRL processes and activities take place in three phases, that is, prior to a task (e.g., formulation of learning goals and strategic planning), during a task (e.g., how best to use learning opportunities, how to work on goals in specific settings), and following a task (self-reflection and self-evaluation).²¹

Before drafting the final questionnaire, we first pilot tested it on 10 respondents for comprehensibility of items, appropriateness of response options, and questionnaire length.²² Following this process, we slightly modified several items to improve comprehensibility. Participants in our pilot tests were 5 medical students (enrolled in clinical clerkships at the time of this study), 2 residents (who had recently completed the undergraduate medical curriculum at the time of this study), 2 physicians and 1 psychologist). Participants were recruited using a snowball sampling strategy. Pilot tests revealed relevant others with whom students could potentially interact during clerkships. Moreover, we decided to measure the regulatory purposes at the level of actor groups rather than at the level of each individual within the network, as respondents indicated that the cognitive load necessary to complete the questionnaire was too high.

Data Analysis

For each actor group in students' networks and for each regulatory activity, we calculated the total number of students indicating that they engaged in CRL with that particular actor group for that particular purpose. This allowed us to create an overview of the proportions of students who engaged the eight actor groups for each of the five regulatory activities. We calculated proportions for all students combined, as well as for each educational year. To examine whether first-, second-, and third-year students differed in the purposes for which they engaged others in their co-regulatory networks, we conducted analyses of variance (ANOVAs) comparing the proportions of students for each regulatory purpose across educational years. We corrected for multiple comparisons (Bonferroni correction). Because we were interested in trends across educational years, and less in demonstrating significance, we will present the results without correction and also give a description of the results with correction for multiple comparisons.

Results

Of the 615 students we invited to participate, a total of 403 completed the questionnaire (65.5% response rate). These respondents included 145 (36%) first-year students, 142 (35%) second-year students, and 116 (29%) third-year students. The sample consisted of 284 women (70.5%) and 117 men, which is representative of the student population in the program (69% female). In presenting the results, we will first describe the aggregated data (i.e., for all students, irrespective of year of study). Subsequently, we will focus on the trends in students' network deployment across educational years, zooming in on actor groups in students' co-regulatory networks, the purposes of co-regulatory network deployment, and interaction between actor groups and purposes.

Figure 5.1 gives an overview of the eight actor groups in students' co-regulatory networks and the purposes for which all students, irrespective of educational year, engaged each group. Although students engaged all actor groups in their co-regulatory networks, they did so to varying degrees and for various purposes. Peers, workplace supervisors, and residents in particular seemed to figure prominently in students' co-regulatory networks; After these groups, the actors that were engaged the most were, in descending order, mentors, friends, physicians, family, and nurses. Nurses were consistently engaged the least in students' networks. The most frequently mentioned purpose of engaging others was to discuss self-reflections and self-evaluations, followed by learning goals, working on learning goals in the workplace, learning strategies, and how to use suitable learning opportunities. Students primarily involved workplace supervisors or mentors, for that matter, with the aim to discuss learning goals, self-reflections, and self-evaluations, whereas they engaged peers to discuss learning strategies, learning opportunities, and how to work on goals in the workplace. Friends and family were among the actor groups students less frequently called upon, and when they did so, interactions were mainly targeted at discussing self-reflections and self-evaluations. In fact, discussing self-reflections and self-evaluations was among the two purposes most frequently mentioned for all actor groups, the group of peers excepted.

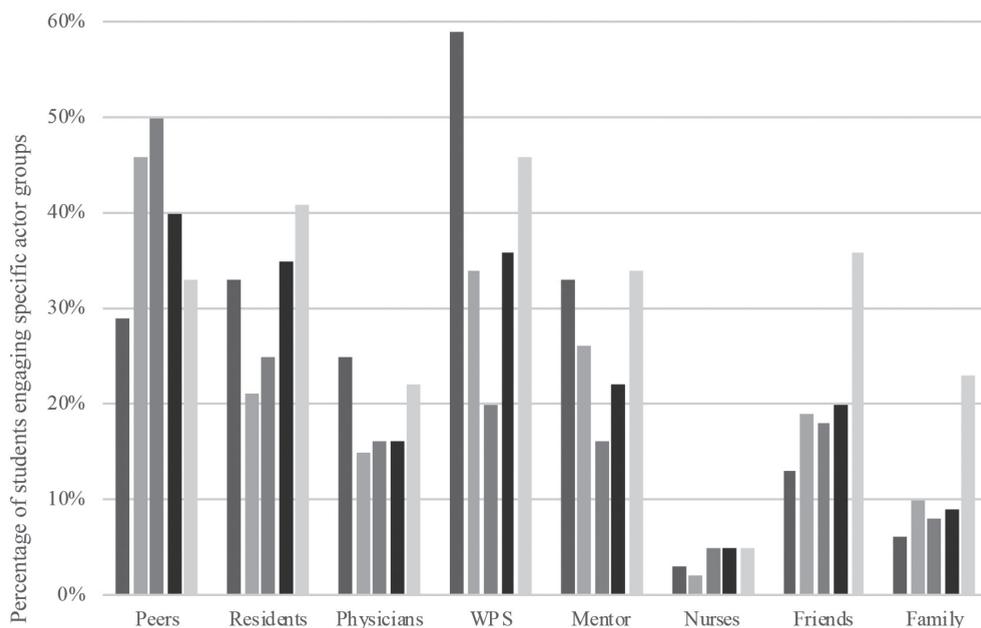


Figure 5.1: Distribution of co-regulatory purposes

Overall distribution of medical students' co-regulated learning with peers, residents, physicians, workplace supervisors (WPS), mentor, nurses, friends, and family for five regulatory activities (discussing learning goals, learning strategies, how to use suitable learning opportunities, how to work on learning goals in the workplace, and self-reflection and self-evaluation). The Y-axis shows the percentage of students who indicated that they engaged specific others for that specific purpose.

Figure 5.2 and table 5.1 present the distribution of students' purposes of engaging the eight actor groups in their co-regulatory networks across educational years. As the percentages of students engaging their network differed greatly across actor groups, the Y-axes of the various graphs in figure 5.2 are presented on different scales. From these data, we may infer that students of all years actively engaged their peers, but especially so in their first year, and that, once more seasoned, they started to favour workplace supervisors. Figure 5.2 furthermore shows that co-regulation of learning strategies with nursing staff dropped to zero for third-year students.

Table 5.2 presents significant findings from the ANOVA tests that compared first-, second-, and third-year students in terms of the purposes for which they engaged others in efforts to regulate their learning. Overall, we discerned two trends: across educational years, students increasingly engaged their workplace supervisors to discuss learning goals, learning strategies, self-reflections, and self-evaluations, and they less frequently called upon their

peers to discuss learning strategies and how to work on learning goals in the workplace. Compared to second- and third-year students, first-year students were, moreover, more inclined to discuss learning strategies with friends. After we corrected for multiple comparisons (Bonferroni), the reduced tendency to discuss learning strategies with peers became non-significant, and the shift in discussing how to work on learning goals with peers became marginally significant (.007 with $\alpha = .0062$).

Table 5.1: Percentages of first-, second-, and third-year students engaging others in their co-regulatory networks for five regulatory purposes.

	Year	Learning goals	Learning strategies	Learning opportunities	Working on goals	Self-reflection and self-evaluation
Peers	1	32	56	54	50	36
	2	27	41	47	36	27
	3	28	40	47	33	35
Residents	1	29	18	26	35	36
	2	40	23	27	36	47
	3	31	22	21	33	39
Physicians	1	21	10	17	11	15
	2	23	15	16	15	25
	3	31	20	15	22	26
WPS	1	44	30	19	26	32
	2	63	25	16	35	49
	3	72	49	26	50	57
Mentor	1	32	27	19	23	31
	2	34	30	13	22	37
	3	31	22	16	21	34
Nurses	1	3	2	3	5	4
	2	1	4	6	4	5
	3	4	0	5	5	7
Friends	1	17	28	20	26	39
	2	8	13	18	18	30
	3	12	16	16	17	41
Family	1	8	9	12	10	26
	2	7	13	6	11	21
	3	4	7	6	6	21

Percentages of first-, second-, and third-year students who engaged peers, residents, physicians, workplace supervisors (WPS), mentor, nurses, friends, and family for each of the five regulatory purposes, namely to discuss: learning goals; learning strategies; how use of suitable learning opportunities; working on learning goals in the workplace; and self-reflection and self-evaluation.

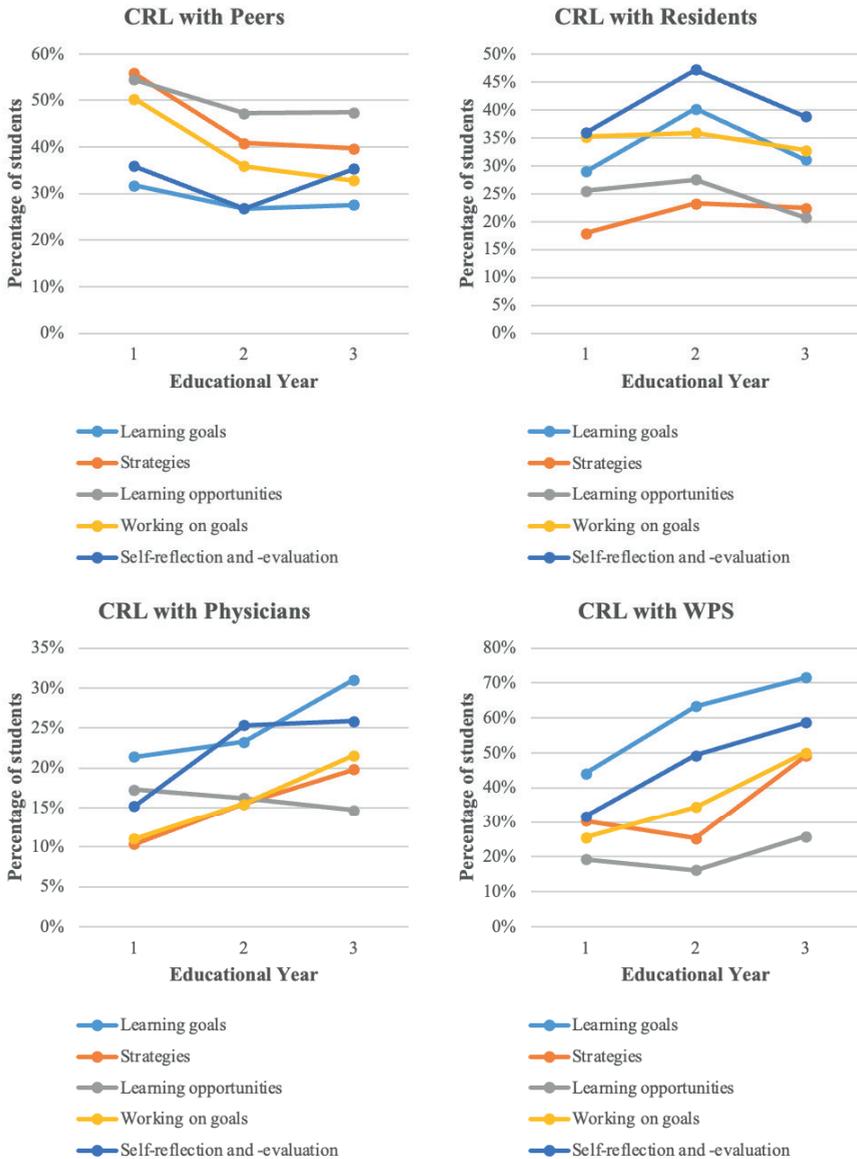


Figure 5.2: Distribution of co-regulatory purposes across educational years

Distribution of students’ regulatory purposes of engaging peers, residents, physicians, workplace supervisors (WPS), mentor, nurses, friends, and family across educational years. The Y-axis shows the proportion of students who indicated that they engaged that specific group; the X-axis shows students’ educational years (first, second, and third year). The lines reflect the five specific regulatory purposes, namely to discuss: learning goals, learning strategies, how to use suitable learning opportunities, how to work on learning goals in the workplace, self-reflections and self-evaluations. Please note that the scales of the Y-axes differ across the various figures.

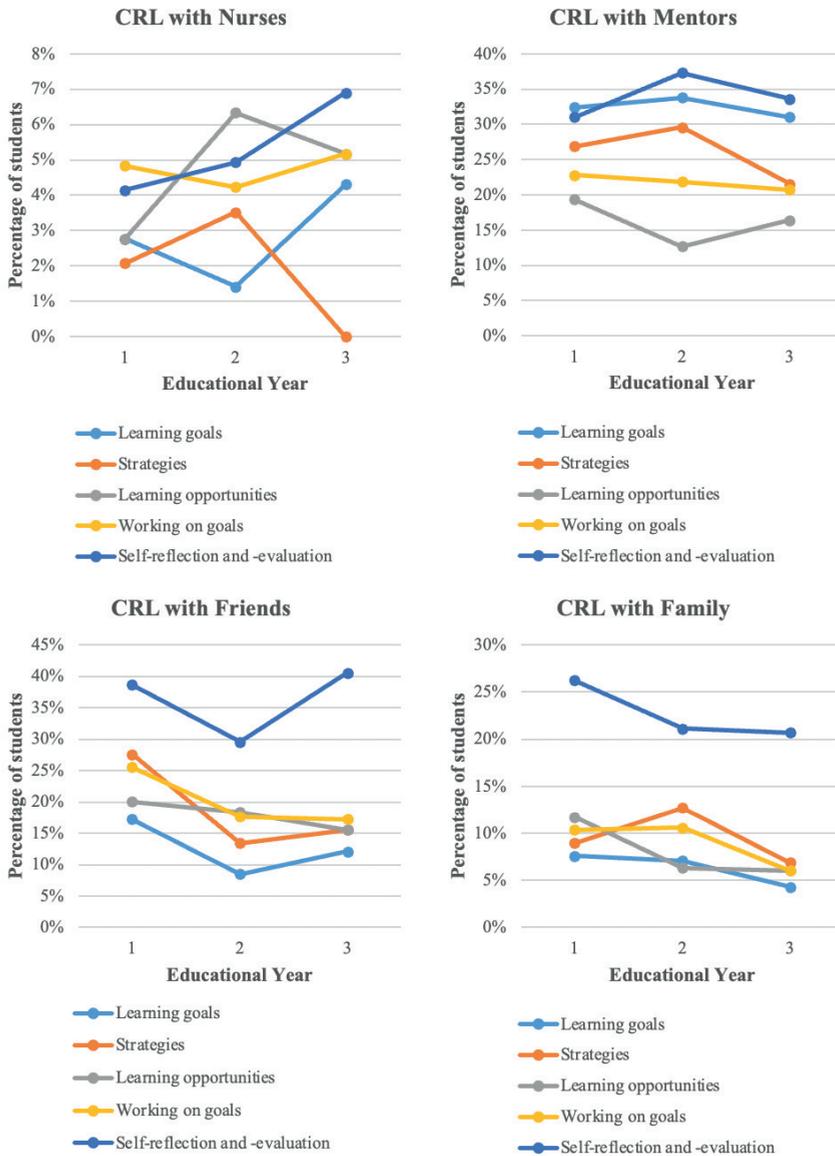


Figure 5.2 continued: Distribution of co-regulatory purposes across educational years

Distribution of students' regulatory purposes of engaging peers, residents, physicians, workplace supervisors (WPS), mentor, nurses, friends, and family across educational years. The Y-axis shows the proportion of students who indicated that they engaged that specific group; the X-axis shows students' educational years (first, second, and third year). The lines reflect the five specific regulatory purposes, namely to discuss: learning goals, learning strategies, how to use suitable learning opportunities, how to work on learning goals in the workplace, self-reflections and self-evaluations. Please note that the scales of the Y-axes differ across the various figures.

Table 5.2 Results of the ANOVA tests comparing proportions of students across three educational years, (N=403).

	Mean Y1	Mean Y2	Mean Y3	Mean difference (Y2-Y1)	Mean difference (Y3-Y1)	Mean difference (Y3-Y2)	F
Discussing learning goals							
WPS	0.44	0.63	0.72	0.19**	0.28***	0.09	11.48
Discussing learning strategies							
Peers	0.56	0.41	0.40	-0.15*	-0.16*	0.01	4.61
WPS	0.30	0.25	0.49	-0.05	0.19**	0.24***	9.05
Friends	0.28	0.13	0.16	-0.15**	-0.12*	0.03	5.47
Discussing working on learning goals							
WPS	0.26	0.35	0.50	-0.09	0.24***	0.15*	8.79
Peers	0.50	0.36	0.33	-0.14*	-0.17*	-0.03	5.07
Discussing self-reflections / self-evaluations							
WPS	0.32	0.49	0.59	0.17**	0.27***	0.10	10.42

Results of the ANOVA tests comparing the proportions of first-, second-, and third-year students regarding the purposes for which they engaged others in their co-regulatory networks. "Mean" refers to the proportion of all students (N=403) who engaged the respective group in the said regulatory activity (discussing learning goals, learning strategies, how to work on learning goals, and self-reflections/self-evaluations). The degrees of freedom for the ANOVA tests were 2 and 400, respectively. For post-hoc tests we mentioned only the rotations that differed significantly following the pairwise t-test. (* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$).

Discussion

This study explored whom students in different phases of clinical medical training included in their co-regulatory networks as well as the purposes for which they engaged others in these networks. It is important to consider that such networks extend beyond the direct clinical workplace, with many actor groups playing a role in students' efforts to regulate their learning. Our findings suggest that medical students select and engage others in their co-regulatory networks to varying degrees and for various purposes. Moreover, the actor groups they engage with and the purposes of engagement seem to shift over time. Subject to variations across individual students and study phases, students engaged all eight actor groups and covered all five regulatory purposes included in our study. Discussing self-reflections and self-evaluations were consistently among the purposes most frequently mentioned by students.

Our findings suggest that clerkship students purposefully engage others in their co-regulatory networks, with self-reflections and self-evaluations often being the focus of such interactions. This may seem surprising at first, as embedding reflection in medical education

has repeatedly been shown to be difficult or even problematic.^{23,24} Prior research has demonstrated, for instance, that reflection does not occur as often as is desirable,²⁴ or fairly often turns into a box-ticking exercise, with students telling others what they think they want to hear rather than engaging in true reflection.²³ The students in our study, however, actively discussed self-reflections and self-evaluations with others, which points to their willingness and ability to deploy others in their co-regulatory network for this particular purpose. In interpreting this finding, we must consider the context in which this study was situated: The Maastricht medical program requires students to engage in self-evaluation and reflective writing throughout the program. Before entering clinical clerkships, students have spent three years developing relevant skills in longitudinal student-mentor relationships. This preparatory training may explain students' ability to purposefully and meaningfully engage others in their networks to co-regulate self-reflections and self-evaluations. As such, our finding underscores the importance of curriculum design and support (e.g., training) in incentivizing students to engage others in reflection.

Another important finding is that students deliberately engaged clinical supervisors (i.e., workplace supervisors, physicians, and residents) in their regulatory learning. They often did so with the aim to discuss learning goals, self-reflections, and self-evaluations. This tendency, too, may be a product of the research setting. By expecting students to formulate learning goals and learning plans, discuss these with workplace supervisors and mentors, and jointly reflect on the process afterwards, the Maastricht University curriculum drives CRL in such a way that it has largely permeated workplace learning.²⁰ As such, these curricular and assessment demands on student-clinical supervisor interactions hint at the presence of an extrinsic dimension, begging the question of how we can support students in shaping their regulation of learning in a more intrinsically motivated fashion.

A third finding worthy of note is that students extended their co-regulatory networks beyond the clinical workplace to include friends and family members. Interestingly, although they did not engage them as frequently as other actor groups, when they did engage them, the aim was mainly to discuss self-reflections and self-evaluations. A potential reason could be that students found in them a safe environment, which is an important condition for self-reflection.^{25,26} As their connection with family members and friends often stretches beyond professional settings and learning situations, students might have felt more comfortable having reflective and evaluative conversations with them. From a different angle, reflections and evaluations can differ in form and focus. This means that students may have wanted to engage different actor groups for different regulatory purposes. Consequently, they may have called upon their "personal" networks (i.e., friends and family) to discuss

more personal matters, such as self-reflections on their identity formation and personal development rather than to evaluate task performance. These findings expose the need for medical education to realize that friends and family play an important role in students' self-reflection and self-evaluation and to reconsider the extent to which we capitalize on the opportunities they offer. We might need to train students to engage in and elicit meaningful learning conversations not only with clinicians but also with friends and family.

We also found that students tend to increase engagement with workplace supervisors in co-regulatory networks and decrease engagement with peers and friends while progressing through the program. These findings echo previous research suggesting that the role of peers in CRL is particularly important at the start whereas more experienced others (residents and physicians) come to the fore toward the end of clinical education.^{5,12} A growing need to reflect on their professional identity¹² and on their future career path might induce more seasoned students to seek interactions with the people they consider their role models.²⁷ As these students, moreover, are more likely to understand the workplace dynamics of existing clinical communities of practice than novice students,^{28,29} they may be more inclined to interact with experienced physicians within their networks. An important lesson to draw from our study is that any group of actors can play an important part in students' SRL and CRL. As such, it is imperative that we support these different actors in fulfilling a meaningful role in co-regulating students' learning processes and activities. To render CRL more effective, we must therefore make clinicians and residents aware of students' specific regulatory purposes so that they can assist students in explicating these purposes.

Finally, we were able to discern a pattern of students underutilizing nurses. Research into the relationships between nurses and medical students has, indeed, suggested that their interactions can be of poor quality, impeding collaboration.^{30,31} Other studies, however, have argued that nurses do play an important, albeit small, role in helping create a safe learning environment and identifying learning opportunities.⁵ While medical students tend to perceive nurses as more caring and less arrogant than physicians, they also regard them as less competent and having less status.³² Yet other studies have added that medical students sometimes find it difficult to understand nurses' professional and educational roles,³³ thereby creating barriers for students to engage nurses in regulatory learning. Therefore, we must first and foremost develop a clear conception of the educational role that nurses can play in students' regulation of learning.

Our results carry practical implications. Students might benefit from existing training programs focused on network building to help them become aware of networking goals and benefits and improve their network-building skills.³⁴ Such trainings should focus on clarifying the potential roles of actor groups in students' learning processes. Our findings also imply that faculty development programs should pay attention to clinical teachers' roles in CRL and provide support in helping them fulfill these roles. To this end, they may offer clinical teachers a similar training on network building to raise awareness of their role and offer tools to help students regulate their learning. When the relevance of interactions and discussions within co-regulatory networks is made explicit, both students and supervisors might be better able to purposefully engage in meaningful co-regulatory interactions that help students to regulate their learning in clinical workplaces. Lastly, to help students effectively co-regulate their learning, SRL and CRL should be made explicit in both the curriculum and the assessment program.

Limitations and Future Directions

This study has limitations. First, our conclusions were based on self-reported data. It may have been difficult for students to recall whom they engaged in their networks and the purposes for which they did so. In network studies, however, self-reports are widely used. Second, as we focused solely on interactions initiated by students, we were able to describe only part of students' co-regulatory activities during clerkships. Third, although we derived the five response options representing regulatory purposes from SRL models and pilot testing, they constitute only part of the processes on the regulatory spectrum with a relatively low level of granularity. Through pilot testing, however, we aimed to minimize this limitation. The present study was among the first to explicitly focus on and explore co-regulatory networks to increase our understanding of medical students' regulatory learning. Its limitations should be considered in light of this exploratory nature accordingly. Future research endeavours might want to move beyond self-reported data and the limitations they are subject to and take an ethnographic approach by observing how students interact with others to co-regulate their learning during clerkships. To cover the full scope of CRL, they might also want to focus on interactions initiated by others in the environment. Finally, we should consider qualitative social network studies that enable a more in-depth exploration and description of how regulatory processes and activities are embedded in co-regulatory networks.

Conclusions

The findings from this study emphasize and reinforce the increasingly acknowledged notion within medical education that students' regulation of learning is embedded in social interactions within co-regulatory networks. They do so by elucidating the extent to which regulatory purposes are distributed across students' co-regulatory networks and exposing which processes students from different educational years regulate and with whom they do so. These insights open up new opportunities to embed learning from and with others in medical education to produce health professionals who are able to think and work beyond the self.

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Appendix

Self-Regulated Learning at Work Questionnaire

Please indicate the extent to which the following statements describe your behaviour. There are no correct or incorrect responses to these questions: please indicate how you typically behave, rather than how you think you should behave.

- Scale: 1 = not at all applicable to me, 2 = sometimes applicable to me, 3 = quite applicable to me, 4 = applicable to me, 5 = very applicable to me.

SRL Forethought scale

- SRL-FT1: I set personal standards for performance in this clerkship.
- SRL-FT2: I set long-term goals (for example: monthly) for myself in order to direct my learning activities.
- SRL-FT3: I set goals to help me plan my learning activities.
- SRL-FT4: I set realistic deadlines for learning when I have identified a learning need.
- SRL-FT5: In this clerkship, I ask myself questions about each task I want or need to learn before I begin.
- SRL-FT6: I think of several ways to solve a problem and choose the best one.
- SRL-FT7: When planning my learning, I adapt strategies that have worked in the past.
- SRL-FT8: I use specific strategies for different things I need to learn in this clerkship.
- SRL-FT9: I think I will be able to use what I learn in this clerkship in the future.
- SRL-FT10: It is important for me to learn new things in this clerkship.
- SRL-FT11: Learning that I undertake in this clerkship is important to me.
- SRL-FT12: I can remain calm when facing difficulties in this clerkship because I can rely on my abilities.
- SRL-FT13: When I am confronted with a problem in this clerkship, I can usually find several solutions.
- SRL-FT14: Whatever comes my way in this clerkship, I can usually handle it.
- SRL-FT15: My past experiences in clerkships have prepared me well for my future as a physician.
- SRL-FT16: I meet the goals that I set for myself in this clerkship.
- SRL-FT17: I feel prepared for most of the demands during this clerkship.

SRL Performance scale

- SRL-PF1: I write down a plan to describe how I hope to achieve my learning goals during this clerkship.
- SRL-PF2: I ask myself how what I'm learning is related to what I already know.
- SRL-PF4: When learning I make notes (for example: diagrams, etc.) to help organize my thoughts.
- SRL-PF5: I focus on the meaning and significance of new information.
- SRL-PF6: I organize my time to best accomplish my goals.
- SRL-PF7: When I'm learning, I try to relate new knowledge I find to what I already know.
- SRL-PF8: When I'm learning, I bring together information from different sources (for example: information I receive from people and information from literature).
- SRL-PF9: I try to apply ideas from my previous clerkships experiences to this clerkship where appropriate.
- SRL-PF10: During learning I treat the resources I find as a starting point and try to develop my own ideas from them.
- SRL-PF11: I try to play around with ideas of my own related to what I am learning.
- SRL-PF12: In this clerkship I think about possible alternative ways to do my tasks.
- SRL-PF13: When I can't understand a task, I ask for help.
- SRL-PF14: In this clerkship I try to identify whom I can ask for help if I need it.
- SRL-PF15: When I am unsure about something I look it up.
- SRL-PF16: I fill in the gaps in my knowledge by getting hold of the appropriate material.
- SRL-PF17: When faced with a challenge in this clerkship I try to understand the problem as thoroughly as possible
- SRL-PF18: I like opportunities to engage in tasks that require me to learn.
- SRL-PF19: I prefer tasks that arouse my curiosity, even if I need to learn to achieve them.

SRL Self-Reflection scale

- SRL-SR1: I know how well I have learned once I have finished a task in this clerkship.
- SRL-SR2: I ask myself if there were other ways to do things after I finish a task in this clerkship.
- SRL-SR3: I think about what I've learned after I finish a task in this clerkship.
- SRL-SR4: I think about how what I've learned in this clerkship fits in to the 'bigger picture' at my education.

SRL-SR5: I think about how what I've learned relates to the team I am part of in this clerkship.

SRL-SR6: I try to understand how new information I've learned impacts my work in this clerkship.

Workplace Learning Context Scale: WLC

Please indicate the extent to which this clerkship provides opportunities for learning and development. There are no correct or incorrect responses to these questions.

- Scale: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often or always

WLC1: This clerkship requires me to be creative.

WLC2: I can decide for myself which tasks I want to perform during this clerkship.

WLC3: I have opportunities to develop unique skills during this clerkship.

WLC4: I can vary how I do my work during this clerkship.

WLC5: This clerkship requires a high level of skill.

WLC6: This clerkship requires me to learn new things.

Social network questionnaire

Who do you approach to discuss issues such as:

- What do I want to learn?
- How do I intend to learn that?
- How or where do I find suitable learning opportunities?
- How do I check whether I have learned something?

Check all job titles with whom you discuss such matters:

- Residents
- Peers (fellow-students)
- Workplace supervisors
- Nurses
- Physicians
- Mentor
- Family members
- Friends

For each selected group, participants then indicated, from a fixed number of options, the total number of individuals from each group with whom they interacted to discuss issues such as “What do I want to learn?”, “How do I intend to learn that?”, “How or where do I find suitable learning opportunities?”, “How do I check whether I have learned something?”. Provided response options are between parentheses:

- Residents (5)
- Peers (fellow-students) (5)
- Workplace supervisors (4)
- Nurses (3)
- Physicians (3)
- Mentor (1)
- Family members (3)
- Friends (3)

For each selected group, participants then indicated, from a fixed number of options, how often they interacted with individuals from that group to discuss issues such as “What do I want to learn?”, “How do I intend to learn that?”, “How or where do I find suitable learning opportunities?”, “How do I check whether I have learned something?”. Response options were:

- 1 = approximately bimonthly
- 2 = approximately monthly
- 3 = approximately biweekly
- 4 = approximately weekly
- 5 = almost daily



CHAPTER 6

HOW TO CONCEPTUALISE SELF-REGULATED LEARNING: IMPLICATIONS FOR MEASUREMENT

Bransen D, Govaerts MJB
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Self-regulated, lifelong learning is considered a key competence in the health professions and, obviously, fostering development of self-regulated learning (SRL) skills is high on the agenda in health professions education worldwide. Monitoring and providing students with meaningful feedback on their SRL development as well as assessing whether our graduates are actually well prepared for lifelong learning calls for appropriate measures that provide valid indicators of SRL behaviours.

Traditional and easy to administer self-report questionnaires, requiring students to retrieve and report SRL strategies from their long-term memory, typically consider SRL to be an aptitude or relatively stable trait. However, as research has shown that students' SRL strategies vary across and within tasks and contexts, their validity has been questioned.¹ Therefore, research increasingly focuses on the use of event measures, such as SRL microanalysis techniques or behavioural traces, which allow for examination of SRL behaviours during specific tasks or events.² Although there is some medical education research exploring such methods to measure SRL,^{3,4} studies that explicitly aim to compare event instruments and self-report questionnaires are very scarce.

The paper by Gandomkar and colleagues,⁵ in this issue of *Medical Education*, therefore makes an important contribution to our current understanding of how to assess students' SRL. Gandomkar and colleagues investigate and compare three different measures of medical students' SRL in biomedical science learning (a self-report questionnaire, SRL microanalysis and behavioural traces).⁵ The authors argue that, in the context of biomedical science learning, microanalysis techniques are to be preferred over aptitude measures, emphasising the need to add event measures to our repertoire of SRL measurement methods.⁵ Findings from their study also suggest that different measures appear to target different, yet relevant aspects of SRL.⁵ These findings are in line with other studies in higher education showing that we probably need a multimethod approach, in which we combine event measures and aptitude measures, to validly assess students' SRL, and that selection of methods is dependent on assessment goals.⁶ Current research findings thus, seem to highlight the complexity of SRL, indicating that the enigma of measuring SRL is far from solved.

One aspect that may be overlooked in our search for appropriate measures is the fact that measurements may not only depend on research or assessment purposes, but also on the way we conceptualise SRL. Typically, research on SRL seems to conceptualise SRL as an individual activity, focusing on cognitive processes within the individual that give rise to supposedly independent and autonomous learning. However, learning and self-regulation are increasingly conceptualised from a sociocultural perspective, which considers learning

to be socially embedded and a highly interactive and collaborative endeavour.⁷ Meaningful learning requires interaction, not only with the learning task itself but also with other individuals in the learning environment. In fact, shared knowledge construction is a pillar of modern learning theories and pedagogical approaches, and many medical programmes facilitate social interactions by, for example, adopting collaborative learning principles within their curricula (e.g., problem-based learning).⁸ Similarly, medical education research increasingly acknowledges that how and what students' learn is influenced by social interactions within their networks.⁹

Social interactions' influence on and contributions to regulation of learning are embodied in the concept of co-regulated learning (CRL). In CRL, cognition, motivation and behaviour are jointly regulated, through social interactions with others, reflecting sociocultural theories of learning. Key to CRL are the interactions between learners and others in the learning environment through which learning activities or processes (e.g., SRL development) are mediated.¹⁰ For example, a student who feels stuck in a particular (learning) task might ask a fellow student for feedback or advice on how best to proceed, thereby co-regulating strategic planning for the task at hand when at the same time learning new and appropriate strategies for self-regulation. Furthermore, previous research findings suggest that relationships between SRL and CRL may best be described as reciprocal. That is, social interactions with others support development of students' SRL, whereas mastery of SRL skills helps students to actively engage others in CRL to enhance their own learning in meaningful ways.¹¹ Students who are able to formulate clear and intrinsically meaningful learning goals, for example, seem to be better able and more willing to interact with others to optimise their learning activities. Within this conceptualisation of regulation of learning, SRL and CRL are inextricably linked and one cannot be seen as separate from the other.

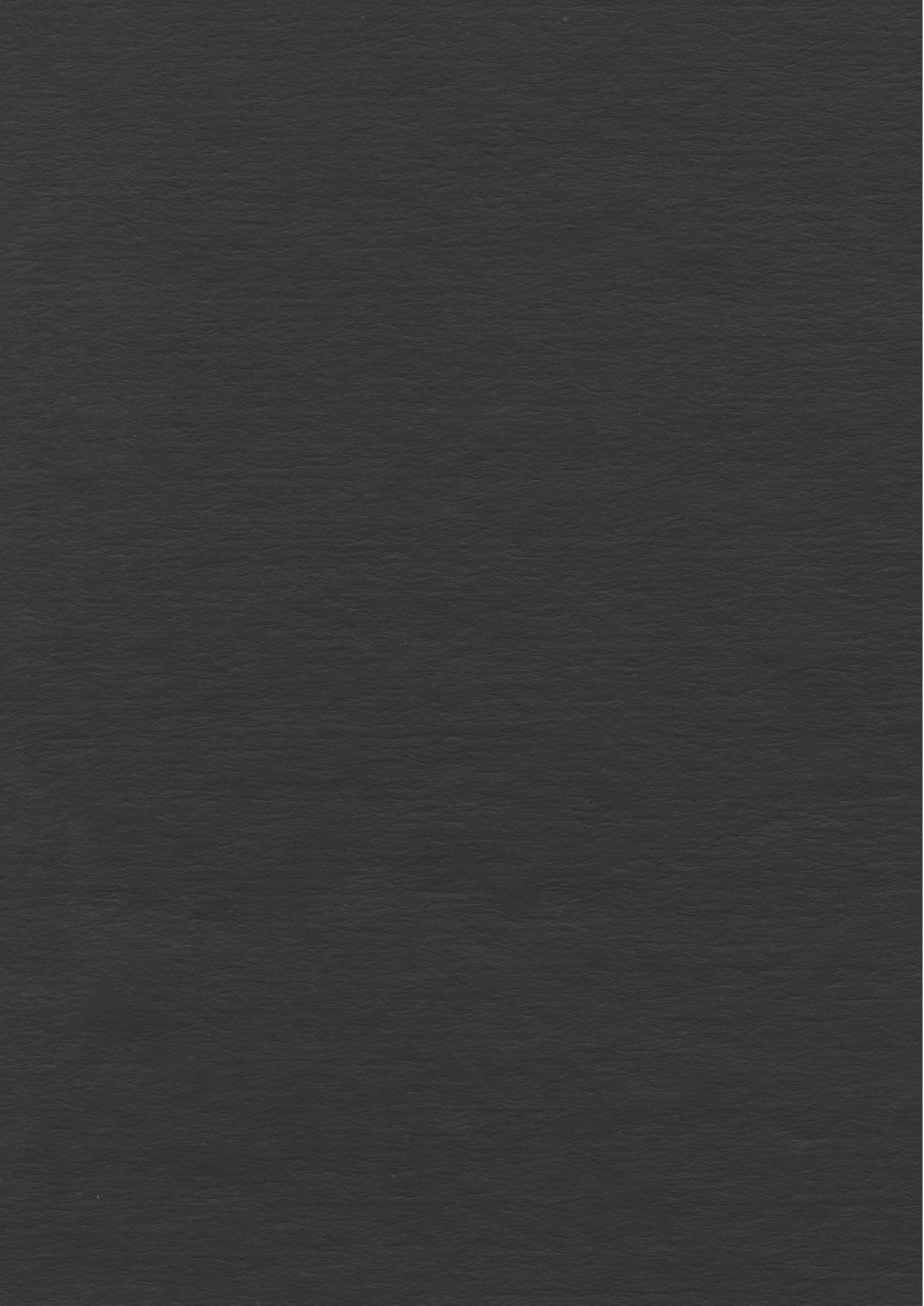
Adopting this conceptual inseparability of CRL and SRL may very well have implications for selection and design of SRL measures. We may have to shift our focus from measuring the (meta) cognitive behaviours of the individual towards assessing how students use affordances in the learning environment, including how they engage in CRL or collaborate with others, in order to regulate and enhance their learning. The conceptualisation of SRL as a socially embedded act therefore calls for further research on development and use of measures that are able to capture the reciprocal relationship between SRL and CRL. From this perspective, findings regarding the use of event measures seem to be highly relevant and promising, as event measures such as microanalysis techniques are pre-eminently suited to capture context-specific learning behaviours. Refining microanalysis techniques to capture CRL may not only help us to better assess students' development in SRL skills, it may

also help us to improve SRL development through a better understanding of if, when and how students' learning and regulation is supported by the social networks in which their learning takes place.

The need to develop and assess our students' SRL is beyond dispute. However, solving the problem of how to measure SRL not only calls for research on measurement instruments, but may first and foremost call for reconsideration of the way we conceptualise SRL.

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CHAPTER 7

GENERAL DISCUSSION

General Discussion

The research aim of this PhD thesis was twofold. First, I aimed to explore conceptualisations of regulatory learning fitting a sociocultural perspective on workplace learning as well as the alignment of socio-cognitive perspectives on self-regulated learning with the social and interactive nature of clinical workplace learning. Second, I aimed to investigate how medical students in clinical learning environments engage in regulation of their learning, using a sociocultural learning perspective. More specifically, I explored medical students' networks in clinical settings, and if and how interactions within these networks affect their regulation of learning. In the subsequent sections, I will reflect on the obtained insights regarding the research aims, followed by a discussion of this dissertation's strengths and limitations, practical implications, and directions for future research.

Introducing concepts of co-regulation and co-regulatory networks

This dissertation highlights the importance of social interactions with others for students' regulatory learning, a notion embedded in the concept of co-regulated learning.¹ Findings largely confirm previous research findings indicating that social interactions with others in clinical workplaces are important for medical students' regulation of learning.²⁻⁵ The concept of co-regulated learning emerged from sociocultural learning theories that focus on how learners' cognitions, emotions, and motivation for learning are mediated through social interactions with others in the environment.⁶⁻⁹ By engaging others in regulatory activities and processes – such as goal setting, performance monitoring, and reflection – the 'co-regulator' mediates (i.e. co-regulates) the metacognitive and cognitive activities of the 'co-regulated', thereby influencing the regulation of his or her learning processes.^{6,9} Co-regulated learning thus reflects a social mode of regulatory learning and comprises an essential mechanism by means of which learning processes and activities are regulated.¹⁰

The studies included in the present dissertation thus reflect sociocultural learning perspectives that place social interactions at the heart of (regulatory) learning.^{6,11} Findings indicate that students' regulatory learning in clinical workplaces takes place to a large extent through interactions with others within students' networks. Specifically, chapter 3 provides initial insights into whom students consider relevant for the regulation of their learning, and reveals that peers, residents, physicians and workplace supervisors play important roles in students' regulation of learning. Based on social network theory and building on social network analysis techniques, chapters 4 and 5 provide a more detailed description of whom and why students engage in regulation of their learning. Importantly, findings suggest that

the networks students use for regulation of their learning – besides the abovementioned actors – also include nurses, mentors, as well as friends and family members. Students seem to use others within their networks to support a wide range of self-regulated learning activities. Whom students engage, however, as well as the purpose of engagement seems to vary and shift as students progress through clinical training. Remarkably, of all purposes for which students engage others in their co-regulatory networks, discussing self-reflections and self-evaluations are consistently among the ones most frequently mentioned. Findings furthermore imply that supporting development of strong networks aimed at frequent co-regulatory interactions enhances medical students' self-regulated learning in challenging clinical learning environments.

I coined the term 'co-regulatory networks' (chapter 4) to capture the notion of networks and interactions within those networks that explicitly focus on, influence, and contribute to students' regulation of learning. Conceptualising of regulatory learning as taking place in co-regulatory networks adds to the current discourse of and research into regulatory learning as it allows capturing the social nature and embeddedness of students' regulatory learning processes and activities. Findings in this dissertation suggest that students' co-regulatory networks – and more specifically, reciprocal relationships and interactions within these networks – are at the very centre of students' regulation of learning. Co-regulatory networks serve as *modus operandi* through which students shape their regulatory behaviour in clinical clerkship environments. I therefore argue that, especially when referring to workplace learning, we may have to question approaches to regulation of learning that focus on the "self" of the individual learner and regulatory learning processes and activities within the individual. Rather, to accurately describe how regulation of students' learning is shaped in clinical settings, we may have to shift attention to the systems in which students learn and engage in regulatory learning, i.e. students' co-regulatory networks.

Regulation of learning in co-regulatory networks

Reflecting on and reviewing the results from the studies in this dissertation, I argue that how medical students engage in regulatory learning may depend on three key factors, which are related to specific characteristics of the network, the student, and the broader context in which regulatory learning takes place. That is, students' regulatory learning in clinical workplaces is influenced by their *embeddedness in co-regulatory networks* and their *co-regulatory intentionality*. Additionally, how these factors influence students' regulation of learning is *context-dependent*. These three factors are distinct but interrelated, and collectively shape students' regulation of learning within the networks they develop during clinical clerkships. I

will discuss each factor in detail below, as well as how they build on one another and jointly provide the affordances and constraints for students' regulation of learning.

Embeddedness in co-regulatory networks

The extent to which students are nested within their co-regulatory networks in clinical learning environments is an essential – even indispensable – component for the regulation of their learning during clinical clerkships. Chapter 3, for example, reveals that establishing relationships with others in the workplace helps students uncover what is expected from them and feel part of the healthcare team, which assists students to effectively regulate their learning activities and processes. Having a more thorough understanding of what is expected from them aids students in deploying others in their co-regulatory networks meaningfully and purposefully, thus enhancing effectiveness of regulatory learning.¹²

The locus of control for embeddedness in co-regulatory networks resides in both students themselves as well as in others in the environment and is materialized in reciprocal relationships in learning and regulation of learning. On the one hand, students' embeddedness in co-regulatory networks may result from student behaviours aimed at purposeful construction of co-regulatory networks, by means of building and maintaining strong and meaningful relationships with others whom students perceive to be potentially relevant for the regulation of learning. On the other hand, students may be engaged by more experienced others – either by residents and supervisors, or by more experienced peers – who then take control of embedding students' in their co-regulatory networks. Findings in this dissertation suggest that taking initiative in co-regulation of learning enhances students' experiences of being a member of a team or community of learning and practice. Likewise, members of students' co-regulatory network may feel encouraged to engage in co-regulation of learning when students demonstrate pro-active behaviours in learning and efforts to regulate their learning.

Relationships in co-regulatory networks thus seem to be reciprocal, and the nature of interactions between members of the network determines effectiveness of co-regulation and workplace learning. The reciprocal nature of relationships in co-regulatory networks may explain findings regarding the role of nurses in medical students' regulatory learning. Research consistently shows that health care training is often perceived as intra-professional rather than inter-professional, and medical students may not recognize the role nurses can play in fostering their competence development.¹³ Nurses, on the other hand, may not always feel comfortable or called upon to engage in regulation of a medical trainee's

learning, especially when excluded from the trainee's network. The importance of being embedded in co-regulatory networks to optimize medical students' learning therefore applies to all healthcare workers within the health care setting.

Characteristics of students' co-regulatory networks and the way students are embedded in these networks create affordances and constraints for students' regulatory tendencies and proficiency. Chapter 4 describes how three co-regulatory network characteristics (network size, network diversity, and interaction frequency) collectively relate to medical students' self-reported proficiency in self-regulatory learning. *Network size* refers to the number of individuals in students' co-regulatory networks, *network diversity* refers to the number of groups to which these individuals belong, and *interaction frequency* refers to how often students engage these groups in co-regulation of learning. Based on findings from the study presented in this chapter, the interaction frequency with which students engaged others in co-regulation of learning seems to be positively related to the size of students' co-regulatory networks and their self-reported self-regulated learning proficiency. In other words, to feel confident in regulating learning processes and activities, students in clinical clerkships may benefit from having many individuals in their co-regulatory networks with whom they frequently discuss their activities, struggles, and considerations regarding regulation of their learning.

While students' peers, as well as residents, and workplace supervisors are important sources for students to discuss various parts of the regulation of their learning, students' co-regulatory networks seem to extend beyond clinical workplaces and included individuals from students' personal lives, such as family members and friends. This finding aligns with notions of workplace learning that go beyond the physical location of where the actual work takes place, or where one actually works.¹⁴ According to these notions, "place" in the context of workplace learning can cover a wide range of situations and also relate to "where it is that we operate cognitively as we think and learn" (p. 8).¹⁴ Especially when transitioning to new and challenging work and learning environments, students may experience that interpersonal places for learning outside the actual work setting provide environments that are psychologically safer and more inviting to engage in reflective thinking or discussing any uncertainties they may have regarding their learning, their progress and future career choices. This seems to be reflected in findings from chapter 5 that show students typically engage friends and family in self-reflection and self-evaluation, activities that typically require students to be open and vulnerable.

As indicated before, findings from chapter 3 reveal that the nature of relationships that students build and maintain in clinical workplaces influence the extent to which they feel

embedded within their co-regulatory networks. That is, if interactions contribute to students' feeling part of the healthcare team, this seems to help students to start moving towards the centre of the community of practice.^{15,16} Feeling part of the healthcare team – as well as developing an understanding of what is expected from them in clinical workplaces through interactions between students and their peers – helps students feel more comfortable and better informed to regulate their learning processes and activities or to purposefully and meaningfully engage others in the regulation of their learning. However, chapter 3 also shows that students need time to build meaningful relationships, and that effectiveness of co-regulatory learning depends on the duration of the relationships. In most clinical curricula, medical students are relatively rapidly propelled from one clinical workplace to the next. This leaves students with little time and space to meaningfully connect with members from the healthcare team. Consequently, there is little continuity in students' co-regulatory networks – with students having to construct and maintain new relationships and new networks relatively quickly, and not being able to capitalize on the relationships students engage in with regards to regulating their learning. Findings from the study presented in chapter 3 confirm that this hinders students' regulation of learning. This lack of opportunity to meaningfully connect to others present in the clinical environment might therefore be an additional factor in leading students towards extending their co-regulatory networks beyond the clinical workplace and including the more stable and long-lasting relationships with their friends and family.

Co-regulatory Intentionality

Students' embeddedness within and deployment of their co-regulatory networks seems to be shaped by the intentions with which students elicit co-regulatory interactions. As such, students' intentions regarding whom to engage with – as well as the specific purpose for engaging others in their networks – play a major role in how students regulate their learning processes and activities in clinical learning environments. Chapters 3, 4, and 5 provide insights into students' intentions in co-regulation of learning. I found that students deliberately deploy their networks for regulation of their learning based on their learning needs in particular situations, and their perceptions of whom in their networks might best serve that particular need. For example, chapter 5 describes how students intentionally engage their friends and family with the aim of discussing self-reflections and –evaluations, whereas chapters 3 and 5 indicate that students intentionally engage their peers to discuss learning goals. The findings regarding students' intentional engagement in co-regulation of learning align with basic assumptions within many SRL models that emphasize active and purposeful engagement in learning processes and activities.^{17–19} Findings from the studies in this dissertation add to this by describing how and why students purposefully

engage others within their networks, depending on their goals and motives to engage in regulatory learning. Findings presented in chapter 3 furthermore suggest relationships between students' purposeful engagement in self-regulation of learning and the extent to which they are able to meaningfully elicit co-regulatory interactions with and from others in clinical learning environments. That is, medical students reported that a firm grasp of their personal learning needs assists them to engage others meaningfully and intentionally – as well as more readily – in the co-regulation of their learning, corroborating findings regarding reciprocity of co-regulatory relationships.

Students' intentions for co-regulatory network deployment furthermore seem to shift over time. Depending on students' developing understanding of what is expected from them in clinical clerkships, as well as on their increasing ability to navigate clinical learning environments, interactions within students' co-regulatory networks shift in nature and focus. More specifically, chapter 3 and 5 show that novice students differ from experienced students regarding their co-regulatory network deployment. Although peers are important co-regulatory sources for all students, they are particularly so for novices. Contrarily, more experienced students seem to intentionally engage more experienced clinicians to discuss various components of regulation of their learning. However, students not only shift regarding whom they engage with, but also regarding intentions with which they engage others in the regulation of their learning. For example, chapter 3 shows how novice students engage others in CRL to set highly specific and clearly demarcated learning goals with high levels of granularity. Contrarily, experienced students concentrate on engaging others in CRL when focusing on broader learning goals that concern professional competence and professional development. Furthermore, chapter 3 also indicates that experienced students are better able to intentionally regulate their learning based on internal drivers, e.g. constructing their regulatory activities based on demands of actual patient care and their developing ideas of the type of physician they want to become. Novice students' motives for engaging in regulatory learning and engaging others, on the other hand, seem to be more externally driven, for instance by specific instructions, explicit guidance from others, or portfolio requirements.

These findings align with previous research findings indicating that students with different levels of experience tend to have different intentions regarding the regulation of their learning and whom they engage in discussions regarding regulatory activities and processes.³ Findings are furthermore in line with research on how medical professionals seem to actually learn in workplace settings.²⁰ Using insights from deliberate practice research, Van de Wiel and colleagues examined the activities physicians engage in to further their professional

development, specifically focusing on goal-setting behaviours as a key element in purposive and effortful improvement of performance. Their findings showed that learning was very much embedded in day-to-day work. Regulation of learning was largely implicit, driven by patient care, rather than by explicitly formulated competence improvement goals.²⁰ In line with these findings, students' regulatory learning may change significantly over time, with respect to active engagement in goal setting, planning as well as selection of learning strategies, as they progress through the programme and are increasingly engaged in actual patient care as a member of the health care team.

Context-dependency

It is widely acknowledged that self-regulation of learning is context-dependent.^{2,4,21,22} First and foremost, regulating one's learning in clinical contexts differs from classroom-based regulation of learning. Learning and regulation of learning in clinical settings is often seen as secondary to the primary aim of providing patient care, requiring students to balance performance in patient care and (regulation of) learning.³ Active participation and experiencing responsibility in patient care, however, often serves as a major trigger for regulatory learning processes and activities.^{2,23–25} Effectiveness of regulatory learning is, however, influenced by contextual features such as the time that is available for (regulation of) learning, the learning and work climate of hospital departments, and engagement with and in the team.^{2,23–25} Chapter 3 underscores this notion of context-dependency of regulatory learning processes and activities. Specifically, students indicate that feeling part of the team, and having an understanding of contextual affordances and constraints affects their engagement in regulatory learning and engagement of others in the regulation of their learning.

Findings as presented in chapter 4 furthermore show that the clerkship context exerts significant influence on the students' possibilities for network construction, as well as on relationships between co-regulatory network characteristics and self-reported self-regulated learning. The clerkship context moderates the relationships between variables, leading to – for example – positive relationships between interaction frequency and self-reported self-regulated learning in some clerkship contexts, but to negative relationships in others. Chapter 4 furthermore reveals an overall positive and significant relationship between students' perceptions of learning opportunities in clinical contexts and their self-reported self-regulated learning. Findings from studies within this dissertation thus emphasize the interrelatedness of social embeddedness and context-dependency of students' regulatory learning. That is, how students are embedded in their co-regulatory networks depends partly on contextual features of clinical learning environments in the sense that contextual

characteristics co-determine whom students can engage with as well as students' co-regulatory intentions (i.e. students' purposes for co-regulatory engagement).

Aligning conceptualisations of regulatory learning with clinical learning and work environments

In chapters 2 and 6, I review current conceptualisations of regulation of learning and theoretical developments regarding regulatory learning. Specifically, chapter 2 questions the alignment of current conceptualisations of regulation of learning with demands for collaboration in educational settings and healthcare practice. I explore different conceptualisations of regulatory learning – self- (SRL), co- (CRL), and socially shared regulation of learning (SSRL) – and elaborate on how integrating these conceptualisations may add to our understanding of regulatory learning in healthcare settings. Generally, SSRL refers to processes and activities by means of which teams regulate their collaborative learning, emphasizing interdependency among team members.^{6,7} Both CRL and SSRL reflect social modes of regulatory learning but differ in how the regulation is distributed among regulators; CRL is considered an 'unevenly distributed' form of social regulation (with one or more team members guiding the regulation of an individual learner), whereas SSRL is considered an 'evenly distributed' form of social regulation (regulation is characterised by group members' reciprocal engagement in regulatory activities and processes).^{10,26}

Based on the findings from studies in this dissertation, I argue that regulation of learning in complex and interactive clinical environments may best be conceptualised using an integrative perspective. Until fairly recently, research tended to focus on regulation of learning that individual learners engage in, with a strong emphasis on the individual, i.e. regulating the self, and to a lesser extent on co-regulation of learning. However, we may want to refrain from viewing regulation of learning from an 'either-or' perspective, aiming to pinpoint whether a learner engages in either SRL, CRL, or SSRL. Rather, I advocate for a conceptualisation of regulatory learning that acknowledges and emphasizes the fact that learning, and hence regulation of learning, in workplace settings is both individual and social, and that an integrative perspective on regulatory learning may fit the dynamic and interactive nature of clinical learning environments best.

Reviewing the concept of collaborative learning may provide useful in elucidating the perspective of SRL, CRL, and SSRL as being integrated in one another. Collaborative learning refers to learning that occurs when team members – who have a collective goal – interact about features of their shared tasks in order to attain their goals.^{27,28} Obviously, team members

remain individually engaged in regulating and monitoring individual effort, attention, and motivation (SRL) in goal achievement.²⁹ During collaborative learning, however, team members may furthermore engage in SSRL when they regulate learning processes as a collective, such as jointly formulating learning goals or task perceptions.⁷ Team members may additionally engage in CRL during collaborative learning when one member guides another team member's regulation of learning. Then, CRL can be considered transitional towards SRL or SSRL, depending on whether CRL is directed towards the team (SSRL) or an individual team member (SRL).^{7,10}

Thus, in day-to-day work settings that typically rely on collaboration within health care teams, self-, co-, and socially shared regulation of learning are interrelated and integrated, with task requirements, learners' personal characteristics, as well as contextual and social attributes jointly influencing the extent to which learners engage in SRL, CRL, and/or SSRL. Certain learning tasks may make a greater appeal on individuals regulating their own learning (denominated SRL) and only a small appeal to CRL and even less on SSRL, whereas other learning tasks may be characterized by interdependency and place heavier demands on CRL and SSRL, and call for engagement in SRL only to the extent that it facilitates CRL and SSRL. We may therefore want to shift from an exclusive focus on how to optimise self-regulation of learning, to the broader perspective of how to most effectively regulate learning, depending on the level at and context in which it takes place.

Strengths and limitations

This dissertation has several strengths. In conducting the empirical studies, I used both qualitative and quantitative research methods to construct insights into medical students' regulation of learning. One of the strengths of this dissertation resides in the sequencing of studies. I set out with a qualitative research design to explore the topics of this dissertation, which provided an initial understanding and theory building of students' co-regulatory behaviours and their perceived influence on SRL. Based on findings from these interviews, I became increasingly interested in students' networks and familiarized myself with social network analysis techniques. I then designed and conducted two studies based on a social network perspective, which allowed for visualisation of students' co-regulatory networks and a better understanding of students' purposes for network deployment and relationships between network characteristics and SRL. By drawing on social network analysis techniques, I introduced ways to operationalize CRL in clinical learning environments. As such, I was able to expand current trends in health professions education that emphasize the social embeddedness and collaborative nature of regulatory learning. Furthermore, the research

team composition has positively contributed to the insights obtained within the studies included in this dissertation, as the team consisted of experts in a variety of disciplines – organizational psychology, medicine, and educational sciences – allowing us to interpret the data from a variety of perspectives.

This dissertation has several limitations. The empirical studies in the present dissertation focused predominantly on students' perspectives of their self- and co-regulatory processes and activities. Therefore, I was only able to inquire the student's perspective while it is conceivable that others in the learning environment may have different perspectives on their role in regulation of learning and co-regulatory networks. I therefore consider my inability to describe the mutuality of CRL as one of the limitations of this dissertation, as my interpretation of how co-regulatory networks function in regulation of medical students' learning may be incomplete or inaccurate. Similarly, in the empirical studies based on the social network perspective (chapters 4 and 5), I did not include patients as a response option, potentially omitting important sources for students' regulatory learning. Furthermore, studies in this dissertation were based on self-reported data from participants which might deviate from actual behaviour. However, in the light of students' development into professionals who are to be engaged in life long regulatory learning, exploring the students' perspective on how regulation of learning takes place in clinical settings is a crucial first step to enhance our understanding and educational practice. Finally, data were collected within one institute and one programme, which might make transfer or generalization of results problematic. Overall, however, findings seem to resonate with other research findings, strengthening credibility and transferability of study findings.

Implications for practice

This dissertation has several implications for practice and education (see table 7.1). Implications relate to programmes in health professions education and clinical workplaces in particular, given their responsibility to create learning environments that help stimulate students' regulation of learning. When regulation of learning is seen as a social act in which individual learning and regulation are to be balanced with co-regulation and socially shared regulation of learning, the importance of creating environments that support building and maintaining of trusting relationships as well as development of relevant competencies for regulation of learning at different levels – both in students and staff – becomes self-evident. Additionally, to optimize learning from and for work, it is important for both health professions education and practice to increase the extent to which regulatory learning activities and processes are made explicit. That is, we need to increase our attention and

efforts toward creation of learning environments that encourage students and professionals to make regulation of learning explicit and to internalize regulatory learning activities and processes. Acknowledging from the start of health professions education that regulation of learning is embedded in social interactions in clinical workplaces (and educational settings in general, for that matter), may contribute to design of curricula that better prepare students to optimise (regulation of) their learning. In the table below, I provide concrete suggestions for improvement of health professions education and practice based on the findings from studies included in this dissertation.

Table 7.1 Practical implications

Creating learning environments supportive for regulation of learning

Clinical contexts should provide opportunities for students to build networks in which frequent co-regulatory interaction is stimulated, for example, by creating partnerships among students, as well as between students and staff in prolonged clerkships. Students and supervisors may then be encouraged and facilitated to formulate learning goals collaboratively, and to frequently interact about how to achieve shared goals in healthcare as well as in student's competence development.

Mentors and supervisors can help students develop co-regulatory networks that provide opportunities for frequent coregulatory interaction.

Staff and students should be supported to re-think learning and regulation of learning in collaborative inter-professional settings, and to purposively create opportunities for reflection on collaborative learning and socially shared regulation of learning.

Development of skills relevant for regulation of learning

To help students develop into learners who are able to regulate their learning in workplace settings, we not only need to provide training and coaching in skills such as goal setting, self-assessment and reflection, but – importantly – need to pay attention to the skills that enable students to engage in CRL and/or SSRL, such as seeking feedback on learning tasks as well as on learning processes and engaging others in learning conversations.

Faculty development programmes should support staff in developing relevant skills for coaching students in their development of regulatory learning and CRL and/or SSRL skills as well as network building skills, and to help students recognize and use available learning opportunities. This should include activities to make students aware of the benefits of co-regulatory networks and foster their ability to act on these benefits intentionally.

Developing trusting relationships

Students might benefit from training programs focused on network-building skills to help students become aware of networking goals and benefits and improve their network-building skills. Especially for novice students, investing in peer-to-peer relationships may enhance students' perceptions of psychological safety and engagement in co-regulation of learning.

Health profession education curricula might want to consider stimulating the development of safe and trusting longitudinal relationships within health care teams in longitudinal (integrated) clerkships. Allowing students to lengthen the time they are present in particular workplaces, might help them build trusting relationships with others that help them regulate their learning.

Future research directions

An important direction for future research relates to examining the mutuality and reciprocity of co-regulation of learning. Inherent to co-regulation is that there are at least two parties, with one party regulating the (learning) activities of the other. While chapter 3 provided some insights into co-regulatory interactions as initiated by supervising physicians, workplace supervisors and residents, the empirical articles in this dissertation focus primarily on how students actively engage in and elicit co-regulatory interactions. As such, students' perspectives, actions, and considerations were central in the research design and insights gained from these studies. Although it is essential to understand what motivates students to discuss the regulation of their learning, it is only part of the equation. It is therefore crucial that future research broadens its scope and shifts attention to others in medical students' networks (e.g., clinical teachers, workplace supervisors, residents, peers as well as patients and friends and family) and their perspectives on their role in students' regulation of learning. By focusing on others' perceptions of their role in the development of students' regulatory learning, as well as how perceptions shape their behaviours in supporting students' learning and regulation of learning we may capture the conceptual mutuality of co-regulation of learning. By focusing on all members of students' networks in clinical learning environments and exploring their perspectives, tendencies, and behaviours for purposes of learning and regulation of learning, we may be better able to describe and improve regulatory learning in complex clinical learning environments and inter-professional patient care.

A second direction for future research is to investigate how different forms of regulatory learning are embedded in collaborative situations. Research into self-, co-, and socially shared regulation of learning in clinical settings has yet to adopt an integrative perspective. Current research typically tends to separate the different forms of regulatory learning or is limited to sub-components of self-, co-, or shared regulation. To improve our understanding of how different forms of regulatory learning are integrated with one another during collaboration and how they jointly shape individual and collective regulatory processes and behaviour, we may need to draw on simulation-based research.³⁰⁻³² Observing how team members shape their individual and collaborative regulation in simulated situations may serve as a useful starting point, based on which initial descriptions of regulatory processes and behaviours during episodes of self-, co-, and socially shared regulation may be constructed. Considering different forms of regulatory learning as being integrated in one another has implications for selection and design of measuring regulatory learning processes and activities. Chapter 6 describes how we may have to shift our focus from measuring the (meta)cognitive behaviours of the individual towards assessing how students use affordances in the learning

environment, and how they engage in CRL, SSRL, or collaborate with others, in order to regulate and enhance their learning. I argue that conceptualising regulatory learning as socially embedded acts, calls for research that is able to capture episodes of SRL, CRL, and SSRL that may reside within one another.

A third important aim of future studies may be to describe the quality of the interactions within students' co-regulatory networks. Chapters 4 and 5 provided insights based on quantitative research methods. Although useful in visualizing students' co-regulatory networks, their purposes for network deployment, and exposing trends across educational years or clinical clerkships, there is still much to gain in terms of the quality of the interactions. To this end, future research could draw on mixed methods social network analysis.³³ Using both quantitative and qualitative methods of collecting data about students' co-regulatory networks, we will be better able to describe the quality of co-regulatory interactions and how they may contribute to the development of students' regulatory learning in clinical clerkships.

Concluding remarks

This dissertation investigated and described how medical students engage in the regulation of their learning through interactions within their networks in clinical learning environments. Regulation of learning is embedded within students' co-regulatory networks. The extent to which students are embedded within their co-regulatory networks, their intentions for engaging others in co-regulation of their learning activities and processes, as well as contextual affordances and constraints interact and influence students' network-based regulatory learning. Increasingly, healthcare is provided by healthcare teams who need to collaborate to ensure high quality patient care. We therefore may want to shift away from exclusively focusing on how to optimise self-regulation of learning, to the broader perspective of how to most effectively regulate learning, depending on the level at and context in which it takes place. Unravelling regulation of learning within the healthcare domain therefore means unravelling the levels of self-, co-, and socially shared regulation of learning. Only then are we able to truly move beyond the self.

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ADDENDUM

IMPACT PARAGRAPH

ENGLISH SUMMARY

NEDERLANDSE SAMENVATTING

SHE DISSERTATION SERIES

ACKNOWLEDGEMENTS

BIOGRAPHY

Impact paragraph

Research: Main research objectives and most important results

This dissertation sought to question the alignment of socio-cognitive perspectives on self-regulated learning with the reality of the social and interactive nature of clinical workplace learning, and to explore conceptualisations of regulatory learning fitting a sociocultural perspective on workplace learning. Additionally, using a sociocultural learning perspective, I explored how medical students in clerkship settings engage in regulation of their learning. More specifically, I explored if and how interactions with others in medical students' networks affect their regulation of learning.

Findings from the studies presented in this dissertation relate to the notion that students' regulatory learning is inextricably linked to the networks students build and maintain during clerkships. I coin the term 'co-regulatory networks' to capture the notion of networks and interactions within these networks that explicitly focus on, influence, and contribute to students' regulation of learning. Conceptualisation of regulatory learning as taking place in co-regulatory networks adds to the current discourse of and research into regulatory learning as it allows for capturing the social nature and embeddedness of students' regulatory learning activities, thus reflecting sociocultural perspectives on learning and regulation of learning. How students regulate their learning processes and activities in clinical settings seems to be influenced by the extent to which they are embedded in co-regulatory networks, their specific intentions for engaging others in the regulation of their learning, and the context in which learning processes and activities are regulated.

Based on the findings from my studies, I argue that regulation of learning in complex and interactive clinical environments may best be conceptualised using an integrative perspective. In order to better align conceptualisations of regulation of learning with current demands for collaboration in educational settings and healthcare practice, I elaborate on how integrating different modalities of regulatory learning – self- (SRL), co- (CRL), and socially shared regulation of learning (SSRL) – may enhance our understanding and use of regulatory learning in healthcare settings. I advocate for a conceptualisation of regulatory learning that acknowledges and emphasizes the fact that learning, and hence regulation of learning in workplace settings is both individual and social, and that an integrative perspective on regulatory learning may fit the dynamic and interactive nature of clinical learning environments best.

Relevance and target group: The (potential) contribution of the results from this research to science, and, if applicable, to social sectors and social challenges

The findings of this dissertation are relevant for the advancement of the domain of and discourse on regulatory learning, as findings call on to broaden our perspectives on regulatory learning. More specifically, findings as presented in this thesis call for a shift in focus beyond the individual (the “self”) in regulatory learning, both in research as well as in educational interventions aimed at supporting development of regulatory learning competencies. Results highlight the importance of networks for students’ regulation of learning as well as the need to consider different levels at which regulation of learning can or should take place in complex workplace settings that increasingly rely on teamwork and collaborative learning. Coining the term co-regulatory networks helps ground the notion of regulation of learning being inextricable linked to the networks in which learning is regulated and provides a way of operationalizing co-regulated learning. Furthermore, by drawing on social network techniques, I illustrated how adding these techniques to our repertoire of research approaches may help us to gain a more in-depth understanding of the social embeddedness of regulatory learning.

Results of this dissertation are relevant for multiple stakeholders. Curriculum designers may draw on concepts of and relationships between different modes of regulatory learning to help capitalize on the opportunities of each mode separately, but more importantly, to integrate different modes of regulatory learning in education and workplace learning. By moving “beyond the self” and focusing on the social nature of regulatory learning, the importance of creating a learning environment that facilitates and fosters appropriate competencies for learning in all relevant stakeholders and for a broad range of learning tasks becomes self-evident. Results of this dissertation are furthermore relevant for medical students, their supervisors and mentors. By making students and their teachers aware of the role of co-regulation in learning and competence development, findings may help shape supervisory relationships that facilitate meaningful co-regulatory interactions and learning conversations. This may subsequently strengthen students’ regulatory proficiency and competence development as well as clinical teachers’ supervisory skills. Furthermore, findings of this dissertation may help healthcare teams think about how they regulate their collaborative learning to maintain and enhance quality of patient care. Explicating team regulatory processes helps stimulate collaborative learning as well as regulation of collaborative learning, contributing to healthcare teams that are able to create dynamics that allow for lifelong (team) learning.

Activity: Dissemination

Published articles included in this dissertation are available online as open access manuscripts in international peer-reviewed scientific journals. These journals reach a broad audience worldwide in the field of health professions education and research. Additionally, I disseminated the research in this dissertation by giving research paper presentations at international and national conferences (e.g. The Association for Medical Education Europe (AMEE); Rogano Meeting Vienna; The Dutch Association for Medical Education (NVMO)). At these conferences, I also delivered workshops and round-table sessions. I was furthermore interviewed by the editor in chief of the journal *Medical Education*, to elucidate my research. These podcasts reach a large and diverse audience. Additionally, I provided a webinar for employees of one hospital, in which I presented my research and trained participants in engaging in co-regulatory interaction and discussions.

English Summary

Medical students in clinical clerkships are expected to regulate their learning processes and activities in complex and often unpredictable clinical workplaces. Because a multitude of aspects influence students' self-regulated learning – related to personal, contextual, and social factors – regulation of learning tends to be challenging for students in clinical clerkships. Health professions education research increasingly acknowledges that medical students in clinical settings need others to regulate their learning and to develop self-regulated learning skills. Furthermore, conceptualisations of regulatory learning tend to focus on (cognitive and meta-cognitive) processes within the individual, even though current healthcare provision increasingly relies on collaboration and collaborative learning. Therefore, this dissertation examined how medical students regulate their learning in the social and dynamic context of clerkships, and questioned the alignment of current conceptualisations of regulation of learning with demands for collaboration in present-day healthcare.

Chapter 2 explored different conceptualisations of regulation of learning (self-regulated learning, co-regulated learning (CRL), and socially shared regulation of learning (SSRL)), and elaborated on how the integration of these conceptualisations may add to our understanding of regulatory learning in healthcare settings. The concept of co-regulated learning essentially captures this act of regulating one's learning by interacting with others. I argue that, in any collaborative learning, engagement in momentary co-regulatory interactions may occur within episodes of both socially shared regulation of learning and self-regulated learning. Thus, learners may concurrently engage in different forms of regulation. The three levels of regulatory learning (self-regulated learning, co-regulated learning, and socially shared regulation of learning) may therefore best be considered as embedded in one another during collaborative learning situations. Conceptualising regulatory learning as consisting of different modes of regulation has implications for research and practice. Given the demands for collaboration in current healthcare, it is important to broaden our perspective on regulatory learning, and we propose that future research adopts a multi-level and integrated perspective, focussing on the levels of self-, co-, as well as socially shared regulation of learning in healthcare (education) settings. To overcome limitations associated with collecting self-reported measures (which may differ from actual behaviour), recent trends draw on technological advancements and point to collecting multimodal data, which involves collecting data from different data channels (i.e. modalities), for example objective physiological data as well as subjective self-report data, allowing researchers to examine features and phases of regulatory learning in complex collaborative learning situations. To improve our understanding of regulation of learning during collaboration, we may want to

draw on simulation-based research in particular, as this more easily allows incorporation of technology. Simulation-based research settings seem therefore eminently suitable for helping scholars analyse and disentangle complex phenomena that are difficult to uncover, such as regulatory learning processes. Practical implications concerned the need to create curricula that explicitly pay attention to development of competencies underlying not only SRL but CRL and SSRL as well. Both students and staff need to be aware of different levels of regulatory learning that are required for effective task performance in nowadays health care settings and maintenance of competence for safe and high-quality patient care.

Chapter 3 explored medical students' perceptions of co-regulated learning in clinical clerkships and its perceived impact on the development of their self-regulated learning. Data were collected through semi-structured interviews with 11 purposively sampled medical students enrolled in clinical clerkships at one undergraduate competency-based medical school. Data collection and analysis were conducted iteratively, informed by principles of constructivist grounded theory. Data analysis exposed three interrelated shifts in co-regulated learning and self-regulated learning as students progressed through clerkships. First, students' co-regulated learning shifted from a focus on peers to co-regulation with clinician role models. Second, self-regulated behaviour shifted from being externally driven to being internally driven. Last, self-regulation shifted from a task-oriented approach towards a more comprehensive approach focusing on professional competence and identity formation. Students indicated that if they felt able to confidently and proactively self-regulate their learning, the threshold for engaging others in meaningful co-regulated learning seemed to be lowered, enhancing further development of self-regulated learning skills. Findings from chapter 3 thus emphasise the notion that self-regulated learning and its development are grounded in co-regulated learning in clinical settings. To optimally support the development of students' SRL, we need to focus on facilitating and organising learners' engagement in co-regulated learning from the start of the medical curriculum.

Chapter 4 and chapter 5 presented two empirical studies on CRL, based on a social network perspective. Data for both studies were collected simultaneously, using an online survey consisting of two parts. The first part focused on self-regulated learning behaviours and students' perceptions of the extent to which the workplace learning context entailed opportunities for learning and SRL. The second part focused on students' co-regulatory networks, providing information about whom students include in their networks, how many individuals students include in their networks, and how often they engaged with others in their networks. The questionnaire was administered to students who were enrolled in one of the following clerkships: internal medicine, surgery, neurosciences, mother and child,

family and social medicine, or HELP (N= 615) in the Master's in Medicine programme at Maastricht University. The response rate was 65,5%.

The aim of the study described in chapter 4 was to explore relationships between characteristics of medical students' co-regulatory networks, perceived learning opportunities, and self-regulated learning. Using multiple regression analysis, structural equation modelling techniques, and analysis of variance, the authors explored relationships between co-regulatory network characteristics (network size, network diversity, and interaction frequency), students' perceptions of learning opportunities in the workplace setting, and self-reported self-regulated learning. Across all clerkships, data showed positive relationships between tie strength and self-regulated learning ($\beta = 0.095$, $p < 0.05$) and between network size and tie strength ($\beta = 0.530$, $p < 0.001$), and a negative relationship between network diversity and tie strength ($\beta = -0.474$, $p < 0.001$). Students' perceptions of learning opportunities showed positive relationships with both self-regulated learning ($\beta = 0.295$, $p < 0.001$) and co-regulatory network size ($\beta = 0.134$, $p < 0.01$). Characteristics of clerkship contexts influenced both co-regulatory network characteristics (size and tie strength) and relationships between network characteristics, self-regulated learning, and students' perceptions of learning opportunities. Findings from chapter 4 thus reinforce the importance of co-regulatory networks for medical students' self-regulated learning. Findings furthermore suggest that supporting development of strong networks aimed at frequent co-regulatory interactions may enhance medical students' self-regulated learning in challenging clinical learning environments.

Chapter 5 presented findings from a more in-depth exploration of how students regulate their learning in clinical clerkships. More specifically, the study reported in chapter 5 explored whom and for which purposes students in different phases of clinical training select and engage others in their networks to regulate their learning. We calculated the proportion of students that engaged specific others in their networks for each of the predefined regulatory activities. In addition, we conducted ANOVAs to examine whether first-, second-, and third-year students differed in how they used their networks to support self-regulation and the purposes for which they did so. Results showed that students used others within their co-regulatory networks to support a wide range of self-regulated learning activities. Whom students engaged, as well as the purpose of engagement, seemed to shift as students progressed through clinical training. Over time, the proportion of students engaging workplace supervisors to discuss learning goals, learning strategies, self-reflections and self-evaluations seemed to increase, whereas the proportion of students engaging peers to discuss learning strategies and how to work on learning goals in the workplace seemed to

decrease. Of all purposes for which students engaged others in their co-regulatory networks measured in this study, discussing self-reflections and self-evaluations were consistently among the ones most frequently mentioned. Chapter 5 thus provides a more in-depth understanding of the extent to which students enact self-regulated learning within their co-regulatory networks and how their co-regulatory learning behaviours develop over time. Findings from the studies as presented in chapters 4 and 5 show that social network approaches offer promising ways of further understanding and conceptualising self- and co-regulated learning in clinical workplaces.

Chapter 6 presents a critical reflection on current methods of measuring self-regulated learning. In this chapter, I elaborate on implications of the findings in this dissertation in the light of current developments in education and health care with a specific focus on implications for measuring regulation of learning. I argue that self-regulated learning may best be considered as a socially grounded act and that measurement methods should be able to capture the social and contextual embeddedness of regulatory learning.

Lastly, chapter 7 described a general discussion in which the results of all studies are summarized, reflected on, and synthesized in relation to the research aims of this dissertation. As such, chapter 7 contributes to the advancement of the academic discourse on regulatory learning. The main conclusion of this dissertation is that regulation of learning is embedded within students' co-regulatory networks, and is to be considered a situated social act. More specifically, the extent to which students are embedded within their co-regulatory networks, their intentions for engaging others in co-regulation of their learning activities and processes, as well as contextual affordances and constraints interact and collectively influence students' network-based regulatory learning. Furthermore, healthcare is increasingly provided by healthcare teams who need to collaborate in order to ensure high quality patient care. We therefore may want to shift away from exclusively focusing on how to optimise self-regulation of learning, to the broader perspective of how to most effectively regulate learning, depending on the level at (self-, co-, and/or socially shared regulation of learning) and context in which it takes place. In line with shifting conceptualisations of regulatory learning, implications for further research and practice are described.

Nederlandse Samenvatting

Van geneeskundestudenten in coschappen verwachten we dat zij hun leerprocessen en activiteiten reguleren binnen complexe en vaak onvoorspelbare klinische werkomgevingen. Omdat een groot aantal aspecten het zelfregulerend leren van studenten beïnvloeden - gerelateerd aan persoonlijke, contextuele en sociale factoren - is het reguleren van leren vaak een uitdaging voor studenten in coschappen. Onderzoek naar onderwijs in de gezondheidszorg erkent in toenemende mate dat geneeskundestudenten in klinische werkomgevingen anderen nodig hebben om hun leren te reguleren en om zelfregulerende leervaardigheden te ontwikkelen. Bovendien zijn conceptualisaties van regulerend leren vaak gericht op (cognitieve en metacognitieve) processen binnen het individu, terwijl de huidige gezondheidszorg in toenemende mate afhankelijk is van samenwerking en samenwerkend leren. Daarom werd in deze dissertatie onderzocht hoe geneeskundestudenten hun leren reguleren in de sociale en dynamische context van coschappen, en werden er vraagtekens gesteld bij de afstemming van huidige conceptualiseringen van reguleren van leren en het leunen op samenwerking in de hedendaagse gezondheidszorg.

Hoofdstuk 2 onderzoekt verschillende conceptualisaties van reguleren van leren (zelfregulerend leren, co-regulerend leren (CRL) en sociaal-gedeelde regulatie van leren (SSRL)). Dit hoofdstuk richtte zich op hoe het integreren van deze conceptualisaties ons begrip over reguleren van leren zou kunnen vergroten in de context van de gezondheidszorg. Co-regulerend leren omvat het reguleren van andermans leren door middel van interactie met anderen. Ik beargumenteer dat, gedurende samenwerkend leren, co-regulerende kunnen optreden binnen episodes van zowel sociaal-gedeelde regulatie leren als zelfregulerend leren. Dat wil zeggen, studenten kunnen tegelijkertijd verschillende vormen van reguleren aangaan. De drie niveaus van regulerend leren (zelfregulerend leren, co-regulerend leren en sociaal-gedeelde regulatie van leren) kunnen, tijdens situaties van samenwerkend leren, daarom het beste worden beschouwd als in elkaar verankerd. Wanneer we reguleren van leren beschouwen als bestaande uit verschillende levels van reguleren, heeft implicaties voor onderzoek en de praktijk. In de huidige gezondheidszorg leunen we op samenwerking. Daarom is het belangrijk om ons perspectief op reguleren van leren te verbreden. Ik stel voor dat toekomstig onderzoek een multi-level en geïntegreerd perspectief aanhangt, waarbij er gericht wordt op de niveaus van zelf-, co- en sociaal-gedeelde reguleren van leren in de gezondheidszorg en (-onderwijs) instellingen. Om beperkingen van het verzamelen van zelf-rapportages (die kunnen verschillen van het werkelijke gedrag) te minimaliseren, wijzen trends naar het verzamelen van multimodale data. Dat houdt in dat er data worden verzameld uit verschillende gegevenskanalen (i.e. modaliteiten), bijvoorbeeld objectieve

fysiologische gegevens naast subjectieve zelfrapportagegegevens. Dit stelt wetenschappers in staat om de kenmerken en fasen van reguleren van leren te onderzoeken, gedurende complexe situaties van samenwerkend leren. Wanneer we meer te weten willen komen over reguleren van leren tijdens samenwerking, zouden we kunnen leunen op simulatie-gebaseerd onderzoek, omdat dit gemakkelijker de integratie van technologie mogelijk maakt. Simulatie-gebaseerde onderzoek lijkt daarom bij uitstek geschikt om wetenschappers te helpen bij het analyseren en ontrafelen van complexe fenomenen die moeilijk te ontdekken zijn, zoals de processen van reguleren van leren. Ik beschreef praktische implicaties, zoals de noodzaak om curricula te creëren die expliciet aandacht besteden aan de ontwikkeling van competenties die niet alleen ten grondslag liggen aan zelfregulerend leren maar ook aan co-regulerend leren en sociaal-gedeeld reguleren van leren. Zowel studenten als staf moeten zich bewust zijn van de verschillende niveaus van reguleren van leren die nodig zijn voor het effectief uitvoeren van taken, en voor het bewaken van kwalitatief hoogstaande gezondheidszorg.

Hoofdstuk 3 exploreerde de percepties van geneeskundestudenten ten aanzien van co-regulerend leren tijdens coschappen en de waargenomen impact daarvan op de ontwikkeling van zelfregulerend leren. Data werden verzameld middels semigestructureerde interviews met 11 doelgericht gesampelde geneeskundestudenten die in coschappen actief waren. Het verzamelen en analyseren van data verliep iteratief, leunend op de principes van constructivistische 'grounded theory'. Data-analyse onthulde drie samenhangende verschuivingen in co- en zelfregulerend leren, naarmate studenten hun coschappen doorliepen. Ten eerste, co-regulerend leren verschoof van co-regulatie met peers naar co-regulatie met clinicus-rolmodellen uit de praktijk. Ten tweede, zelfregulerend gedrag verschoof van extern gedreven naar intern gedreven. Ten derde, zelfregulerend leren verschoof van een taak-georiënteerde benadering richting een meer omvattende benadering waarbij ze zich richtten op professionele competenties en identiteitsformatie. Studenten gaven aan dat als zij zich in staat voelde om proactief en zelfverzekerd hun eigen leren te (zelf-) reguleren, de drempel voor het betrekken van anderen in het reguleren van leren (co-regulerend leren) lager werd. Dit hielp studenten vervolgens in het verder ontwikkelen van hun zelfregulerende leervaardigheden. Bevindingen uit hoofdstuk 3 benadrukken het idee dat zelfregulerend leren (en de ontwikkeling daarvan) verankerd liggen in co-regulerend leren binnen klinische contexten. Om de ontwikkeling van het zelfregulerend leervermogen van studenten goed te kunnen ondersteunen, moeten we focussen op het faciliteren en organiseren van interactie in co-regulerend leren, vanaf het begin van het curriculum.

Hoofdstukken 4 en 5 presenteren twee empirische studies naar co-regulerend leren, gebaseerd op een sociaal-netwerk perspectief. Data voor beide onderzoeken werden gelijktijdig verzameld met gebruik van een online survey die uit twee delen bestond. Het eerste deel richtte zich op zelfregulerend leren en de percepties van studenten over de mate waarin de context mogelijkheden voor leren en zelfregulerend leren bevatte. Het tweede deel richtte zich op de co-regulatiernetwerken van studenten. Dit gaf informatie over wie er in netwerken van studenten opgenomen worden, hoeveel individuen er in de netwerken worden opgenomen, en hoe vaak zij betrokken worden in het reguleren van leren. De survey is afgenomen bij studenten die waren ingeschreven in één van de volgende coschappen: interne geneeskunde, chirurgie, neurowetenschappen, moeder en kind, huisarts- en sociale geneeskunde, of de GEZP (gezondheidsparticipatie) in het masterprogramma van de geneeskundeopleiding van Maastricht University. Het responsepercentage was 65,5%.

Het doel van de studie in hoofdstuk 4 was om de relaties te exploreren tussen de eigenschappen van co-regulatiernetwerken van studenten, waargenomen leermogelijkheden, en zelfregulerend leren. Met behulp van multi-pele regressie analyse, structural equation modelling technieken, en variantieanalyse, exploreerden we de relaties eigenschappen van co-regulatiernetwerken (grootte van het netwerk, diversiteit van het netwerk, interactiefrequentie met anderen in het netwerk), de percepties van studenten op de aanwezigheid van mogelijkheden voor leren en reguleren van leren, en hun zelf-gerapporteerde zelfregulerend leren. Over alle coschappen heen lieten de data positieve relaties zien tussen interactiefrequentie en zelfregulerend leren ($\beta = 0,095$, $p < 0,05$) en tussen netwerk-grootte en interactiefrequentie ($\beta = 0,530$, $p < 0,001$), en een negatieve relatie tussen netwerkdiversiteit en interactiefrequentie ($\beta = -0,474$, $p < 0,001$). De percepties van studenten ten aanzien van leermogelijkheden lieten een positieve relatie zien met zowel zelfregulerend leren ($\beta = 0.295$, $p < 0.001$) als met de netwerk-grootte van co-regulatiernetwerken ($\beta = 0.134$, $p < 0.01$). De specifieke eigenschappen van coschapcontexten beïnvloedden zowel de eigenschappen van co-regulatiernetwerken alsook de relaties tussen netwerkeigenschappen, zelfregulerend leren, en de percepties van studenten ten aanzien van leermogelijkheden. Bevindingen uit hoofdstuk 4 bekrachtigen daarom het belang van co-regulatiernetwerken voor het zelfregulerend leren van geneeskundestudenten. De bevindingen suggereren het ontwikkelen van sterke netwerken gericht op frequente co-regulerende interacties het zelfregulerend leren van studenten kan verbeteren uitdagende, klinische leeromgevingen.

Hoofdstuk 5 presenteerde resultaten van een meer diepgaande verkenning van de manier waarop studenten hun leren reguleren tijdens coschappen. De studie die in hoofdstuk 5 wordt gerapporteerd, onderzocht wie en voor welke doeleinden studenten (in verschillende fasen van klinische training) selecteren en betrekken in hun netwerken om hun leren te reguleren. We hebben de proportie studenten berekend die specifieke anderen in hun netwerk heeft ingeschakeld, voor elk van de vooraf gedefinieerde regulerende leeractiviteiten. Daarnaast hebben we ANOVA's uitgevoerd om te onderzoeken of eerste-, tweede- en derdejaarsstudenten verschilden in de manier waarop ze hun netwerk gebruikten om zelfgereguleerd leren te ondersteunen en de doeleinden waarvoor ze dat deden. De resultaten toonden aan dat studenten anderen binnen hun co-regulatie netwerken gebruikten om een breed scala aan zelfregulerende leeractiviteiten te ondersteunen. Wie studenten betrokken, alsook het doel waarmee dat gebeurde, leek te verschuiven naarmate studenten hun coschappen doorliepen. Naarmate studenten hun coschappen doorliepen, leek de proportie studenten dat werkplekbegeleiders inschakelde om leerdoelen, leerstrategieën, zelfreflecties en zelfevaluaties te bespreken toe te nemen, terwijl de proportie studenten dat medestudenten betreft bij het bespreken van leerstrategieën en hoe te werken aan leerdoelen op de werkplek leek af te nemen. Van alle doeleinden (die in dit onderzoek zijn gemeten) waarvoor studenten anderen in hun co-regulatiernetwerken opzoeken, was het bespreken van zelfreflecties en zelfevaluaties consequent een van de meest frequent gerapporteerde. Hoofdstuk 5 geeft ons daarom een diepgaander inzicht in de mate waarin studenten zelfgereguleerd leren aangaan in hun co-regulatiernetwerken en hoe hun co-regulerend leergedragingen zich ontwikkelen gedurende coschappen. Bevindingen uit de onderzoeken zoals gepresenteerd in hoofdstuk 4 en 5 laten zien dat sociale netwerkbenaderingen veelbelovende manieren bieden om zelf- en co-regulerend leren op klinische werkplekken verder te begrijpen en te conceptualiseren.

Hoofdstuk 6 presenteert een kritische reflectie op de huidige methoden om zelfregulerend leren te meten. In dit hoofdstuk ga ik dieper in op de implicaties van de bevindingen in dit proefschrift in het licht van de huidige ontwikkelingen in onderwijs en gezondheidszorg, met een specifieke focus op implicaties voor het meten van reguleren van leren. Ik beargumenteer dat zelfregulerend leren het best kan worden beschouwd als een sociaal gefundeerde handeling en dat meetmethoden in staat moeten zijn om de sociale en contextuele inbedding van reguleren van leren te vangen.

Ten slotte beschreef hoofdstuk 7 een algemene discussie waarin de resultaten van alle onderzoeken worden samengevat, erop gereflecteerd wordt, en gesynthetiseerd worden in relatie tot de onderzoeksdoelen van dit proefschrift. Zodoende draagt hoofdstuk

7 bij aan de vooruitgang van de academische discussie over reguleren van leren. De belangrijkste conclusie van dit proefschrift is dat reguleren van leren ligt ingebed in de co-regulatiernetwerken van studenten, en moet worden beschouwd als een context-specifieke sociale handeling. Meer specifiek houdt dit in dat de mate waarin studenten zijn ingebed in hun co-regulatiernetwerken, specifieke intenties van studenten om anderen te betrekken bij co-regulatie van hun leeractiviteiten en -processen, evenals contextuele mogelijkheden en beperkingen, interacteren en beïnvloeden gezamenlijk het reguleren van leren dat in netwerken plaatsvindt. Bovendien wordt gezondheidszorg in toenemende mate verleend door zorgteams die moeten samenwerken om hoogwaardige patiëntenzorg te kunnen garanderen. Het is daarom wenselijk onze aandacht te verleggen van een nagenoeg uitsluitende focus op het optimaliseren van zelfregulatie van leren, naar het bredere perspectief van hoe het leren het meest effectief kan worden gereguleerd, afhankelijk van het niveau waarop (zelf-, co- en/of sociaal gedeelde regulatie). van leren) en de context waarin het plaatsvindt. In lijn met verschuivende conceptualisering van het reguleren van leren, worden implicaties voor verder onderzoek en de praktijk beschreven.

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31. Schreurs, S. (20-03-2020) Selection for medical school; the quest for validity
32. Schumacher, D. (19-03-2020) Resident Sensitive Quality Measures: Defining the Future of Patient-Focused Assessment
33. Sehlbach, C. (21-02-2020) To be continued.... Supporting physicians' lifelong learning

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 Joy
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 Suzanne
 Alexander
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 Barend
 Anique
 Janneke
 Michelle
 Emmaline
 Kwak
 Rix
 Piet
 Maurice
 Juliet
 Hennie
 Patrick
 Sanne
 Cindy
 Hennie
 Sanne

About the author

Derk Bransen was born in Amsterdam, the Netherlands, on October 14th, 1987. After graduating with distinction from the Work and Organisational Psychology programme at Maastricht University in 2015, he started working as an Executive Search Consultant. Soon, however, he made his way to Maastricht University, the Faculty of Health, Medicine, and Life Sciences in 2017, where he could pursue his research ambitions at the School of Health Professions Education (SHE). At Maastricht University, he was able to combine conducting research and writing his PhD dissertation with teaching activities and mentoring undergraduate medical students. He has been involved in organising and facilitating the SHE Presents sessions and PhD platforms. His research interests are regulation of learning, workplace learning, and undergraduate medical education.

