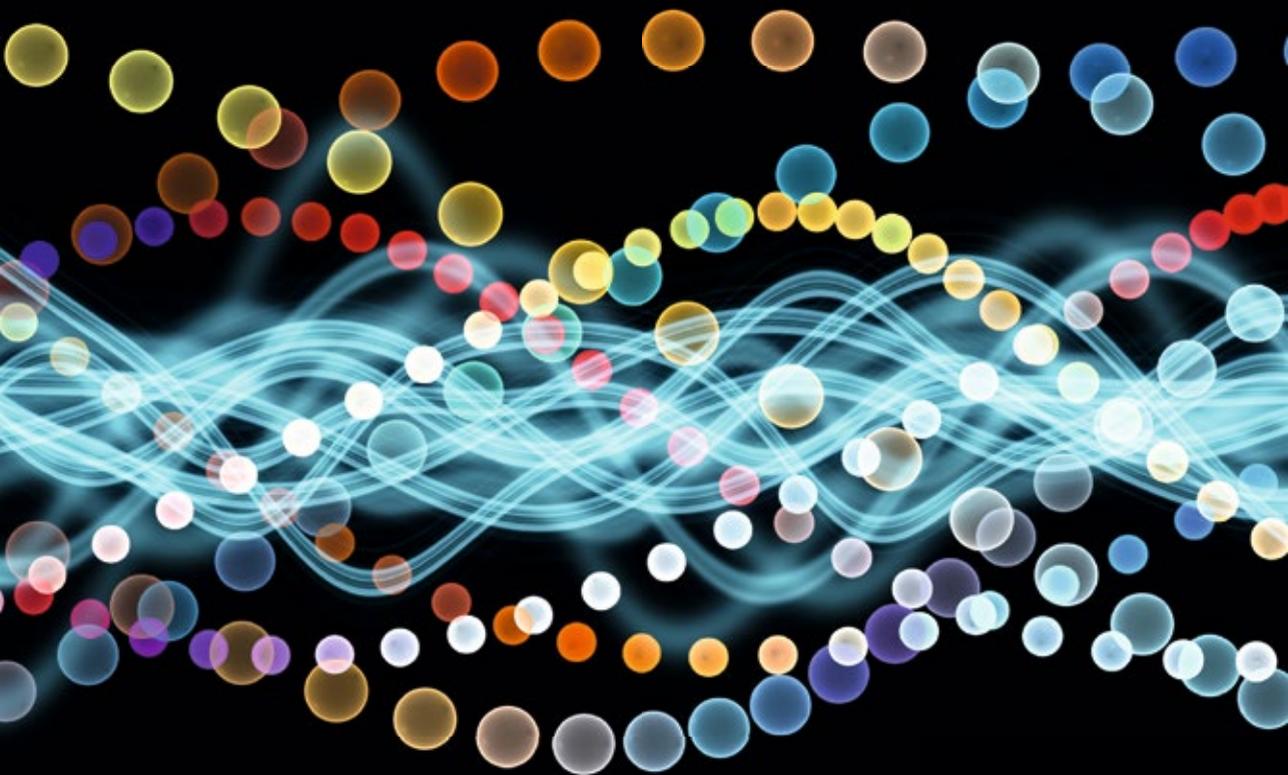


# **INTERPERSONAL DYNAMICS IN TEACHER-STUDENT INTERACTIONS AND RELATIONSHIPS**



**Helena J. M. Pennings**



**INTERPERSONAL DYNAMICS  
IN TEACHER-STUDENT INTERACTIONS AND  
RELATIONSHIPS**

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ISBN: 978-94-028-0580-2

Printed by: Ipskamp Printing, Enschede

Layout and Cover design: Heleen Pennings

Copyright cover illustration sine wave pattern: Agsandrew, Shutterstock.com

This research was made possible by funding from the Netherlands

Organization for Scientific Research, NWO/PROO 411-07-363

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# **INTERPERSONAL DYNAMICS IN TEACHER-STUDENT INTERACTIONS AND RELATIONSHIPS**

Interpersoonlijke dynamiek in docent-leerling interacties en relaties  
(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de Universiteit Utrecht op gezag van  
de rector magnificus, prof. dr. G.J. van der Zwaan,  
ingevolge het besluit van het college voor promoties in het openbaar te verdedigen op  
donderdag 4 mei 2017 des middags te 12.45 uur

door

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geboren op 6 mei 1984 te Venlo

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**CHAPTER I**

**GENERAL INTRODUCTION**

Teaching is a complex job (Chang, 2009; Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006). The crucial role of teacher-student relationships in the quality of teaching has been demonstrated in many studies (e.g., Pianta, 2006; Wubbels et al., 2006). Not only have teacher-student relationships been found to be associated with students' cognitive learning outcomes and motivation (e.g., Cornelius-White, 2007, Den Brok, 2001; Roorda, Koomen, Spilt, & Oort, 2011), but also with teachers' well-being (e.g., Spilt, Koomen, & Thijs, 2011) and job satisfaction (Veldman, Van Tartwijk, Brekelmans, & Wubbels, 2013). Negative teacher-student relationships go together with classroom management problems, teacher burnout, and low job-satisfaction (Friedman, 2006; Wubbels et al., 2015; Walker, 2009). Given the importance of teacher-student relationships in education, the ability to stimulate the development of productive working relationships with students is a crucial component of teacher competence.

The present dissertation is part of an interlinked research project entitled '*Development of teacher competence during the professional career: An interpersonal perspective*' funded by the Netherlands Organization for Scientific Research [Grant number NWO/NRO 411-07-360]. The goal of this interlinked research project was to gain more understanding of how the micro-level or daily classroom processes in terms of teachers' *appraisals* of classroom situations (Van der Want, 2015), their *scripts* about interactions with individual students (Claessens, 2016), and the *interpersonal behaviors* of teachers and students in whole-class interactions (this dissertation) are related to the macro-level variable of teacher interpersonal competence in terms of teacher-student relationships. Working conditions and personal factors evidently influence the development of teacher interpersonal competence. As one criterion for a positive development, teacher's job satisfaction in terms of burnout and work engagement can be used.

The four studies in this dissertation focus on interpersonal behavior and teacher-student interactions and their associations with the teacher-student relationship. They are embedded in a long tradition of studies on teacher-student relationships and interpersonal behavior. This research tradition was started in the early 1980's by Wubbels and his colleagues (e.g., Brekelmans, 1989; Créton & Wubbels, 1984; see also Wubbels et al., 2006). They studied classroom management problems from an interpersonal perspective, focusing on the teacher-student relationship in the classroom. Brekelmans (1989) and Den Brok (2001) studied how teacher-student relationships are related to cognitive and affective outcomes of students. Van Tartwijk (1993) focused on the micro-level when studying how nonverbal behaviors of teachers were related to certain types of teacher-student relationships.

Mainhard (2009) systematically studied teacher-student interactions as the building blocks of relationships (Granic & Patterson, 2006). However, our knowledge of how micro-level teacher-student interactions are related to macro-level teacher-student relationships remains limited. Especially, how interpersonal behaviors of teachers and students become interrelated and how well those interpersonal behaviors fit together (Ramseyer & Tschacher, 2016; Warner, 1991) is further explored in the studies presented in this dissertation.

In this introduction, we first present theory on teacher-student relationships and aspects of interpersonal behavior and teacher-student interactions. We subsequently give an overview of the chapters in this dissertation.

### **Teacher-Student Interactions and Relationships**

Interactions between people can be understood as a process of consecutive events that unfold over time (e.g., Pincus et al. (2014)). Interpersonal behaviors of interaction partners adapt to each other in such a way that patterns in interactions emerge (Kenny & Kashy, 1991; Pincus et al., 2014; Ramseyer & Tschacher, 2016; Sadler, Ethier, Gunn, Duong, & Woody, 2009). Pincus et al., (2014) and Vallacher, Nowak, and Zochowski (2005) refer to these patterns of adaptive changes as the *Interpersonal Dynamics* of interactions. The interpersonal dynamics of interactions are related to the quality of interactional outcomes like relationships (Kiesler, 1996; Ramseyer & Tschacher, 2016; Vallacher & Nowak, 2005).

To conceptualize interpersonal behavior, interactions, and relationships, researchers typically use Interpersonal Theory (e.g., Carson, 1969; Fournier, Moskowitz, & Zuroff, 2011; Horowitz & Strack, 2011; Kiesler, 1996; Leary, 1957; Wiggins, 1991). Interpersonal theorists state that every interpersonal behavior can be captured as distinct combinations of two orthogonal dimensions: *Agency* and *Communion*<sup>1</sup> (e.g., Bakan, 1966; Carson, 1969; Fournier, Moskowitz, & Zuroff, 2011; Kiesler, 1996; Leary, 1957; Wiggins, 1991). A person's position on the Agency dimension manifests in strivings, or lack thereof, for a certain degree of power and control, whereas a person's position on the Communion dimension manifests in strivings for a certain degree of friendliness and affiliation (Horowitz & Strack, 2011; Gurtman, 2009). Interacting individuals constantly negotiate how agentic and communal they

---

<sup>1</sup> The terms Agency and Communion are meta-labels (Fournier et al., 2011; Wiggins, 2003) and depending on the context the two dimensions can be given different names, such as control and affiliation or influence and proximity (e.g., Bruckmüller & Abele, 2013; Wubbels, et al., 2012; Wiggins, 2003).

need to be with each other, and those dynamics develop into a relationship (Kiesler, 1996)

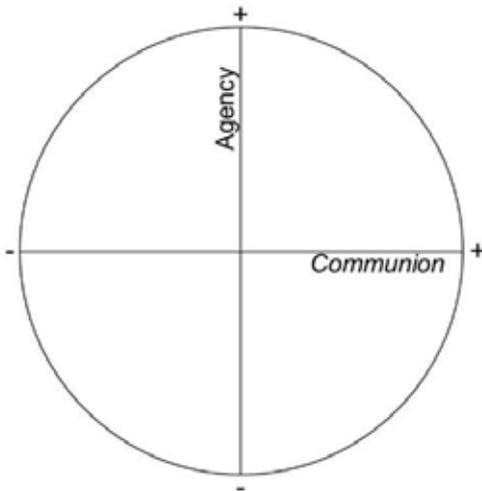


Figure 1.1. Interpersonal Circle.

quite quickly (Mainhard, Brekelmans, & Wubbels, 2011).

Agency and Communion can be used to describe micro-level interpersonal behaviors as well as macro-level relationships (Fournier et al., 2011; Wubbels et al., 2006). This is usually done by positioning behaviors and relationships in a coordinate system based on their corresponding levels of Agency and Communion. This coordinate system necessarily follows a circular ordering and is called the *Interpersonal Circle* (IPC) or *Interpersonal Circumplex* (Figure 1.1) (Carson, 1969; Fabrigar, Visser, & Browne, 1997; Gurtman, 2009; Horowitz & Strack, 2011; Kiesler, 1996; Leary, 1957).

In all four studies in this dissertation, micro-level interpersonal behaviors of teachers and students and the quality of macro-level teacher-student relationships are described in terms of levels of Agency and Communion and placed within the IPC. We studied three dynamic aspects that are considered important to describe behavior and interactions, which we will introduce underneath: interpersonal content (e.g., Hollenstein, 2013), interpersonal structure (e.g., Hollenstein, 2013), and interpersonal adaptation (e.g., Capella, 1996).

### ***Interpersonal Content***

*Interpersonal content* refers to the description of behaviors that recur frequently within an interaction. In the studies described in this dissertation, interpersonal content is

conceptualized as (1) the average level of Agency and Communion in micro-level teacher and student behavior and (2) attractors (e.g, Granic & Hollenstein, 2003; Mainhard, Pennings, Wubbels, & Brekelmans, 2012). Attractors are stable and recurrent behaviors or behavior sequences that a system (e.g., person, dyad, or group) “prefers” (Granic & Hollenstein, 2003; Mainhard et al., 2012; Thelen & Smith, 2006) or tends to get “stuck” in (Lunkenheimer & Dishion, 2009). Attractors develop through repetition and, once stabilized, are difficult to change (Lunkenheimer & Dishion, 2009). According to Granic and Hollenstein (2003), attractors in micro-level interactions are related to the quality of macro-level relationships. For example, when a teacher often compliments students this could indicate a positive teacher-student relationship.

### ***Interpersonal Structure***

According to Dishion, Nelson, Winter, and Bullock (2004) as well as Hollenstein and Lewis (2006), the structure of interactions refers to variability and predictableness of interactions; in other words, interpersonal structure refers to the processes of behavioral change in interactions (Dishion, Nelson, Winter, & Bullock, 2004; Hollenstein & Lewis, 2006; Hollenstein, 2013).

Several measures to describe interpersonal structure are included in the four studies in this dissertation. They are obtained with State Space Grid analysis (Lewis, Lamey, & Douglas, 1999) and (cross-)spectral analysis (see Capella, 1996; Warner, 1998) and will be explained in chapter 3, 4, and 5.

### ***Interpersonal Adaptation***

Interpersonal adaptation defines the interplay of behavior between two participants in interaction (Capella, 1992; Sadler et al., 2009; Warner, 1998), or more specifically, how levels of interpersonal behaviors of both participants fit together, mutually adjust to each other, and change over the course of interactions (Sadler et al., 2009; Sadler, Ethier, & Woody, 2011). To study interpersonal adaptation in teacher-student interaction, we used the interpersonal complementarity principle (Kiesler, 1983), Interpersonal complementarity in terms of Agency is defined as reciprocity and tends towards oppositeness. For example, if a teacher takes control (high Agency) students usually tend to listen and go along with the teacher (low Agency). Interpersonal complementarity in terms of Communion is defined through correspondence, and tends towards sameness (Sadler et al., 2009). For example, if

the Teacher acts friendly towards the students (high Communion), it is likely that the students act friendly towards the teacher (high Communion).

Interpersonal adaptation in terms of complementarity can also be operationalized with various measures, such as linear trends, (detrended) cross-correlations, degree of entrainment (i.e., coherence), or degree of displacement between levels of Agency and Communion in teacher behavior versus student behavior shown at the same time point in the interaction (i.e., phase). These measures are described in detail in chapter 5.

### **Instruments and Analyses**

In the studies described in this dissertation, we gathered data with questionnaires and a continuous observation method and used various kinds of analyses to study the data.

To collect data on the macro-level variables, the teacher-student relationship and teachers' feelings of burnout, we used questionnaires. To measure the teacher-student relationship we used the 24-item Dutch version of the Questionnaire on Teacher Interaction (QTI; Wubbels et al., 2006). We asked the teacher to administer the QTI in at least two classes, preferably both the class that the teacher had the best relationship with and the class the teacher had the worst relationship with (according to the teacher). To measure teachers' feelings of burnout we asked them to fill out the 22 item Dutch version of the Maslach Burnout Inventory (Maslach & Schaufeli, 1993), i.e., the *Utrecht Burnout Scale for Teachers* (UBOS-L; Schaufeli & Van Dierendonck, 2000). Both questionnaires were administered four times within five school years, from 2010-2015.

The micro-level variables, interpersonal teacher behavior and interpersonal student behavior, were observed using *Continuous Assessment of Interpersonal Dynamics* (CAID; Lizdek, Woody, Sadler, & Rehman, 2016; Sadler et al., 2009). This approach, which is used by Sadler and colleagues, captures interpersonal dynamics as a continuous, contextualized flow of behavior based on continuous coding of videotaped behaviors using a computer joystick apparatus. Behavior is coded as a specific blend of Agency and Communion (Markey, Lowmeister, & Eichler, 2010), As opposed to coding both dimensions separately, which has previously been done (e.g., by Mainhard et al., 2012 or Roorda, Koomen, Spilt, Thijs, & Oort, 2013). The videotapes used to code interpersonal teacher and student behavior were recorded in the first wave of data collection, school year 2010-2011.

Continuous coding of teacher and student behavior generates time series data. Basically, a time series is a long data sequence of repeated measurements of a certain variable (Glass,

Willson, & Gottman, 1975), which can be used to compare variables measured simultaneously in time (Glass et al., 1975).

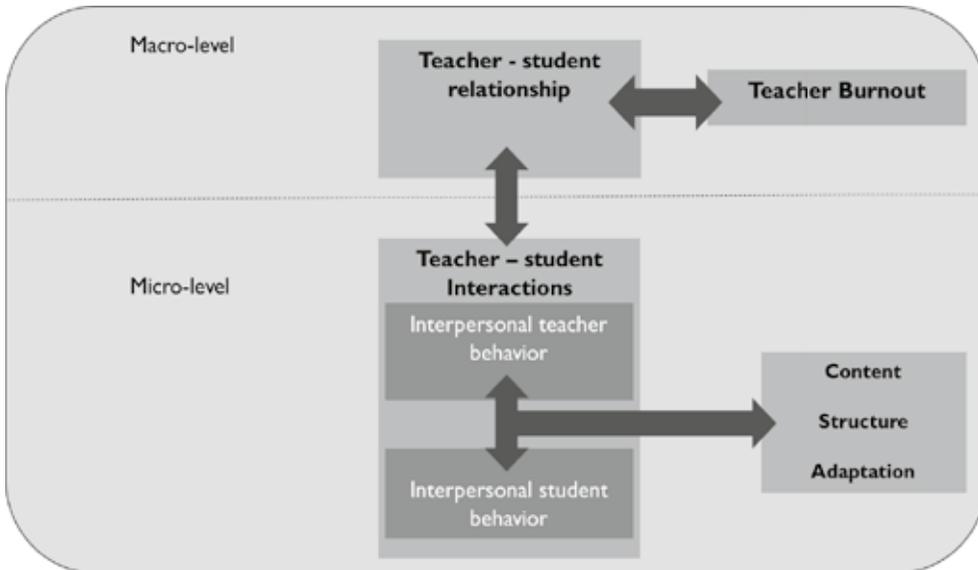


Figure 1.2. Schematic overview of the variables included in this dissertation

For example, to study how these adapt to each other and move together in time (Holmes & Poole, 1991). We used two types of time-series analysis. In chapter 3 and 4 we used *State Space Grid analysis* (Lewis, Lamey, & Douglas, 1999; Hollenstein, 2013) to study interpersonal content and structure. In chapter 5 we used various methods, such as *regression analysis*, *Pearson's correlations*, and *(cross-)spectral analysis* (e.g., Warner, 1998) to study interpersonal structure and adaptation in terms of linear trends, (detrended) cross-correlations, rhythmicity, coherence, and phase. Both SSG analysis and cross-spectral analysis are explained in detail in those chapters.

## OUTLINE OF THE DISSERTATION

Four studies are presented in this dissertation. One study examines how teacher-student relationships are related to teachers' feelings of burnout; the other three studies focus on how the dynamics in micro-level teacher-student interactions are related to the macro-level teacher-student relationship. Figure 1.2 presents a schematic overview of the important variables of the four studies.

## Overview of the Chapters

A quick overview of the titles, research questions, variables, measures, time-scales, methods of analysis, and number of participants in the studies is provided in Table 1.1.

In the first study, described in *chapter 2*, we used a repeated measures design with four measurements (across five school years), to study how changes in the relationships of 178 teachers with their students are associated with changes in the three dimensions of burnout over time. The aim was to validate the importance of teacher-student relationships for teacher well-being. The study adds to the existing knowledge base by the examination of within-teacher variation, the use of a sound theoretical framework, and more advanced methods of analysis. We answered the following research questions: (1) *How do teachers' feelings of burnout vary across five years?* and (2) *How is teacher burnout associated with teacher-student relationships?* The first question was aimed at the characterizing variation in teacher burnout, which helped us to better understand the subject of the second question, namely its association with the teacher-student relationship.

In the second study, which is described in *chapter 3*, we took a one-sided approach to micro-level interactions. We studied the interpersonal content and interpersonal structure in micro-level interpersonal teacher behavior by observing eight teachers during a 30-minute part of a lesson. We answered the following research question: *Are there differences in the content and structure of micro-level interpersonal behavior of teachers with different macro-level teacher-student relationships?*

In the third study, which is described in *Chapter 4*, we focused on both teacher and student behavior with an exploratory case study. We studied interpersonal content, interpersonal structure, and interpersonal complementarity as three dyadic characteristics of teacher-student interactions. We selected two teachers with distinct teacher-student relationships: Teacher A with a repressive style characterizing the teacher-student relationship and Teacher B with a tolerant style characterizing the teacher-student relationship. We also selected three different situations within a lesson: the lesson start, a negative situation (e.g. when students are not listening to the teacher), and a positive situation (e.g. when the teacher and students are laughing together). We explored the discriminant validity of the three characteristics of interactions between the two teachers and across the three situations.

In the fourth study, described in *chapter 5*, we observed 35 teacher-class combinations during the lesson start and used a fine-grained method to study how teachers and students adapt their behavior to each other while interacting. The following research question guided

this study: *What is the degree and nature of interpersonal adaptation in moment-to-moment teacher-student interactions in classrooms?* We tried to answer this question by focusing on several indicators of interpersonal adaptation: (1) overall level of Agency and Communion (Content), (2) detrended correlations as an overall measure of complementarity, (2) associations of linear trends, (3) cyclical patterns (coherence and phase), and (4) residual fluctuations.

In the final chapter, *chapter 6*, the findings of the four studies are summarized, a discussion of several topics to which the studies contributed, as well as a discussion of the limitations, suggestions for future research, and practical implications, will be provided.

Table 1. *Overview of the dissertation.*

CHAPTER	TITLE	RESEARCH QUESTIONS/AIMS	VARIABLES
1	General introduction		
2	Teachers' feelings of burnout and the relationships with students: Between and within teacher differences across five years	(1) How do teachers' feelings of burnout vary across five years? (2) How are teachers' feelings of burnout associated with teacher-student relationships?	<ul style="list-style-type: none"> <li>▪ Teacher-student relationship</li> <li>▪ Teacher burnout</li> </ul>
3	A nonlinear dynamic systems approach to real-time teacher behavior: Differences between teachers	Are there differences in the content and structure of moment-to-moment interpersonal behavior (micro-level) of teachers with different teacher-student relationships (macro-level)?	<ul style="list-style-type: none"> <li>▪ Content of teacher-student interactions</li> <li>▪ Structure of teacher-student interactions</li> <li>▪ Teacher-student relationship</li> </ul>
4	Real-time teacher-student interactions: A dynamic systems approach	We explore the discriminant validity of the three characteristics of real-time teacher-student interactions between two teachers with different teacher-student relationships	<ul style="list-style-type: none"> <li>▪ Content of teacher-student interactions</li> <li>▪ Structure of teacher-student interactions</li> <li>▪ The degree of complementarity in teacher-student interactions</li> <li>▪ Teacher-student relationship</li> </ul>
5	Interpersonal adaptation in teacher-student interaction	What is the degree and nature of interpersonal adaptation in moment-to-moment teacher-student interaction in classrooms?	<ul style="list-style-type: none"> <li>▪ Adaptation in teacher-student interactions               <ol style="list-style-type: none"> <li>(1) Mean level</li> <li>(2) Linear change</li> <li>(3) Complementarity</li> <li>(4) Rhythmicity</li> <li>(5) Coherence</li> <li>(6) Phase</li> </ol> </li> <li>▪ Teacher-student relationship</li> </ul>
6	General discussion		

MEASURES	TIME-SCALES	ANALYSIS METHOD	NUMBER OF PARTICIPANTS
QTI UBOS-L (repeated measures) in the school years 2010-2011, 2011-2012, 2012-2013, and 2014-2015.	Macro-level	Multilevel regression analysis	178 teachers and for most teachers, 2 classes per year, the average number of students in each class is 22.
CAID QTI School year 2010-2011	Micro-level vs. macro-level	<ul style="list-style-type: none"> <li>▪ State Space Grid analysis</li> <li>▪ Spearman rank correlations</li> </ul>	8 teachers and 1 of their classrooms
CAID QTI School year 2010-2011	Micro-level vs. macro-level	<ul style="list-style-type: none"> <li>▪ State Space Grid analysis</li> <li>▪ Regression analysis</li> <li>▪ (Detrended) Cross-Correlations</li> </ul>	2 teachers and 1 of their classrooms
CAID QTI School year 2010-2011	Micro-level vs. macro-level	<ul style="list-style-type: none"> <li>▪ Regression analysis</li> <li>▪ Detrended Cross-Correlations</li> <li>▪ Cross-Spectral analysis</li> </ul>	35 teachers and 1 of their classrooms



## CHAPTER 2

### TEACHERS' FEELINGS OF BURNOUT AND THE RELATIONSHIPS WITH STUDENTS: BETWEEN AND WITHIN TEACHER DIFFERENCES ACROSS FIVE YEARS<sup>2,3</sup>

#### ABSTRACT

In the present study, we investigated whether and how the teacher-class relationship could explain differences between and within secondary education teachers' feelings of burnout across a period of five school years. With a repeated measures design with four waves (178 teachers), we found substantial within teacher variation over the time span of five years, but on average no downward burnout spiral.

For all three burnout dimensions (emotional exhaustion, depersonalization, and personal accomplishment) teacher Communion significantly explained differences between teachers. The more Communion students perceived in their teachers' interpersonal behavior the lower teachers' feelings of emotional exhaustion and depersonalization and the stronger the feelings of personal accomplishment. We did not find significant effects for teacher Agency. When examining teachers' individual trajectories across the five school years, we found that teachers experienced less burnout, when their Agency was higher in their class with a relatively negative relationship.

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<sup>2</sup> This chapter is based on Pennings, H. J. M., Brekelmans, M., Van der Want, A., Claessens, L. C. A., & Van Tartwijk, J. (Soon to be submitted for publication). Teachers' feelings of burnout and the relationships with students: Between and within teacher differences across five years.

<sup>3</sup> Acknowledgement of author contributions: HP, MB, and JvT designed the study, HP, MB drafted the manuscript, LC, HP, and AvdW collected the data, HP and MB analyzed the data, MB and JvT supervised the study.

Teaching is a stressful job and teachers regularly experience feelings of burnout (e.g., Gu & Day, 2007; Hakanen, Bakker, & Schaufeli, 2006; Spilt, Koomen, & Thijs, 2011). Maslach (1993) defined burnout as “a psychological syndrome of emotional exhaustion, depersonalization, and reduced personal accomplishment that can occur among individuals who work with other people in some capacity” (pp. 20-21). The prevalence of burnout in high contact professions, such as health care, social work, and education, is indeed higher than in non-contact professions (Maslach, 2003; Maslach, Schaufeli, & Leiter, 2001; Van Droogenbroeck, Spruyt, & Vanroelen, 2014). Feelings of burnout affect teachers’ professional and psychological well-being. For teachers, high levels of burnout are related to absenteeism and are an important reason to leave the profession (Chang, 2009; Van Droogenbroeck et al., 2014). High levels of burnout also impair teachers’ ability to teach adequately (Pietarinen, Pyhälthö, Soini, & Salmela-Aro, 2013; Taris, Le Blanc, Schaufeli, & Schreurs, 2005), and thereby, have negative consequences for the quality of the learning process of students (Arens & Morin, 2016; Klusmann, Richter, & Lüdtke, 2016).

In recent years, it has increasingly been acknowledged that more research on individual changes in teacher burnout is needed to improve the understanding of burnout (e.g., Fernet, Guay, Senécal, & Austin, 2012). Cross-sectional studies obscure individual differences in the stability and change of feelings of burnout. Until now, longitudinal studies on teacher burnout are scarce and generally span only two measurement moments, mostly within one school year. In the present study, we extend the existing research base with a repeated measures study that covers a time span of five school years.

Although working with other people is seen as an important determinant of the relatively high level of burnout in contact-professions (e.g., Friedman, 2006; Maslach, 2003; OECD, 2013; Taris et al., 2005), thorough empirical evidence for teacher-student relationships as a burnout correlate is lacking (e.g., Spilt et al., 2011). With the present study, we add to the existing knowledge base by embedding teacher-student relationship in a sound theoretical framework, the use of validated instruments, and advanced methods of analysis. The findings of the present study may inform the development of screening and intervention procedures to prevent and reduce teacher burnout.

### **Burnout**

Authors such as Maslach and Jackson (1981) conceptualize *Burnout* as a primarily work-related syndrome, characterized by (1) *emotional exhaustion*, i.e., having the feeling of being emotionally drained by one’s work, (2) *depersonalization*, i.e., having a negative or excessively

detached attitude towards the job, and (3) *reduced professional accomplishment*, i.e., having feelings of incompetence in accomplishing work related goals. There are different models for the causal relationships among the three dimensions. Empirical support is strongest for emotional exhaustion leading to depersonalization (e.g., Park & Lee, 2013; Taris et al., 2005). Empirical support for the specific role of personal accomplishment is less univocal, as personal accomplishment is empirically validated as a consequence of depersonalization (e.g., Taris et al., 2005) as well as a precursor of depersonalization (e.g., Park & Lee, 2013). Both models can be understood as self-protecting coping strategies. In the model where emotional exhaustion leads to depersonalization, teachers' feelings of detachment from the job and cynicism towards students, colleagues, and/or parents, may seem to prevent spending additional energy, and thus, prevent teachers from depleting their entire energy resources. In the model where personal accomplishment leads to depersonalization, withdrawal may serve as an escape from feelings of guilt, which teachers experience due to feelings of professional failure. Both these coping strategies are ineffective for dealing with job related problems. For example, feelings of detachment diminish the ability of teachers to effectively interact with students, colleagues or parents, which leads to reduced feelings of satisfaction with their personal goals (Park & Lee, 2013; Schaufeli & Taris, 2005).

Until now teacher burnout is mainly studied with cross-sectional designs, but the number of studies with longitudinal designs (i.e., at least two waves) is growing. Longitudinal designs, preferably with at least three waves, acknowledge the importance of individual stability and change, and provide the possibility to study burnout as a developing process. In a literature search<sup>4</sup>, we identified eight studies with at least three waves of burnout measurement (Capel, 1991; Dworkin & Tobe, 2014; Goddard, O'Brien, & Goddard, 2006; Hoglund, Klinge, & Hosan, 2015; Hultell, Melin, & Gustaffson, 2013; Nagy & Nagy, 1992; Park & Lee, 2013; Pas, Bradshaw, & Hershfeldt, 2012).

In general, authors of these longitudinal studies agree on burnout as a psychological state (not a trait), which implies (work)context-dependency and time variability. Time-variability in burnout is viewed as a gradually downward spiral, characterized as "erosion of engagement with the job" (Maslach et al., 2001, p. 416). Results of the longitudinal studies showed, that, when changes in burnout were described at the group level (differences in mean scores at different measurement moments) they appeared to be rather small. Correlations between

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<sup>4</sup> Psychinfo and Web of science (terms longitudinal\* and teacher\* and burnout anywhere in the abstract, until November, 8, 2016).

the different measurement moments showed at least rank-order stability. However, when researchers looked at trajectories of individual teachers during the period of measurements, stable, increasing, decreasing, and non-linear trajectories were found (Capel, 1991; Hoglund et al., 2015; Hultell et al., 2013; Pas et al., 2012). Despite the perspective on burnout as a process of erosion over time, results of the longitudinal studies, on average, revealed a rather stable pattern, and also no consistency in change patterns of individual teachers.

Because of these mixed results and the short time span used in most studies (maximal two school years), in the present study, we explored the size of, and trends in time-variability of teacher burnout across a five-year time span. We strengthened the empirical findings of earlier studies by using a multilevel modeling approach. This approach recognizes the clustered structure of the data (i.e., multiple correlated measurements within teachers). In the present study, we explored the time variation in teacher burnout with the ultimate aim to enhance the understanding of the association between teacher burnout and the relationship with students.

### **Burnout and Interpersonal Relationships in Education**

Being involved with people is an important source of burnout (Maslach, 1993; 2003). According to the OECD (2013) relationships at work are one of the main factors determining employment quality. Teachers in secondary education are constantly and simultaneously interacting with students from multiple classes. Feelings of burnout may be largely affected by problems occurring in these interactions (Taris et al., 2005). For example, when classroom settings are highly demanding due to high aggregate externalizing behaviors of students, teachers experience more burnout (Hoglund et al., 2015).

Despite claims on the importance of being involved with people as an important source of burnout, empirical evidence for this claim is scarce in the educational context. Based on a review of the literature, Spilt et al. (2011) concluded that there are hardly any empirical studies that have been explicitly designed to examine the effects of teacher–student relationships on teacher well-being. The few studies that did address the association between burnout and the teacher-student relationship, mostly did this as one of a series of possible correlates (e.g., Cano-Garcia, Padilla-Muñoz, & Carrasco-Ortiz, 2005; Dorman, 2003; Grayson & Alvarez, 2008; Hoglund et al., 2015; Pas et al., 2012; Van Droogenbroeck et al., 2014), and evidenced the association of teacher-student relationships and teacher burnout. Van Droogenbroeck et al. (2014) showed that (for senior teachers) relationships with students play a more important role than relationships with colleagues or parents.

Because in most studies a sound theoretical framework and (substantially) validated instrumentation for teacher-student relationships were lacking, we wanted to strengthen the evidence of earlier research by using interpersonal theory (e.g., Horowitz & Strack, 2011) and its application in the educational context (e.g., Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006) to define and measure the relationship of teachers with students. With a four waves repeated measures design, we also wanted to add to the knowledge on intra-personal associations of burnout and teacher-student relationships, as results from earlier research were mostly based on cross-sectional designs.

### Research Questions

To investigate whether and how the teacher-class relationship can explain differences between and within teachers in their feelings of burnout across a period of five school years, we formulated the following research questions:

(1) *How do teachers' feelings of burnout vary across five school years?*

(2) *How is teacher burnout associated with teacher-student relationships?*

The first question was aimed at the characterizing variation in teacher burnout, which helped us to better understand the subject of the second question, namely its association with the teacher-student relationship.

## METHOD

### Participants and Procedure

Secondary education teachers in The Netherlands were invited to participate in the study in 2010 via their school boards, by distributing flyers, by advertisement in professional magazines and forums for teachers, and by announcements at teacher conferences. Initially, 189 teachers from 84 schools signed up to participate in the study, 11 teachers from 4 schools dropped out before data collection started. Of the participating 178 teachers, 81 were male and 97 (54%) were female. At the start of the study, age ranged from 21 to 62 years ( $M=41.71$ ,  $SD=11.23$ ), and teaching experience from 1 to 38 years ( $M=12.40$ ,  $SD=10.64$ ). Data on burnout were collected in November (2010, 2011, 2012, 2014); data on the teacher-student relationship were collected during spring following the November data-collection.

Parental consent was in accordance with policies of the schools of the participating teachers. Most schools had written consent of parents allowing their children to participate in research. In schools without such a policy, teachers were provided with consent letters

for parents. None of the parents objected. After data collections were finished, teachers received a written report on their levels of burnout and on the students' perceptions of the teacher-student relationship and a €10 gift certificate per measurement.

## Measures

### Burnout

Burnout was measured with the Dutch 22-item version of the widely used Maslach Burnout Inventory-Human Services Survey (MBI-HSS/ES, e.g., Maslach & Schaufeli, 1993), i.e., the *Utrecht Burnout Scale for Teachers* (UBOS-L; Schaufeli & Van Dierendonck, 2000). Items were rated on a 7-point Likert-type scale, ranging from 0 “never” to 6 “always”. Items represent the three different aspects of burnout (emotional exhaustion (EE), 8 items, for example “I feel emotionally drained from my work”; depersonalization (DP), 7 items, for example, “I don't really care what happens to my students”; personal accomplishment (PA), 7 items, for example “I feel that I achieve many important things in my job”).

Table 1. *Factorial validity of burnout measurement at four waves (T0, T1, T2, T4).*

wave	N	Model	$\chi^2$	df	<i>p</i>	TLI	CFI	RMSEA
T0	175	1 factor	718.79	209	< .001	.564	.605	.118
		3 factors	346.62	204	< .001	.875	.890	.063
T1	155	1 factor	729.10	209	< .001	.495	.543	.127
		3 factors	369.81	204	< .001	.835	.854	.072
T2	145	1 factor	831.72	209	< .001	.565	.606	.143
		3 factors	396.77	204	< .001	.862	.878	.081
T4	93	1 factor	594.87	209	< .001	.621	.657	.141
		3 factors	313.87	204	< .001	.889	.902	.076

Note: To compare: Dutch reference group (N=580): 1 Factor: RMSR=.13; CFI=.63;

3 Factor: RMSR=.07; CFI=.88 (Schaufeli & Van Dierendonck, 2000).

Table 2. *Reliability of burnout-scales and their associations in the present study (N=568) and results of a Dutch reference group (N=580)*

	Cronbach's $\alpha$			Pearson's <i>r</i>	
	Present study	REF <sup>a)</sup>		Present study	REF <sup>a)</sup>
EE	.88	.92	EE with DP	.51	.42
DP	.68	.73	EE with PA	-.27	-.35
PA	.82	.83	DP with PA	-.34	-.39

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment;

<sup>a)</sup> Dutch reference group (Schaufeli & Van Dierendonck, 2000).

Confirmatory factor analyses supported the superiority of the three-factor structure over a one-factor structure at all four measurement moments. In line with the Manual of UBOS-L we included two correlated errors (with highest modification index values). Information on factorial validity is presented in Table 1.

Although model fit at the four measurement moments was not very strong (see Brown, 2006, CFI, TLI > .90, RMSEA < .08) we decided to use the three original scales with all 22 items. Information on reliability (Cronbach's  $\alpha$ ) of the burnout scales and their associations is presented in Table 2.

We considered the reliabilities of the scales in the present study sufficient, and reliabilities and associations between scales, in general, comparable with the Dutch reference group (Schaufeli & Van Dierendonck, 2000).

### ***Teacher-Student Relationship***

In the present study, the teacher-student relationship was measured by gathering data on the interpersonal behaviors a teacher generally shows in interaction with students in class (Wubbels et al., 2006). Extensive research has shown that two independent dimensions are both necessary and sufficient to describe interpersonal behavior: the Agency dimension (degree of control) and the Communion dimension (degree of affiliation) (e.g., Horowitz & Strack, 2011).

To prevent from self-reporting bias we used the class of students as multiple informants on their teacher's interpersonal behavior (Wubbels et al., 2006) instead of self-reports by the teachers. To measure teacher interpersonal behavior, students completed the Dutch 24-item Questionnaire on Teacher Interaction (QTI, Wubbels et al., 2012). Example items of the QTI are "This teacher has a sense of humor", "This teacher is reliable", "This teacher is strict". Individual student perceptions were aggregated at the class level.

We measured teacher interpersonal behavior in the same school year (spring) as teachers reported on their feelings of burnout (November). We assumed one measurement a year to be representative for the teacher-student relationship in that specific school year, as earlier research showed that this relationship is quite stable during a school year (Brekelmans, 1989; Mainhard, Brekelmans, Den Brok, & Wubbels, 2011).

We derived Agency and Communion scores by weighting the items based on their position on the Teacher Interpersonal Circle, i.e., a two dimensional circular representation of descriptions of interpersonal teacher behavior (e.g., Wubbels et al., 2012; see also Locke, 2011). Based on a large database, this circular structure showed satisfactory model fit indices

for individual student perceptions (Browne's circular stochastic process model tested with CIRCE, Grassi, Luccio, & Di Blas, 2010):  $\chi^2 (28, N = 18,424; \text{ of each classroom one student was chosen at random}) = 64917.46; p < .01, RMSEA=0.043; CFI = .99, TLI = .97$ ; Pennings et al., 2014). In the present study, the aggregated class measurements were sufficiently reliable: internal consistency (Cronbach's  $\alpha$ ) for Agency was .83, for Communion .95, with  $r=.08$  as the correlation between Agency and Communion; class consensus (ICC(k=class size)) varied for Agency from .85 to .97 ( $M=.95, SD=.01$ ), for Communion from .87 to .97 ( $M=.96, SD=.01$ ) (see Lüdtke, Robitzsch, Trautwein, & Kunter, 2009).

As we expected a class with a negative relationship to be a stronger stressor for teachers than a class with a positive relationship, we preferred a sample with classes with negative teacher-student relationships. To come close to such a sample, firstly, we asked teachers to administer the questionnaire in at least two different classes, preferably the classes with whom they, in their opinion, had the best and the worst teacher-student relationship. Secondly, based on the level of teacher Agency and Communion as perceived by students, we then standardized for each teacher the class with the relatively negative teacher-student relationship. We based this standardization on the level of teacher Communion in the relationship with students (i.e., lowest on Communion is a relatively negative teacher-student relationship). In several studies it has been found that the level of teacher Communion best explained variations in classrooms (Brekelmans, 1989; Mainhard, 2009) and that teacher Communion is more important for student and teacher outcomes than teacher Agency (e.g., Brekelmans, Slegers, & Fraser, 2000; Claessens, et al., 2016; Den Brok, Van Tartwijk, Wubbels, & Veldman, 2010; Telli, 2016). To validate our selection of classes with relatively negative relationships, we compared the predictive power for teacher burnout of these classes with classes with a relatively positive relationship, and classes based on a random selection.

### **Method of Analysis**

To answer the first research question, which focused on how teachers' feelings of burnout vary across five school years, we performed multilevel regression analysis (SPSS MIXED, version 24) with the three burnout dimensions (EE, DP, PA) as separate dependent variables and year (T) as independent variable, centered at the first wave. One of the main strengths of multilevel models is that across-cases fluctuating number and spacing of time points do not constitute a problem. When data are available only in one wave these data can still

contribute information (although little) to the estimation of the random part of the models (Singer & Willett, 2003; Snijders & Bosker, 1999).

To answer the second research question, which focused on the association of teacher burnout with teacher-student relationships, we performed multilevel regression analysis (SPSS MIXED, version 24) with the three burnout dimensions as separate dependent variables and teacher Agency and Communion as independent variables. General teacher Agency and Communion, averaged over time and grand mean centered to provide a feasible interpretation of the intercept coefficient, were added as level-2 predictors, and group mean centered school year specific teacher Agency and Communion were added as time variant level-1 predictors. Full maximum likelihood estimation was used when both regression coefficients and variance components were tested, restricted maximum likelihood estimation when variance components were involved (Hox, Moerbeek, & Van de Schoot, 2010).

### **Study dropout**

For 90 teachers (51%) we had burnout data on all four waves, for 53 teachers (30%) on three, for 14 (8%) on two waves, and for 21 (12%) on one wave. We tested if the number of burnout scores available for each teacher was related to the average level of their burnout scores. Correlations (emotional exhaustion: -.06; depersonalization: .03; personal accomplishment: .01) were non-significant ( $p < .05$ ). To detect systematic dropout at the different data collection moments, we performed logistic regression analyses with study-dropout (available vs. missing data) as the dependent variable, and time and mean level of the burnout dimensions as independent variables. Results of the analyses showed no significant interaction effects for the burnout variables with time (Wald statistics,  $p < .05$ ).

### **Assumptions**

Regression diagnostics were based on analyses of the level-1 and level-2 standardized residuals in both the intercept-only and final models (see Hox 2010). To test for residual outliers, we assessed the number of standardized residuals exceeding 3.29 (Tabachnik & Fidell, 2007, p.73). We considered the number of outliers to lie within an acceptable range (below 1.5% in all models). Inspection of (detrended) normal Q-Q plots suggested normal distributions of all residuals (skewness between -1.033 and 1.021, kurtosis between 0.518 and 2.407, without outliers all values between -.530 and .632). Inspection of plots of standardized residuals against predicted values did not indicate strong violations of assumptions of linearity and homoscedasticity. In the single level regression analysis,

collinearity diagnostics were no cause for concern. As testing the final model with and without outliers revealed comparable conclusions, results are presented with outliers included.

## RESULTS

### **Variation in Teachers' Feelings of Burnout Across Five Years (RQ1)**

Table 3 presents descriptives for feelings of burnout of the teachers in the present study, compared with a Dutch reference group (Schaufeli & Van Dierendonck (2000). On average, the degree of burnout of the teachers in the present study was low and lower than the scores of the Dutch reference group ( $t, p < .001$ ).

In the present study 13% of all emotional exhaustion scores (from 22% of the teachers) were high ( $>2.75$ ), 12% of all depersonalization scores (from 24% of the teachers) were high ( $>2.18$  for male,  $> 1.57$  for female teachers), and 9% of all personal accomplishment scores (from 14% of the teachers) were low ( $<3.29$ ); norms for high and low scores were based on the Dutch UBOS-L test manual (2000).

To examine the degree of variability between and within teachers across the time span of five years, we tested the intercept-only model for emotional exhaustion, depersonalization and personal accomplishment. This model showed significant between and within variance in teacher burnout across the five-year period (Wald  $Z, p < .001$ ). The amount of variance within teachers was respectively 30%, 37%, and 37% ( $ICC = .70, .63, .63$ ).

We then explored to what extent a linear trend could characterize the variation within teachers across the five year period. In line with an erosion view on burnout we expected on average a negative linear effect of time for emotional exhaustion and depersonalization, and a positive effect for personal accomplishment.

The results in Table 4 show no significant upward or downward linear trend in the average change trajectories of the burnout-dimensions. The model predicts that, on average, the value will be stable across the five-year period. As burnout feelings of most teachers in our sample were rather low, we selected those teachers who had high burnout scores (see below Table 3) and compared their average change trajectory with that of teachers without high scores. For both groups, average trajectories were stable; we found no significant interaction effects ( $t, p < .05$ ) of high/not high burnout with time. Thus, mean differences between both groups at the start maintained over the five-year period.

Table 3. Descriptives for teachers' feelings of burnout (level 1)

	Present study 568 measurements 178 teachers			Dutch reference group <sup>a)</sup> 603 teachers		
	Range	M	SD	Range	M	SD
EE	0.00 - 5.75	1.69	0.98	0.00 - 6.00	2.04	1.20
DP-male	0.00 - 3.00	1.11	0.60	0.00 - 4.43	1.63	0.87
DP-female	0.00 - 3.86	0.96	0.66	0.00 - 3.29	1.16	0.67
PA	1.14 - 6.00	4.39	0.81	0.00 - 6.00	3.83	0.83

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment;

<sup>a)</sup> Schaufeli & Van Dierendonck, 2000

Table 4. Results of Multilevel linear trend analyses - Fixed effects (N=178)

	M T0	SD T0	T-lin	t	p
EE	1.66	0.83	.010	.584	.559
DP	1.00	0.50	.020	1.569	.117
PA	4.42	0.63	-.020	-1.262	.208

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment

As teachers showed substantial variation over the four measurements of burnout, we examined within teacher variation more closely by investigating the pattern of change of individual teachers over the four measurements. Most teachers had a pattern in which the changes in feelings of burnout fluctuated over the five-year period. For teachers with data on all four waves (N=90) feelings of emotional exhaustion and depersonalization were fluctuating for 87% of the teachers, higher each year for 4% (EE), and 2% (DP), and lower for 9% (EE) and 11% (DP). Feelings of personal accomplishment were fluctuating for 81% of the teachers, lower each year for 16%, higher for 3%. To indicate the size of the differences between years, we compared absolute differences in teacher burnout scores between two waves of data collection (T0-T1, T1-T2, T2-T4) with the size of the between teacher standard deviation in the Dutch reference group (Schaufeli & Van Dierendonck, 2000).

Table 5. Differences in burnout scores between two waves within teachers

	Weighted <sup>a)</sup> mean difference (N=386)	Between teacher standard deviation <sup>b)</sup>
EE	0.534	1.20
DP	0.385	0.87(male)/0.67(female)
PA	0.477	0.83

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment.

<sup>a)</sup> Mean was weighted according to the number of measurements available in each wave.

<sup>b)</sup> Dutch reference group (see Table 3).

CHAPTER 2

Table 5 shows that on average, differences between two waves were meaningful (about half a standard deviation for teachers in the Dutch reference group). The difference between the highest and lowest burnout score of individual teachers in the five-year period was on average 0.93 ( $SD=0.62$ ) for emotional exhaustion, 0.69 ( $SD=0.41$ ) for depersonalization and 0.87 ( $SD=0.50$ ) for personal accomplishment. These differences are respectively 0.8 (EE), 0.9 (DP), and 1.0 (PA) the size of the standard deviations in the reference group (see Table 3).

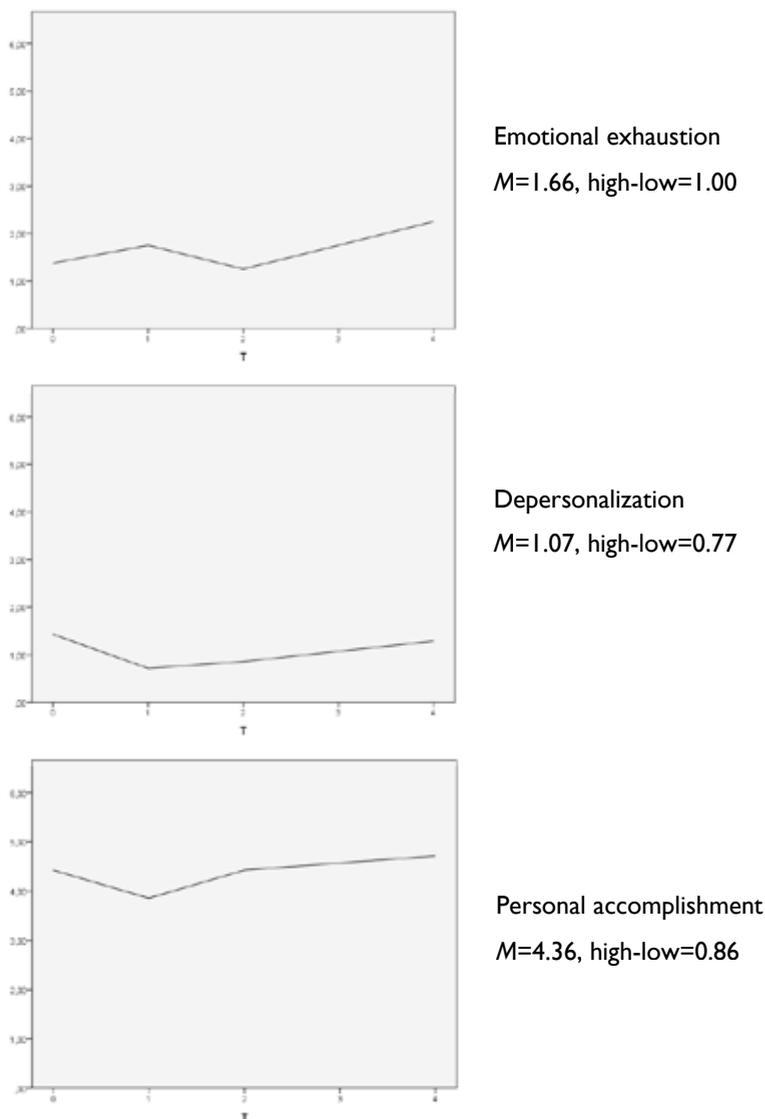


Figure 1. Illustrative examples of teachers whose means scores and difference between highest and lowest score are comparable with the mean values in the sample.

As an illustration Figure 1 presents the burnout scores of teachers whose mean scores and difference between highest and lowest score are comparable with the mean values in the sample. The first illustrative example shows an up and down pattern for emotional exhaustion, the second example a pattern of depersonalization that goes down in the second year of measurement, but upwards (increasing burnout) in the third and fifth year. The third example is of a teacher with a comparable pattern (but decreasing burnout) for personal accomplishment. We concluded that in our sample - with teachers with in general low feelings of burnout-, on average, no clear erosion trend in burnout scores across the five-year period could be distinguished. Again, such a trend was also not discernable for teachers with high burnout scores. (see for criteria for high scores below Table 3). Yet, different change patterns in individual teacher's levels of burnout were found. Time variant contextual or situational factors may be responsible for these different change patterns. With our second research question, we explored the teacher-student relationship as a potential correlate for these changes in burnout.

### Association of Teacher Burnout and Teacher-Student Relationship (RQ2)

For 140 teachers from 69 schools, data were available on feelings of burnout and for the interpersonal relationships with their students in at least two classes. This enabled us to

Table 6.

*Results of multilevel analyses – Model fit M1 compared to M0*

	$\Delta$ Deviances M0-M1		
	Chisq	df (7-3)	p
EE	15.927	4	.003
DP	13.400	4	.009
PA	41.382	4	<.001

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment

Table 7.

*Results of multilevel analyses – fixed effect parameters*

	Level-2		Level-1	
	COM	AG	COM-T	AG-T
EE	-0.883*	-0.075	-0.279	-1.071**
DP	-0.823**	-0.051	-0.231	-0.011
PA	1.548**	0.572	.447*	.756*

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment; COM=Communion, AG=Agency. \*\*  $p < .01$ , \*  $p < .05$  (t-test)

Table 8. Results of multilevel analyses – explained variance

	Intercept variance			Residual variance		
	M0	M1	% explained	M0	M1	% explained
EE	0.644	0.629	2.33	0.302	0.291	3.52
DP	0.254	0.234	8.07	0.159	0.159	0.01
PA	0.381	0.291	23.58	0.262	0.254	3.19

Note: EE=Emotional exhaustion, DP=Depersonalization, PA=Personal accomplishment

select the class with the most negative relationship (lowest Communion score) for each measurement moment. In our sample these classes, on average, had a positive level for Communion ( $M=.24$ ,  $SD=.23$ ) and for Agency ( $M=.20$ ,  $SD=.15$ ). These levels are comparable with the mean level of a large Dutch sample ( $N>18,000$  classes) for Communion ( $M=.22$ ,  $SD=.22$ ;  $t=1.07$ ,  $p=.284$ ) and significantly higher for Agency ( $M=.09$ ,  $SD=.18$ ;  $t=7.21$ ,  $p<.001$ ).

With the data from the classes with the relatively negative relationship we analyzed mixed models (M1) with teacher burnout (EE, DP, PB) scores as dependent variables, general Agency and Communion as between teacher predictors, and time-variant Agency, and Communion as within teacher predictors. In Table 6, 7 and 8 we summarize the results.

All three models improved significantly compared to the intercept only model (M0). In Table 7 results are presented in terms of the fixed effects parameters, i.e., level-2 parameters for between teacher differences, and level-1 parameters for within teacher differences. In all three models teacher Communion in classes with a relatively negative teacher-student relationship, significantly explained differences between teachers in their feelings of burnout.

The more Communion (COM) students perceived in their teachers' interpersonal behavior the lower teachers' feelings of emotional exhaustion (EE) and depersonalization (DP), and the stronger the feelings of personal accomplishment (PA). We did not find significant effects for Agency (AG).

When looking at teachers' individual trajectories across the five school years, we found that, when teachers' Agency was higher in their relatively negative class, they experienced less burnout: their feelings of emotional exhaustion were lower, and their feelings of personal accomplishment higher. For feelings of personal accomplishment, the positive effect was also found for the level of Communion.

For feelings of personal accomplishment, the teacher-student relationship explained 24% of the differences between teachers, compared to 8% of their feelings of depersonalization and only 2% of their feelings of emotional exhaustion. Additional variance explained at level-1

was 4% for emotional exhaustion, 0% for depersonalization, and 3% for personal accomplishment.

To evaluate our selection of relatively negative classes, we also performed the multilevel analyses with relatively positive relationship classes and random selected classes. As for the classes with the relatively positive relationship, we found that teachers with higher levels of Communion across the five-year period had less strong feelings of emotional exhaustion and depersonalization, and stronger feelings of personal accomplishment. For Agency, there was no between teacher effect. The predictive power of the teacher-student relationship (i.e., % explained between teacher variance) varied from 8% (EE), 10% (DP), to 28% (PA) in case of randomly selected classes, and from 4% (EE), 10% (DP), to 28% (PA) for classes with a relatively positive relationship. Regarding differences between teachers, the randomly selected class or the class with the relatively higher Communion score could explain at least the same amount of variance compared to the class with the relatively lower Communion score. For within teacher variation, there was only a significant (negative) effect for emotional exhaustion. This effect was smaller than for classes with the relatively negative relationship (1% versus 4% explained variance). Regarding the differences within teachers, the predictive power of classes with a relatively negative relationship seems somewhat stronger than the power of the other type of classes.

## DISCUSSION

In the present study, we investigated whether and how the teacher-class relationship could explain differences between and within teachers in their feelings of burnout across a period of five school years. We will discuss here, how the present study both strengthens and expands upon previous findings.

With the aim to enhance the understanding of the association between teacher burnout and teacher-student relationships, we first explored the variation in teacher burnout. We found substantial within teacher variation over the time span of five years, but we didn't find, on average, an upward trend in emotional exhaustion and depersonalization or a downward trend in personal accomplishment. So, in line with earlier research (e.g., Capel, 1991; Hultell et al., 2013; Hoglund et al., 2015), the findings of the present study, did not support the view on teacher burnout as a process of erosion, not even over a time span of five school years, or for teachers with high levels of burnout scores. A pattern of fluctuations seems a more adequate representation of teachers' feelings of burnout across the five-year period. It remains important to note that these results apply to teachers who, on average, had lower

feelings of burnout than a reference group. Still, about one fifth of the teachers in our sample experienced high levels of burnout feelings during the time span of five school years. The teaching profession is often characterized as one of the most emotionally draining occupations (Chang, 2009; Maslach et al., 2001). The (fluctuating) burnout feelings we found in the present study, are probably innate to the teaching profession. In our opinion, burnout feelings of teachers, therefore, deserve permanent attention, for researchers in exploring factors that can explain these (fluctuating) burnout levels, as well as for educational practice to prevent or lower these levels.

In exploring teacher-student relationship as a correlate to explain the between and within teacher variation in teacher burnout, especially the level of Communion in the behavior of teachers proved to be the determinant predictor for differences between teachers in their feelings of burnout, not so much their level of Agency. Relationships with students are for teachers at the core of their professional identity (e.g., Beijaard, 1995; Van der Want et al., 2015). Being perceived by students as someone who is helping and friendly (higher level of Communion) seemed to have more impact on teachers' feelings of personal accomplishment, depersonalization, and emotional exhaustion than being perceived by students as someone who is in control (higher level of Agency). Being in control, however, can account for fluctuations across school years in feelings of emotional exhaustion and personal accomplishment within individual teachers. Higher levels of teacher Agency contribute to a more structured classroom climate (Wubbels et al., 2006), and may thereby lower feelings of emotional exhaustion and elevate feelings of personal efficacy, within a relatively stable level of Communion. Thus, results of the present study empirically evidenced the claim of the association between teacher-student relationship and burnout, and refined this claim by showing the importance of teachers' level of Communion in their relationship with students.

As the present study showed: classes with relatively negative relationships predict within teacher variation better than classes with relatively positive teacher-student relationships. These classes are probably informative, for researchers, when collecting longitudinal data on individual burnout trajectories of teachers including teacher-student relationships, or, for teacher educators, when designing interesting targets for individual teacher coaching.

### **Limitations and Future Directions**

The methods used in the present study don't allow for conclusions about causation. Besides, reciprocity in the association of teacher-student relationship and teacher burnout,

which is more likely than one-sided effects, did not get attention in the present study. When teachers struggle in building high quality relationships with students, their feelings of burnout may elevate. Reciprocally, with elevated feelings of burnout, teachers may have more difficulty in maintaining the quality of their relationship with students. On the road to a more comprehensive model to understand teacher burnout, the present study contributed by exploring temporal patterns of teacher burnout over a five-year time span, and by analyzing how burnout and teacher-student relationships co-varied with multilevel regression analysis. However, to allow for conclusions about reciprocity and causality, different methods, like cross-lagged panel analysis, or experimental designs, are needed.

To measure teacher-student relationships, we used perceptions of students. By including self-perceptions of teachers of their relationship with students, we could have found a larger effect on teachers' feelings of burnout than we now found with perceptions of students. However, associations of self-perceptions of teachers of their relationship with students and their feelings of burnout, may overestimate the strength of these associations because they may suffer from self-report bias. In future research, it could be compared how a teacher's ideal perception, his or her self-perception, student perceptions and the discrepancies between these perceptions contribute to teachers' feelings of burnout.

In the present study, we left the selection of the classes to gather data on the teacher-student relationship to the teachers. They were asked to administer the QTI-questionnaire to students of at least two different classes, preferably the classes with whom they, in their opinion, had the best and the worst teacher-student relationship. One can imagine that teachers are not always aware of the quality of the relationship with their students or (unintentionally) avoid a confrontation with negative information on relationships with their students. This could have contributed to selection of classes that are suboptimal stressors. In future research, alternative methods of selection could be used, such as the view of, for example, colleagues, school leaders, and coaches on the class in which the teacher has the most negative relationship with students.

Also, we based our selection of the class with the relatively negative relationship only on a teacher's level of Communion. It would be preferable if we could select this class based on the combination of the level of Communion and Agency to represent the blended character of interpersonal behaviors, in line with the Teacher Interpersonal Circle model. However, to base selection on a quantitative procedure, circular statistics is needed and this is, unfortunately, at the moment, still in its infancy.

In the present study change patterns of teacher burnout were studied without a well-defined starting point, such as the start of the teaching career (cf. Hultell et al., 2013). In our sample, teachers have varying work experience (between 1 and 38 years). This limits the possibility to hypothesize models with specific stressors, for example, typical for a specific phase of the professional career of teachers. The contribution of the present study is, therefore, mainly restricted to the length of the period in which teachers' feelings of burnout were studied.

A last, but not least, caution concerns the generalizability of the sample of the present study. As we emphasized before, the teachers in our sample have relative low feelings of burnout. These teachers may have systematically differed from a sample with representative, or higher scores; for example, by lower percentages of trajectories of erosion of engagement, or less variance in teacher Communion and Agency.

### **Practical Implications**

We are aware that formulating practical implications presupposes causality of results and that this is not justified by the correlational design of the present study. Our practical implications have to be understood as suggestions that perhaps may aid in the identification of targets for interventions to reduce feelings of burnout.

Even though the overall level of burnout was relatively low in our sample, still, around 20% of the teachers experienced high levels of burnout during the five school years. In our opinion, support in identifying and managing burnout should be available for these teachers. Because burnout seems to be an innate problem of the teaching profession, for all teachers prevention management should be addressed. As depersonalization is not a preferable strategy to cope with feelings of reduced personal accomplishment or emotional exhaustion, exploring ways to improve (awareness of) the relationship with students seems a more fruitful start for improvement.

Findings of the present study suggest the degree of Communion in teacher interpersonal behavior in classes as a target for interventions. Also, comparing student perceptions to the teacher's self- and ideal perceptions, may provide useful information for coaching teachers. The selection of a specific class for exploration of problems for professional development and coaching purposes, can probably be based best on the teacher's personal preferences and learning goals, as the present study showed no clear differences in the predictive power for teacher burnout of classes with a different type of teacher-student relationships.

A comparison of the different dimensions of burnout feelings in the previous year(s) may be another helpful issue to address in teacher coaching. In case of changed feelings of burnout across years, exploration of concurrent changes in contextual or situational factors, such as personal life factors, or work conditions may be clarifying. In case of changes in emotional exhaustion or personal accomplishment a closer comparison of the Agency level of the teacher-student relationship in classes with a relatively negative relationship may be of help.



## CHAPTER 3

### **A NONLINEAR DYNAMIC SYSTEMS APPROACH TO REAL-TIME TEACHER BEHAVIOR: DIFFERENCES BETWEEN TEACHERS<sup>5,6</sup>**

#### **ABSTRACT**

A positive teacher-student relationship is important for students' motivation, students' academic achievement, and teacher well-being. How the teacher-student relationship develops in real-time has hardly been studied. In the present study, we explored real-time interpersonal behavior (micro-level) for teachers with different relatively stable patterns of interpersonal teacher behavior (macro-level), i.e., interpersonal profiles. Interpersonal profiles are considered indicative of the teacher-student relationship. Interpersonal teacher behavior was conceptualized using Interpersonal Theory in terms of (a blend of) Agency and Communion. We used a Nonlinear Dynamic Systems (NDS) approach to explore differences in content (attractors) and structure of changing behavior (variability) in real-time interpersonal teacher behavior using State Space Grid (SSG) analyses. We found the expected differences between teachers and correspondence between the location of the attractors in the SSG and the blend of Agency and Communion characterizing the teachers' interpersonal profiles. Regarding structure, we found the expected higher variability in real-time behavior for teachers with interpersonal profiles characterized by lower levels of Agency and Communion. We concluded there is sufficient potential of NDS to differentiate between teachers to use a NDS approach in future research on the connection between teacher-student relationship and real-time teacher interpersonal behavior.

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<sup>5</sup> This chapter is based on Pennings, H. J. M., Brekelmans, M., Wubbels, T., Van Der Want, A. C., Claessens, L. C. A. & Van Tartwijk, J. (2014). A Nonlinear Dynamical Systems Approach to Real-Time Teacher Behavior: Differences between Teachers. *Nonlinear Dynamics, Psychology, and Life Sciences*, 18(1), 23-45.

<sup>6</sup> Acknowledgement of author contributions: HP, MB, and JvT designed the study, HP, MB, TW, and JvT drafted the manuscript, LC, HP, and AvdW collected the data, HP analyzed the data, MB and JvT supervised the study.

In educational settings, peer-peer and teacher-student relationships form the classroom social climate (Mainhard, Pennings, Wubbels, & Brekelmans, 2012). The social climate affects student motivation, student academic achievement (Brekelmans, 2010; Cornelius-White, 2007; Den Brok, Brekelmans, & Wubbels, 2004; Hamre & Pianta, 2001; Henderson, 1995; Roorda, Koomen, Spilt, & Oort, 2011; Thijs & Koomen, 2008), and teacher well-being (Brekelmans, 2010; Evertson & Weinstein, 2006; Spilt, Koomen, & Thijs, 2011; Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006). Teacher-student relationships develop from teachers' daily (real-time) classroom behavior. Our knowledge, based on the association between real-time teacher behavior (micro-level) and the teacher-student relationship (macro-level), is limited.

In the present study we take a first step in exploring daily classroom dynamics and focus on how teachers behave interpersonally in real-time during a lesson. To make a connection between real-time behavior (micro-level) and the teacher interpersonal profile (macro-level), an instrument is required that maps characteristics of real-time behavior *and* has the power to discriminate between teachers with different teacher student relationships. The ultimate goal of our study is to increase understanding of the development of teacher-student relationships from real-time interpersonal teacher behavior. This increased understanding may also contribute to the development of interventions for teachers' professional development.

### **Interpersonal Theory**

Wubbels and colleagues (2006) developed a model to describe interpersonal teacher behavior: the "Teacher Interpersonal Circle" (see Fig. 1). This model was based on interpersonal theory (Horowitz & Strack, 2011) and Leary's circle of personality (Leary, 1957). Interpersonal theory describes the behavior of persons relating to and interacting in a system with other persons (Kiesler, 1996) based on the assumption that human behavior is best understood within the context of transactional causality and reciprocal influence (Strack & Horowitz, 2011). A basic premise of interpersonal theory is that all interpersonal behavior occurs along two orthogonal dimensions together forming the basis of a circular, or circumplex, structure (Fabrigar, Visser, & Browne, 1997; Gurtman, 2009; Horowitz & Strack, 2011; Kiesler, 1983; Leary, 1957; Sadler, Ethier, & Woody, 2011; Wubbels et al., 2012). Depending on the context (e.g., psychiatry, family, education) the dimensions are designated differently with Agency and Communion as meta-level labels (Bakan, 1966; Fournier, Moskowitz, & Zuroff, 2011; Gurtman, 2009; Wiggins, 1991). Agency suggests someone is

becoming individuated, dominant, and has power and control; whereas, *Communion* means someone is social, shows love, union, friendliness, and affiliation (Gurtman, 2009). The circumplex structure (Guttman, 1954), implies that all interpersonal behavior can be ordered along the circumference of a circle. Depending on its position in the interpersonal circle, all behavior can be seen as a specific blend of Agency and Communion (Fabrigar et al., 1997; Gurtman, 2009; see Fig. 1).

Since Leary (1957) noted that people differ in interpersonal behaviors and that these behaviors and corresponding traits can be ordered in a circumplex structure extensive research has been carried out to study the validity of this structure. Validity was established in different contexts by means of more traditional methods, such as exploratory factor/principal component analysis and multidimensional scaling, and recently using a more advanced and accurate covariance structuring modeling approach developed by Browne (1992). See Fabrigar et al. (1997) for an overview of methods and studies assessing validity of circumplex models. Some examples of studies assessing circumplex validity: Chuang (2005) who found a two-factor structure (principal components analysis) in interpersonal behavior of family members; Wubbels et al. (2006) who found a two-factor structure (structural equation modeling) in interpersonal behavior of secondary education teachers; Grassi, Luccio, and Di Blas (2010) who found that quantitative model fitting indices (Browne's circular stochastic process model) showed that 5<sup>th</sup> grade children's ratings of their interpersonal behavior confirmed to a circumplex structure.

In the last three decades, a large amount of studies using the Teacher Interpersonal Circle have been conducted in different countries across the world (e.g., USA, Australia, China, The Netherlands; for an overview see Wubbels et al., 2006 and Wubbels et al., 2012). One of the results of these studies was that eight different teacher interpersonal profiles could be distinguished (e.g., Brekelmans, 1989; Wubbels et al., 2006). Based on the corresponding blend of Agency and Communion, each interpersonal profile can be positioned in the Teacher Interpersonal Circle (See Fig. 1). Students in classes of teachers whose interpersonal profiles are characterized by high levels of both Agency and Communion (i.e., a profile in the upper right part of the Teacher Interpersonal Circle) have higher affective and cognitive outcomes than students in classes of teachers with lower levels of Agency and Communion (i.e., a profile in the lower and left parts of the Teacher Interpersonal Circle) (Brekelmans, 1989; Cornelius-White, 2007; Den Brok, 2001; Thijs & Koomen, 2008). During their professional career, teachers' relationships with students, on average, develop towards

interpersonal profiles with increasing Agency and also, but less, increasing Communion (Brekelmans, Wubbels, & Van Tartwijk, 2005).

Until recently, research on teacher-student relationships mainly focused on a macro-level time scale, where questionnaires were used to map perceptions of students and teachers, and to study relatively stable patterns in teacher and student behavior over several months or a school year. Fogel (2011) calls this type of studying the outcome of development. Such studies do not reveal the real-time or micro-level dynamics maintaining the behavioral patterns leading to a specific teacher-student relationship (Dishion, 2012; Fogel, 2011; Sroufe & Rutter, 1984). To explore these dynamics, we used insights from Non-Linear Dynamic Systems (NDS) theory.

### **Nonlinear Dynamic Systems Theory**

An important premise within NDS theory is that development is nonlinear and should be studied as it unfolds over time (Dishion, 2012). NDS theory focuses on studying the relationship between the outcomes of development (macro-level timescale) and the process of development (micro-level timescale). According to NDS theory, human development is hierarchically nested in time (Hollenstein, 2007). In the case of interpersonal relationships as outcomes, real-time behaviors are the building blocks of these relationships (Granic & Patterson, 2006; Oullier, Guzman, Jantzen, Lagarde, & Kelso, 2008). In turn, interpersonal relationships constrain real-time behavior (Hollenstein & Lewis, 2006).

In the past, several NDS studies on interpersonal relationships and interpersonal behavior of interaction partners have been carried out. Some of these studies employed interpersonal theory (Altenstein, Krieger, & Grosse Holtforth, 2013; Chuang, 2005; Lizdek, Sadler, Woody, Ethier, & Malet, 2012; Markey, Lowmaster, & Eichler, 2010; Pincus, Fox, Perez, Turner, & McGreehan, 2008; Pincus & Guastello, 2005; Sadler, Ethier, Gunn, Duong, & Woody, 2009; Sadler et al., 2011; Sadler & Woody, 2003). Such research studied both interaction partners' behaviors separately and combined these later in their analyses. These studies, for example, focused on therapist-client interactions (Altenstein et al., 2013; Pincus & Guastello, 2005), interactions between same sex or cross-sex partners (e.g., Lizdek et al., 2012; Markey et al., 2010; Sadler & Woody, 2003; Sadler et al., 2009 & 2011), small groups (Pincus & Guastello, 2005; Pincus et al., 2008), and family relationships (e.g., Branje, 2008; Chuang, 2005; Granic & Hollenstein, 2003).

### ***Interpersonal Content and Structure***

To study real-time behavior, NDS theorists use two characteristics: content and structure. *Content* of real-time behavior is conceptualized in terms of *attractors*, which are commonly used in studies based on NDS Theory (e.g., Granic & Hollenstein, 2003; Mainhard et al., 2012). An attractor is a behavioral *state*, a mode of behavior, that a system prefers (Thelen & Smith, 2006) or tends to get “stuck” in (Lunkenheimer & Dishion, 2009). Attractors represent stable and recurrent states or patterns of real-time behavior (Granic & Hollenstein, 2003; Mainhard et al., 2012) that are developed through repetitive occurrences and are difficult to change (Lunkenheimer & Dishion, 2009). In the context of interpersonal teacher behavior, an attractor can be defined in terms of a frequently occurring or preferred behavior with a specific combination of Agency and Communion. For example, a teacher with frequently uncertain (i.e., talking in a very soft voice), hesitating (i.e., stuttering) and objecting (i.e., complaining about students) behavior can be characterized by an attractor with low levels of Agency, as well as low levels of Communion.

In addition to the content of real-time behavior, NDS theory characterizes real-time behavior by means of *structure*. Based on Hollenstein (2013) we assume that structure may also play a crucial role in the development of interpersonal profiles from real-time behaviors. More specifically, Hollenstein explains that structure can be interpreted as the process of states transforming into different states as a response to change in the environment. Structure provides insight in the shifts between behavioral states (Dishion, Nelson, Winter, & Bullock, 2004; Hollenstein & Lewis, 2006; Hollenstein, 2013). Thus, structure refers to the dynamics of a system. For example, take the case of a teacher who has two attractors, one showing friendly-submissive (i.e., high Communion and low Agency) behavior and one showing unfriendly-dominant (low Communion and high Agency) behavior. When a teacher shows friendly and submissive behavior most of the time, this makes quite a positive impact on his or her relationship with the students. Thus, occasionally showing unfriendly-dominant behavior, if necessary, may not hamper the teacher-student relationship. However, when the teacher switches between the friendly-submissive and unfriendly-dominant behavior very often, his or her behavior may become unpredictable to students and may impact the teacher-student relationship negatively. How the teacher-student relationship is defined for this particular teacher, thus, depends on the structure in his or her changing behavior.

The importance of structure for understanding the development of relationships in different contexts has been shown. For example, Pincus et al. (2008) studied the dynamics of turn-taking patterns in small group conversations and the effect of conflict within an

individual on group processes. They found that conflict within an individual significantly decreased variability in small group turn-taking patterns. Granic and Hollenstein (2003) found that development of healthy parent (mother)-child relationships required a structure that represents variability reflecting the skills to adapt to changes in the environment. Mainhard et al. (2012) conducted one of the few studies exploring the use of NDS theory to study teacher-student relationships. Two teachers with distinct interpersonal teacher-student relationships were compared to each other. In contrast to the family studies of, for instance, Granic and Hollenstein (2003), Mainhard et al. (2012) found that variability was highest for the teacher with a classroom social climate characterized by low levels of Agency and Communion. According to Brekelmans, Levy, and Rodriguez (1993) this type of social climate corresponds to an aggressive kind of disorder, and in previous research this type of classroom climate has been related to negative student outcomes (Wubbels et al., 2006). Mainhard et al. (2012), thus concluded there is a possible disadvantage of high variability for developing positive teacher-student relationships.

### **The Present Study**

Studying differences in real-time teacher behavior is the first step required to explore the strength of using NDS to study the development of teacher-student relationships. Bloom (2011) states that seeing the nonlinear nature of teacher-student relationships is valuable, and NDS research on relationships in education is important. Therefore, in the present study, we will answer the following research question: Are there differences in the content and structure of real-time interpersonal teacher behavior (micro-level) of teachers with different interpersonal profiles (macro-level)?

We define *micro-level interpersonal teacher behavior* as real-time behavior of a teacher towards students, conceptualized in terms of (a blend of) Agency and Communion. We define *interpersonal profile* (macro-level interpersonal teacher behavior) as the relatively stable and predictable pattern of teacher behavior resulting from frequent interpersonal behavior exchanges between a teacher and his or her students (cf., Mainhard et al., 2012). This interpersonal profile is also conceptualized in terms of (a blend of) Agency and Communion. We consider a teacher's interpersonal profile an important aspect of a teacher-student relationship.

## METHOD

### Design

We used a multiple case-study (Gast, 2010) to compare data on interpersonal content and structure of eight teachers' real-time interpersonal behavior during one lesson. The eight teachers had different interpersonal profiles.

### Participants

The eight teachers participating in the present study were selected from a larger sample of 128 secondary education teachers. The teachers were selected in such a way that the interpersonal profiles of the eight teachers were distributed over the eight octants of the Teacher Interpersonal Circle (cf., Figure 1, teachers A-H). On average, the teachers had almost 7 years of experience ( $M= 6.75$ , range: 1-31), were around 40 years of age; ( $M= 39.6$ , range: 27-56), and taught different subjects including geography ( $N=1$ ), math ( $N=1$ ), French ( $N=2$ ), chemistry ( $N=3$ ), and physics ( $N=1$ ). Three teachers were men and five were women.

### Measures and Procedure

#### ***Macro-Level Teacher Interpersonal Profiles***

Data on the participants' interpersonal profiles were gathered using the 24-item version of the Questionnaire on Teacher Interaction (QTI, 3 items per octant; Wubbels et al, 2012). Using the QTI, a teacher's interpersonal profile is mapped using the students' perceptions of their teachers' interpersonal behavior on a general (i.e., referring to their perception based on several months of classroom experience) and class-aggregated level). Examples of items are, "This teacher has humor," and "This teacher is dissatisfied." Every item consists of a five-point scale (1 = *never* and 5 = *always*). From the scores on the QTI-items, values for Agency and Communion were derived by weighting the items based on their connection to the octants of the Teacher Interpersonal Circle. The reliability of the questionnaire was good; alpha levels for Agency and Communion were .86 and .96 respectively. The circumplex structure (Browne's circular stochastic process model tested with CIRCE , Grassi et al., 2010), showed satisfying model fit indices for individual student perceptions ( $\chi^2(28, N = 18,000$ ; of each classroom one student was chosen at random) = 64917.46;  $p < .01$ , the Root Mean Square Error of Approximation (RMSEA)=0.043; Bentler's comparative fit index (CFI) = .99, Tucker-Lewis index (TLI) = .97).



Figure 1. Teacher Interpersonal Circle and position of interpersonal profiles of the teachers who participated in the study (A-H)

### **Micro-level Interpersonal Teacher Behavior**

In the present study, data on micro-level teacher behavior were gathered by coding the real-time level of Agency and Communion of teacher behavior on video. We used one lesson of each participating teacher. The lesson was filmed with a camera positioned in the back of the classroom. Consent for videotaping was in accordance with policies of the schools of the participating teachers. Most schools had written consent of parents allowing their children to participate in research and video-observation. In schools without such a policy, teachers were provided with consent letters for parents to return in case they objected to their child being filmed. All parents consented. Lessons differed in length; the average duration of each lesson was 45 minutes. In some of the recorded lessons, the end of the lesson was reserved for activities such as taking tests, working on assignments, or completing questionnaires. To be able to compare the recordings, we included only the first 30 minutes of the lesson, which started when the students entered the classroom.

Real-time interpersonal teacher behavior was coded continuously, within the interpersonal circle, by two trained observers who followed an online-scoring procedure using a computer joystick device (Figure 2) (Lizdek, Sadler, Woody, Ethier, & Malet, 2012). The observers coded the recordings independently. To ensure the observers could maintain concentration during the observations, each 30-minute observation was divided into three ten-minute coding sessions.



Figure 2. Computer Joystick Method

The computer joystick device for coding enabled us to code teacher interpersonal behavior as a blend of Agency and Communion resembling people's perceptions of interpersonal behavior in real-life, instead of coding behavior separately for each dimension. The data generated with the joystick were processed by a computer program (Joymon.exe; Lizdek et al., 2012). The Joymon program numerically recorded the exact location (based on X- and Y-coordinates) of the cursor within a two-dimensional space meant to represent the interpersonal circle. This two-dimensional space was visible in a separate window on the computer screen (Markey et al, 2010; Sadler et al., 2009). The coordinates ranged from -1000 = very low Agency/Communion to +1000 = very high Agency/Communion ensuring maximum sensitivity of the computer joystick device. A dot marked the location of the cursor within the two-dimensional interpersonal space; during coding this dot turned red. We used the default setting of the program to record the cursor location twice per second.

Establishing inter-rater reliability

To learn how to observe teacher behavior with the computer joystick, one of the researchers (first author) participated in a computer joystick training<sup>7</sup>. A second observer was trained by the first observer, and inter-rater reliability was established for the present

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<sup>7</sup> The joystick training was provided by Pamela Sadler and Ivana Lizdek at Wilfried Laurier and Waterloo University in Canada. The training included general observations of interpersonal behavior with the joystick and was not related to the educational context.

study. First, the observers practiced coding with the joystick and discussed any inconsistencies in coding. The two observers jointly established rules for coding the teacher behaviors. For example, when the teacher was talking to the class as a whole, then changed his behavior by writing something on the blackboard and thereby could not see what was happening in the classroom, the joystick was moved down on the Agency coordinate. If at the same time the teacher also got angry because he had to explain things twice, the joystick was also moved down on Communion (from *directing* to *objecting*, i.e., from the upper right to the lower left part in the Teacher Interpersonal Circle).

After ten hours of training and discussing the observations, inter-rater reliability was established on new data. We used Intra Class Correlations (ICC) as a measure to check the psychometric quality of the observations (Field, 2013; Lüdtke, Robitzsch, Trautwein, & Kunter 2009; McGraw & Wong, 1996). ICC measures the agreement between codes of the same variables, such as the agreement between two or more observers' codes of behavior (Field, 2013). There are two different types of ICC. The first type, ICC(1), measures the reliability of the measurements of a single observer. The second type, ICC(K), measures the reliability of averaged measurements of multiple observers (Field, 2013; Lüdtke et al., 2009; McGraw & Wong, 1996). In the current study the second type of ICC was calculated, because all observations were carried out by two observers. Averaged scores were used for the analysis of content and structure. ICC(K=2) values were .74 for Agency and .78 for Communion, indicating strong agreement between both observers (LeBreton & Senter, 2008).

### **Analyses**

After coding the real-time teacher behavior, the Joymon program provides scores (x and y coordinates) for both dimension separately, generating a 30-minute time-series for both Agency and Communion for each teacher. Based on the procedures used by Lizdek et al. (2012) and Sadler et al. (2009), the first 10 seconds from every time series were omitted to avoid the possibility of "boxcar" artifacts (Warner, 1998). A boxcar artifact is a spurious coding, in rectangular form, arising from preparatory and starting observations occurring when the joystick is moved from its origin to the first intended coordinate in the interpersonal circle. All coordinates between the origin and the first intentional coding were recorded, thus, the boxcar artifact could seriously influence the data and results.

To analyze the characteristics of real-time teacher interpersonal behavior, the averaged time-series of Agency and Communion were combined in Gridware (Lamey, Hollenstein,

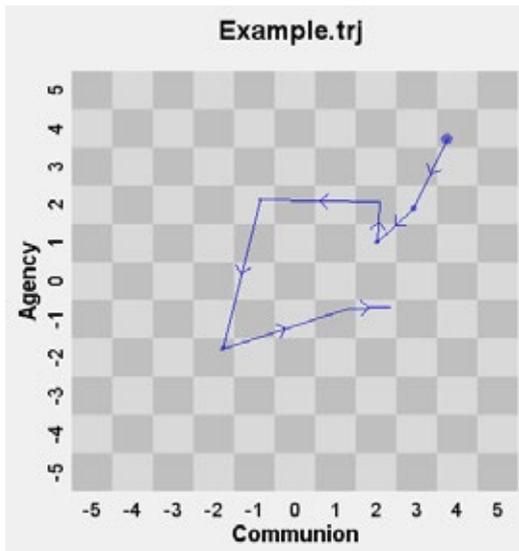


Figure 3. Example of a State Space Grid of interpersonal teacher behavior in terms of Agency and Communion. The horizontal axis shows the Communion behavior and the vertical axis the Agency behavior of the teacher. The arrowed line represents the change in Interpersonal behavior over the course of a few minutes (i.e., the interpersonal behavior trajectory). The size of the dots indicates the duration of each interaction state. The position of a dot in a cell is arbitrary. The trajectory shown in this example is a simulation.

Lewis, & Granic, 2004) to create State Space Grids (SSGs) of interpersonal teacher behavior (Lewis, Lamey, & Douglas, 1999). SSG analysis seems a very useful and promising tool to study real-time interpersonal teacher behavior and teacher interpersonal profiles. SSG analysis has successfully been used in several psychological and life sciences studies, such as for example, in the study of family relationships (Granic & Hollenstein, 2003; Hollenstein, 2013). A SSG is a two-dimensional-state space with two or more categories on each variable or dimension in this study on Agency and Communion. The categorical combinations of Agency and Communion together form a grid of cells (Hollenstein, 2013). Each cell in the grid represents a specific behavioral state. In the SSG, a trajectory of a particular system's (e.g., teacher's) real-time behavior can be plotted as a visual representation (Hollenstein, 2013). The behavioral trajectory reveals the total of behavioral states, the preferred behavioral states (content / attractors), and variability of the systems' behavioral states (structure of change).

Gridware could not run a SSG with 4004001 cell combinations (i.e., the coordinates for both Agency and Communion range from -1000 to 1000, combined in a SSG, which results in

2001\*2001=4004001 possible combinations of coordinates). To solve this problem, the coded teacher behavior coordinates were recoded into 20 categories with a width of 100 coordinate points, and 1 category included just the 0 value, resulting in 21 categories per dimension ranging from -10 = *Very low Agency/Communion* (0 = *Neutral*) to 10 = *Very high Agency/Communion*. These categories of Agency and Communion were plotted against each other in a SSG to create a visual representation of the blend of a teacher's Agency and Communion behavior.

An example of a SSG is presented in Figure 3. Note that the data for this SSG example are simulated and are meant for explanatory purposes only. The X-axis represents teacher Communion and the Y-axis represents teacher Agency. Each cell in the grid represents a specific combination (*state*) of teacher Agency and Communion. For example, the cell -7/7 means very low teacher Agency and very high teacher Communion, representing somewhat "tolerant" teacher behavior (i.e., wholeheartedly accepting students' behavior).

### ***Interpersonal Content***

Hollenstein (2013) explained several methods to identify attractors, some more rigorous than others. One method is to select the cell or cells with the (a) highest mean durations of visits and (b) highest number of visits (Hollenstein, 2013). We used this method and formulated the following criteria for "highest":

- (a) Highest mean duration: >100 sec; for 30 minutes coding and 441 cells; a cell duration is 4.08 sec by chance.
- (b) Highest number of visits: the number of visits to a cell has to be larger than two times the mean number of visits to the visited cells of all eight teachers.

The eight teachers who participated in the present study were all perceived differently by their students in terms of Agency and Communion on a macro-level (interpersonal profile). We concluded that teachers differ in the content of real-time interpersonal behavior if they differ in (a) presence of attractors (attractors vs. no attractors) or (b) when attractors are located in different regions in the SSGs. We expected a correspondence between the content of macro-level interpersonal profiles (level of Agency and Communion) and real-time interpersonal teacher behavior. We formulated specific expectations. First, we expected that teachers with an interpersonal profile characterized by high levels of Agency and Communion would have attractors in the upper right part of the SSG: high occurrences of e.g., laughing, helping, and explaining in a friendly manner. Second, we expected that teachers with an interpersonal profile characterized by low levels of Agency and high levels

of Communion would have attractors in the lower right part of the SSG: high occurrences of, e.g., tolerant or understanding behavior that gives students freedom. Third, we expected that teachers with an interpersonal profile characterized by low levels of Agency and Communion would have attractors in the lower left part of the SSG: high occurrences of, e.g., aggressive, hesitating, and uncertain behavior. Last, we expected teachers with an interpersonal profile characterized by high levels of Agency and low levels of Communion to have attractors in the upper left part of the SSG: high occurrences of, e.g., making sarcastic remarks or confronting and enforcing behavior. As an additional indicator of content correspondence between macro-level interpersonal profiles and real-time interpersonal teacher behaviors, we calculated the Pearson correlation between the Agency and Communion scores measured with the QTI and the mean Agency and Communion scores from the joystick observations. We expected both correlations to be positive.

### ***Interpersonal Structure***

Several whole grid measures can be calculated as indicators of the structure of real-time of teacher behavior (Hollenstein, 2007). In the present study, we used (1) the number of unique cells visited, (2) the mean duration that behavioral states were visited and (3) visit entropy.

In the SSG, the behavior trajectory consists of a series of visits to cells (Hollenstein, 2013). The *unique cells visited* is the number of behavioral states (specific combination of Agency and Communion) a teacher has uniquely shown in his or her real-time behavior (range 1-441). The *mean duration of visits* is the duration of the observed lesson period divided by the number of visits to cells (note: a cell can be visited more than once). The mean duration of visits to cells indicates the overall variability of behavior, which Hollenstein (2013) calls “the overall stuckness or rigidity of the trajectory” (p. 72). When teacher’s behavior during the observed period remains in one specific cell, the mean duration of visits will be relatively high. When teachers in the observed lesson period often switch from one cell to another, the mean duration of visits will be lower. *Visit entropy* (Hollenstein, 2013) indicates the extent to which a systems’ behavior is predictable. We used the visit entropy measure provided by Gridware, (i.e., the program to create SSG’s). This visit entropy measure is based on information processing theory. Visit entropy is calculated by summarizing the conditional probabilities of cell visits (Dishion, et al., 2004; Hollenstein, 2013).

To calculate visit entropy the following Shannon and Weaver (1949) formula was built into Gridware:

$$\sum (P_i * \ln(1/P_i))$$

in which  $i$  is an index of each cell on the grid and  $P_i$  is the probability in cell  $i$ . Thus, for visit entropy,  $P_i$  is the number of visits to cell  $i$  divided by the total number of visits in the entire trajectory. When visit entropy is high, the system's behavior changes often, indicating that the pattern of interaction is unpredictable. Low visit entropy means behavior remains in only a few states, or returns to the same states often; this indicates a highly organized and predictable pattern in behavior (Dishion et al., 2004; Hollenstein, 2013; Lunkenheimer & Dishion, 2009).

We concluded that there were differences in structure in real-time interpersonal behavior between teachers when differences regarding number of visited cells and mean duration per visit were larger than 1 SD. For visit entropy, we followed the procedure of Dishion et al. (2004) using the first quartile (i.e., 25<sup>th</sup> percentile), the second quartile (i.e., the median split), and the third quartile (i.e., 75<sup>th</sup> percentiles) as cutoff points to determine whether visit entropy values were high or low.

For structure in real-time interpersonal behavior, we explored whether differences between teachers are related to the level of Agency and Communion of their macro-level interpersonal profile. We calculated Spearman's rank-order correlations. We expected negative values for correlations of Agency and Communion with the number of visited cells and with visit entropy, and positive values for the correlation of Agency and Communion with the mean duration per visit. We expected that teachers with interpersonal profiles characterized by lower levels of Agency and Communion would have higher variability (higher number of visited cells, lower mean duration) and less predictable behavior trajectories (higher entropy) in real-time interpersonal teacher behavior than teachers with interpersonal profiles characterized by higher levels of Agency and Communion.

## RESULTS

### Interpersonal Content

The SSGs for the eight teachers are provided in Figure 4. The location of teachers' behavior on the SSGs differed for most teachers. Table 1 lists the attractor cells with corresponding total duration and number of visits for each teacher. Five attractors were

identified for Teacher A; for teachers B and C, four; for teacher F, one; for teacher H, two; and for teachers D, E, and G, no attractors were identified.

Teachers A and B had a teacher-student relationship characterized by high levels of Agency and Communion. Teachers with this interpersonal profile have an authoritative teacher-student relationship. They are enthusiastic and open to students' needs.

The classroom climate is pleasant and structured (Brekelmans et al., 1993). The attractors in the SSG were located in the upper right region for these teachers, which also indicates high Agency and Communion in their real-time behavior.

Teacher C's interpersonal profile was characterized by high levels of Communion and low levels of Agency. Teachers with this interpersonal profile have a tolerant teacher-student relationship. Their classroom climate is supportive and students enjoy attending class (Brekelmans et al., 1993). Students have freedom and some power to influence curriculum and instruction. This finding corresponds to this teacher's real-time behavior that was situated in the right part of the circle, high on Communion, but not particularly high or low on Agency. Two clusters of attractors could be identified, both in the right part of the SSG, one characterized by lower and one by higher Agency, but not different on Communion.

Teachers D and E had an interpersonal profile characterized by a very low level of Agency and low level of Communion. Teachers with this interpersonal profile have an undetermined, and sometimes aggressive, teacher-student relationship. They show less leadership in class, and their lessons are poorly structured (Brekelmans et al., 1993). The classroom climate has a (generally tolerant) disorderly character (Brekelmans et al., 1993). This disorder could also be seen in their SSGs; their behavior changed frequently. Consequently, no attractor could be identified for these teachers.

Teacher F's interpersonal profile was characterized by a low level of Agency and a very low level of Communion. Teachers with this interpersonal profile have an irritable teacher-student relationship. Aggression is characteristic for the social climates in their classrooms (Brekelmans et al., 1993). Teacher and students regard each other as opponents and spend a great deal of time in symmetrically escalating conflicts. This finding corresponds to where most of teacher F's behavior was found, in the lower left part of the SSG where we identified an attractor.

Teacher G's interpersonal profile was characterized by a high level of Agency and a low level of Communion. Teachers with this interpersonal profile have a confrontational teacher-student relationship. They continually struggle to manage the class. The SSG of the real-time

interpersonal behavior of teacher G resembled the SSG of teacher D, covering a large part of the SSG; no attractor could be identified for this teacher.

Finally, teacher H's interpersonal profile was characterized by a high level of Agency and a low level of Communion. Teachers with this interpersonal profile have a repressive relationship. Students in their classes are uninvolved and extremely docile. They follow the rules because they are afraid of the teacher. The real-time interpersonal behavior of teacher H was found in the upper level of SSG, high on Agency, with attractors in the upper right part of the SSG.

We also calculated correlations between the real-time observations of teacher behavior and macro-level QTI scores for Agency and Communion score, to study the general correspondence. For Agency  $r = .90$  and for Communion  $r = .94$ . Thus, the macro-level Agency and Communion scores correspond to the degree of Agency and Communion in the teachers' real-time interpersonal behavior.

### **Interpersonal Structure**

We used several indicators for interpersonal structure of real-time teacher behavior: (1) the number of unique cells visited; (2) the mean duration of visits in seconds for each teacher; and (3) visit entropy, i.e., the number of transitions between the visited cells.

In Table I, the structure indicators are presented per teacher. The number of cells visited and the duration of the visits by the teachers differed per teacher. The number of visited cells was lowest for teachers B and C (i.e., 43 and 44, respectively), but the mean duration in the visited cells was longer (42.57 and 41.56 seconds) than for other teachers (75-114). The number of visited cells for teachers A and H was higher (i.e., 75 and 88), but the duration was shorter (i.e., about 24.98 and 20.34 seconds). For teachers D, E, F, and G, the number of visited cells was highest (i.e., 103, 112, 114, and 113), and the mean duration in these most visited cells was lowest (i.e., 17.51, 16.26, 15.82, and 15.62).

Based on the aforementioned criterion of 1 standard deviation to determine the difference between teachers in the number of visited cells ( $SD=29.8$ ) and the duration of visits to these cells ( $SD = 11.38$ ), we concluded that the number of unique visited cells of teachers B and C differed from all other teachers. The number of visits of teachers A, D, and H were not different from each other, and teacher A differed from teachers E, F, and G. For the duration of visits, we can conclude that teachers B and C differed from all the other teachers, but there was no difference among teachers A, D, E, F, G, and H.

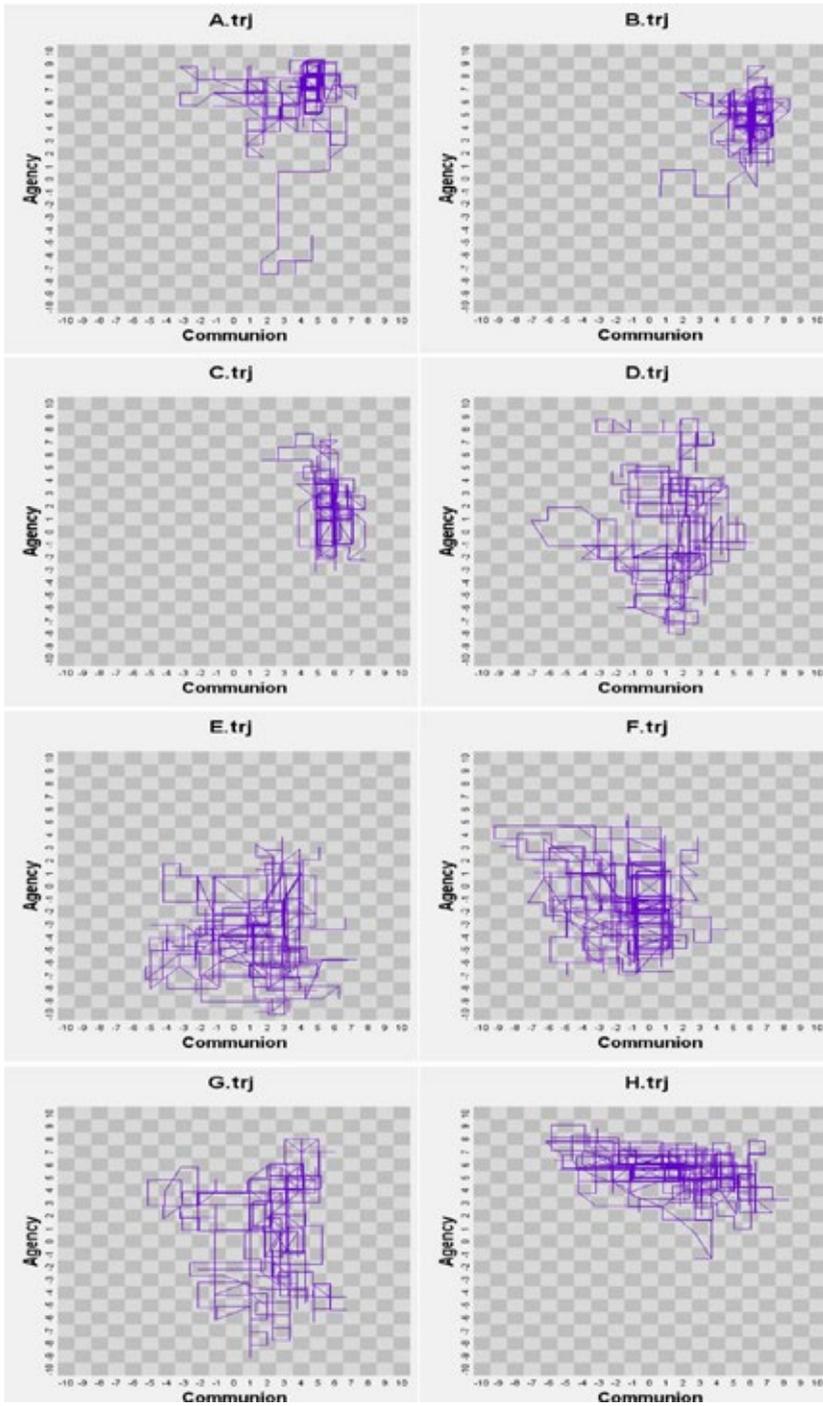


Figure 4. State Space Grids of the teachers who participated in the study (A-H)

Table 1. Means for Observed Agency and Communion: Whole Grid Measures, and Identified Attractor Cells for Teachers A-H.

	Whole Grid Measures					Attractor Cells		
	Agency	Communion	Number of visited cells	Duration in visited cells	Visit Entropy	Cells	Total Duration	Number of visits
A	595.11	354.85	75	24.98	3.54	8/4	107.0	41
						7/4	166.5	48
						9/5	110.5	18
						8/5	209.0	43
						7/5	166.5	55
B	407.69	523.26	43	42.57	3.07	5/5	143.50	28
						6/6	172.5	46
						5/6	199.5	56
						4/6	212.5	62
C	182.03	520.23	44	41.56	3.29	-1/5	101.0	15
						3/6	115.5	34
						2/6	124.5	35
						-1/6	360.5	20
D	54.24	106.06	103	17.51	4.35	NAS	NAS	NAS
E	-334.71	107.64	112	16.26	4.39	NAS	NAS	NAS
F	-155.80	-89.65	114	15.82	4.23	-2/-1	108.5	41
G	10.32	223.17	113	15.62	4.46	NAS	NAS	NAS
H	455.54	242.18	88	20.34	3.99	6/4	102.0	26
						5/5	111.0	32

Note. The notation of the attractor cell is Category for Agency/Category for Communion; NAS = No Attractor Specified.

Table 2. Spearman's Rank-order Correlations for Agency, Communion with the Structure Measures.

	Number of visited cells	Duration in visited cells	Visit Entropy
Agency	-.36	.33	-.05
Communion	-.90**	.86**	-.73*

Note. \* $p < .05$ , one-tailed. \*\* $p < .01$ , one-tailed.

For the third measure, visit entropy, we followed the procedure of Dishion et al. (2004) to use the first quartile (i.e., 25<sup>th</sup> percentile), the second quartile (i.e., the median split), and the third quartile (i.e., 75<sup>th</sup> percentiles) as cutoff points to determine whether visit entropy values were high or low and whether they differed among teachers. In the present study, the median was 4.11, the 25<sup>th</sup> percentile was 3.35, and 75<sup>th</sup> percentile was 4.38. The visit entropy values for teachers A, B, C, and H were below the median value, and for teacher D, E, F, and G, visit entropy values were higher than the median. Table 1 illustrates that visit entropy for teachers B and C is below the 25<sup>th</sup> percentile, and for teachers E and G, it is above the 75<sup>th</sup> percentile.

Thus, there are some differences in structure, but not among all eight teachers. Teachers D, E, F, and G are comparable to each other and have more unpredictable real-time behavior compared to teachers A, B, C, and H. The visit entropy values for teachers A, D, F, and H lie around the mean visit entropy value found in our sample. Teachers B and C's real-time behavior is regarded as more predictable and the real-time behavior of teachers E and G is less predictable than other teachers' real-time behavior.

In addition, we calculated rank-order correlations (Spearman's rho) to verify whether there is a relationship between Agency, Communion and the three structure measures. The findings of the rank-order correlations are presented in Table 2.

From Table 2 we can conclude that all rank-order correlation coefficients show the expected sign. For number of visited cells and visit entropy we found negative correlations and for the mean duration of visits we found positive correlations with both Agency and Communion. However, only the correlations for Communion with the structure measures were significant. Thus, we could only confirm our expectations on the relation between macro-level Communion and micro-level structure of interpersonal teacher behavior.

## DISCUSSION

In the present study, we used a NDS-based tool to map characteristics of real-time interpersonal teacher behavior, and explored differences in the content and structure of real-time interpersonal behaviors of teachers whose relationship with their students was perceived differently in terms of Agency and Communion. We expected to find correspondence between the macro-level of Agency and Communion, characterizing the interpersonal profiles of the teachers, and the micro-level content in terms of attractors. For structure, our expectation was based on the study of Mainhard et al. (2012). We also expected to find less variability in real-time behavior of teachers with a teacher-student relationship characterized by high levels of Agency and Communion, and higher variability for teachers with teacher-student relationships characterized by low levels of Agency and Communion.

Regarding content, we *did* find the expected correspondence between the location of the attractors in the grid and the level of Agency and Communion characterizing the teacher interpersonal profile for five teachers; however, for three teachers, we could not identify attractors. Interestingly, these three teachers have interpersonal profiles characterized by low levels of Agency and Communion representing uncertain, disorderly, and aggressive classroom social climates where teachers are not consistent in their behavior. In addition, we also found correspondence between the teachers' macro-level Agency and Communion (characterizing their interpersonal profile) and the mean level of real-time Agency and Communion.

Regarding structure, we found the expected higher variability and less predictable trajectories of real-time behavior for the teachers with an interpersonal profile characterized by lower levels Communion. We also found lower variability and higher predictable trajectories of real-time behavior of teachers with higher levels of Communion. We did not obtain the same results for Agency. Yet, the direction of the relationship did show some sign towards this relation. This finding of higher variability in real-time behavior of teachers with lower levels of Communion possibly explains why we could not identify attractors for these teachers.

Although we did not find all the expected differences in the real-time interpersonal behavior of all eight teachers who participated in our study, the results provide several useful insights about differences between pairs of teachers. For this reason, we conclude that the SSG analysis was useful to explore differences between the content and structure of the eight teachers' real-time interpersonal behavior.

Use of NDS tools allows researchers to characterize real-time interpersonal teacher behavior by means of qualitative and quantitative measures. The measures from this study help to describe the development of real-time interpersonal behavior of teachers over a longer period, and as such, might help to understand the development of teacher-student relationships. NDS tools that can discriminate between teachers with different interpersonal relationships may also provide useful information for helping teachers and student teachers struggling with classroom management problems because their relationship with their students is problematic. The tools we explored in the present study can be used for making macro-level outcomes visible in real-time, thereby providing teachers with a lever for problem solving and professional development. For example, results showed that teachers' interpersonal profiles characterized by high levels of Agency and Communion (e.g., teachers A, B) showed less variability in real-time interpersonal behavior than teachers with an interpersonal profile characterized by low levels of Agency and Communion (teachers D, E, and G). Diagnosing their own classroom situation in terms of structure in their real-time interpersonal behavior can help teachers to get insight into the effects of "low Agency and Communion behavior" and "unpredictable behavior." To broaden the usability for teacher professional development, these tools for diagnosing attractors and variability in real-time interpersonal behavior require additional tools, e.g., a comprehensive qualitative description of the real-time interpersonal behaviors corresponding to the different cells of the grid. This component would help teachers gain insight into their existing behavior and to reflect and experiment with alternative real-time interpersonal behavior to improve their relationship with students.

Our study has limitations. First, the present study was exploratory, using only eight teachers to explore the possibilities of a NDS tool to study differences in real-time teacher behavior. The criteria we employed to conclude differences among teachers were rather coarse-grained and need to be validated for use in teacher interpersonal profiles, perhaps by studying whether specific behaviors in real-time that differ according to our criteria represent behaviors perceived as different by the participants involved in the classroom situation, i.e., students and teachers. Thus, in future research the justification and usefulness of this SSG analysis and the criteria should certainly be explored further.

Second, in future studies it might be fruitful to include both teacher and student interpersonal behavior to study real-time interactions instead of only studying teacher behavior. To be able to study teacher-student interactions we need to (1) define a Student Interpersonal Circle, (2) increase our knowledge about the mechanism of complementarity

in hierarchical relationships, and (3) increase our knowledge about observing interpersonal behavior of multiple students as a group. How these interactions have to be analyzed needs further work because, as Pincus and Guastello (2005) have already shown, interactions in (even small) groups are dynamical and complex. Besides, we expect added value to the knowledge base of teacher student real-time interactions when we could study the interplay between teacher and student behavioral trajectories based on the blend of Agency and Communion of the behavioral states of both participants. This implies methods that take the circular nature of the interpersonal construct into account. Gurtman's (2011) vector-based analyses method and circular statistics (Berens, 2009) are promising techniques to analyze data with a circular nature.

### **Practical Implications**

The ultimate goal of our study, is to increase understanding of the development of teacher-student relationships (macro-level) from real-time teacher behavior (micro-level). Seltzer-Kelly et al. (2011) believe that studying teacher-student relationships from a NDS perspective is necessary for obtaining knowledge on how to prepare student teachers to develop good teacher-student relationships. We hope such an understanding will help to create awareness among teachers regarding the effect of teacher behavior on the teacher-student relationship and the classroom climate. Teachers are known to experience difficulties in changing routines or patterns in their behavior (Eraut, 2004), yet teachers are highly motivated to learn or change when they see the effect of their behavior on students (Van Eekelen, Vermunt, & Boshuizen, 2006). Video guided training has effectively been used in teacher development programs to create a better understanding of the role of teacher behavior in teacher-student relationships (Brouwer, 2011; Fukkink, Trienekens, & Kramer, 2011; Tripp & Rich, 2012). Actively analyzing the role of teacher behavior in real-time situations will also encourage teachers to stay focused, view their practice from another perspective, and implement change (Tripp & Rich, 2012).





**CHAPTER 4****REAL-TIME TEACHER-STUDENT INTERACTIONS: A DYNAMIC SYSTEMS  
APPROACH<sup>8,9</sup>****ABSTRACT**

Teacher-student relationships develop from real-time teacher-student interactions. These real-time interactions can be characterized by interpersonal content, structure, and complementarity. We studied how teacher-student interactions measured in terms of these characteristics differed for two teachers with distinct teacher-student relationships. A computer joystick device enabled us to measure teacher and student interpersonal behavior as a two-dimensional construct, a blend of Agency and Communion. Our results indicated that interpersonal content and complementarity discriminated between teachers, and that interpersonal structure did not. Measuring these characteristics seems promising to understand differences in teacher-student relationships.

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<sup>8</sup> This chapter is based on Pennings, H. J. M., Van Tartwijk, J., Wubbels, T., Claessens, L. C. A., Van Der Want, A. C., & Brekelmans, M. (2014). Real-time teacher-student interactions: A Dynamic Systems approach. *Teaching and Teacher Education*, 37, 183-193.

<sup>9</sup> Acknowledgement of author contributions: HP, MB, and JvT designed the study, HP, MB, TW, and JvT wrote the manuscript, LC, HP, and AvdVW collected the data, HP analyzed the data, JvT participated in and created the accompanying video (see <http://www.sciencedirect.com/science/article/pii/S0742051X13001303>), MB and JvT supervised the study.

Good relationships between teachers and students are important for student motivation, their academic achievement (Brekelmans, 1989; Den Brok, 2001; Cornelius-White, 2007; Goh, 1994; Hamre & Pianta, 2001; Henderson, 1995; Henderson, & Fisher, 2008; Roorda, Koomen, Spilt, & Oort, 2011; Thijs & Koomen, 2008), and for teachers' well-being (Evertson & Weinstein, 2006; Spilt, Koomen, & Thijs, 2011; Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006). Poor teacher-student relationships are related to classroom management issues and are an important reason for leaving the profession (De Jong, Van Tartwijk, Verloop, Veldman, & Wubbels, 2012; Walker, 2009). Many studies have been carried out all over the world to study teacher-student relationships in various countries (e.g., The Netherlands, the United States, Canada, Australia, China, and Indonesia) and various educational contexts (e.g., secondary, vocational, and university education). All of these studies reported the significant and crucial role of teacher-student relationships in education (e.g., Fisher & Rickards, 1998; Fricke, Van Ackeren, Kauertz, & Fisher, 2012; Georgiou & Kyriakides, 2012; Henderson, & Fisher, 2008; Klem & Connell, 2004; Lepointe, Legault, & Batiste, 2005; Levpuscek, Zupancic, & Socan, 2012; Maulana, Opdenakker, Den Brok, & Bosker, 2011; Mireles-Rios & Romo, 2010; Pianta, Mashburn, Downer, Hamre, & Justice, 2008; Wei, Den Brok, & Zhou, 2009; Wentzel, 1998; Wentzel, 2012). Teacher-student relationships develop from daily classroom interactions between teacher and students. The knowledge base on the relation between these daily interactions and the teacher-student relationship is limited. With the present study, we want to add to this knowledge base.

In this study, we define interactions as real-time behavioral exchanges of two or more participants (e.g., teacher-student or student-student) (Markey, Lowmaster, & Eichler, 2010), and relationships as relatively stable patterns in these behavioral exchanges (Mainhard et al., 2012). When studying how daily classroom interactions and teacher-student relationships influence each other, it is fruitful to use an approach based on Dynamic Systems (DS) theory (Granic & Hollenstein, 2003; Hollenstein, 2007; Hollenstein, 2013). According to this theory any development of a system (e.g., a person, a dyad or a group) is hierarchically nested in time (Hollenstein, 2007; Thelen & Smith, 2006). Development is therefore studied by examining the relation between experiences and processes on different time levels, i.e., micro-level (e.g. real-time teacher-student interactions) and macro-level (e.g., teacher-student relationships). Experiences and processes on a *real-time* level denote what happens within or between humans from second to second. Experiences and processes on a *developmental time* level denote the relatively stable state of certain human characteristics. Studying the development of teacher-student relationships using a DS approach includes

three basic tenets (a) real-time interactions between teachers and students in classrooms are the building blocks of teacher-student relationships (Hollenstein, 2003); (b) these relationships become manifest through the development of recurrent, relatively stable patterns in real-time interactions (Thelen & Smith, 2006); and (c) these relationships constrain real-time processes and experiences (Hollenstein & Lewis, 2006).

In various social contexts studies on relationships have been carried out using a DS approach. Examples are studies on parent-child relationships (Granic et al., 2003), on homogeneous interaction partners (e.g. females; Markey, et al., 2010), and on mixed-sex relationships (Sadler & Woody, 2003). Harjunen (2012) emphasized the importance of power in classroom interactions as dynamic systems. Yet, to our knowledge only very few studies have been carried out using this DS approach to empirically study interpersonal relationships in educational settings (Mainhard et al., 2012; O'Connor, 2010; Roorda, 2012).

In studies that use the DS approach real-time interactions are characterized by their content and structure. In the present study, we will study these characteristics in the context of teacher-student relationships: interpersonal content and interpersonal structure. According to Mainhard (2009) identifying the interpersonal content and interpersonal structure in teacher-student interactions may be critical for understanding teacher-student relationships. We will also add a third distinctive characteristic of real-time interactions that is used in studies building on Interpersonal theory (Horowitz & Strack, 2011; Kiesler, 1996): interpersonal complementarity (De Jong et al., 2012; Kiesler, 1983; Sadler, Ethier, Gunn, Duong, & Woody, 2009; Tracey, 2004). According to (Gurtman, 2001) interpersonal complementarity is probably the most predictive characteristic of interactions for studying differences in relationships.

As a first step in studying on the relation between real-time teacher-student interactions and teacher-student relationships we will explore if teachers with different relationships with their students also differ in interpersonal content, structure and complementarity of the real-time interactions with their students. This discriminant validity of these real-time characteristics is a prerequisite for studying the relation between real-time (micro-level) and developmental time (macro-level) processes and experiences. Insight in the relation between real-time and developmental time processes and experiences contributes to the understanding of the development of teacher-student relationships, and to interventions to improve teaching practice.

### **Interpersonal Content**

In the present study, we conceptualize the interpersonal content of the interactions in terms of *attractors*. Attractors are commonly used in studies based on DS Theory (Granic et al., 2003; Mainhard et al., 2012). An attractor is a behavioral state (e.g., a mode of behavior) a system prefers (Thelen & Smith, 2006), an attractor represents stable and recurrent patterns of real-time behaviors or interactions (Granic et al., 2003; Mainhard et al., 2012). When a particular state or typical positions in real-time interactions occur both frequently and for a longer time, this is a sign of the presence of an attractor (Granic et al., 2003). These attractors in real-time interactions contribute to the development and characterization of relationships on a developmental time-scale. For example, when a teacher often compliments students, thus encourages students to participate in classroom processes this might imply that this teacher has a positive relationship with his or her students.

### **Interpersonal Structure**

Dishion, Nelson, Winter, and Bullock (2004) and Hollenstein and Lewis (2006) refer to variability and stability of the systems' behavior (e.g., participants in the real-time interactions) as the structure of the interactions. In studies on mother-child interactions it has been found that variability is necessary for development of healthy parent-child relationships (Granic et al., 2003). However, in a study that compared two teachers with a desirable and less desirable teacher-student relationship, Mainhard et al. (2012) found that less variability was related to the desirable relationship and high variability was related to the less desirable relationship. They concluded that stability in interactions seems important to accomplish positive teacher-student relationships.

### **Interpersonal Complementarity**

Before defining interpersonal complementarity, we first describe the underlying theoretical framework of interpersonal theory (Horowitz & Strack, 2011; Kiesler, 1996). In interpersonal theory two basic dimensions form the basis for studying interpersonal behavior of a person. These dimensions have been given various names in the literature depending on the context in which they are used (Bruckmüller & Abele, 2013; Wiggins, 1991; Wubbels, et al., 2006). According to interpersonal theorists, these various names should be interpreted in reference to the meta-concepts Agency and Communion (Gurtman, 2009; Horowitz & Strack, 2011). In this study, we use these meta-concepts to describe both teacher and student interpersonal behavior. A high position on the *Agency*-dimension means someone is dominant, takes matters in his or her own hand, has power, and control; a high position on the *Communion*-dimension means that someone shows love, friendliness, and

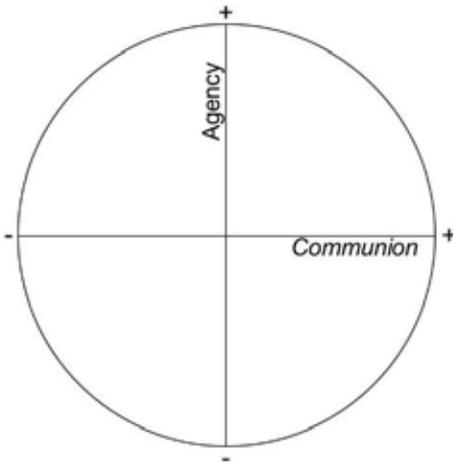


Figure 1. Interpersonal Circle.

affiliation (Gurtman, 2009). According to interpersonal theory, the interpersonal meaning of each behavior represents a specific blend of Agency and Communion, that can be graphically represented using the interpersonal circle (IPC, see Figure 1) (Fabrigar, Visser, & Browne, 1997; Gurtman, 2009; Kiesler, 1983; Leary, 1957; Sadler et al., 2009).

Interpersonal complementarity is a central aspect of interpersonal theory. This concept defines the interplay of behavior between two participants in interaction. It describes how the interpersonal behaviors of both participants fit together, mutually adjust to each other, and how this dynamically changes during interactions (Sadler et al., 2009; Sadler, Ethier, & Woody, 2011). Complementary in terms of Agency is defined as *reciprocity*, and tends towards *oppositeness*. For example, if a teacher takes control (high Agency) students usually tend to listen and go along with the teacher (low Agency). Teacher behavior then elicits opposite student behavior, thus, reciprocity. Complementary in terms of Communion is defined through *correspondence*, and tends towards *sameness* (Sadler et al., 2009).

For example, if the Teacher acts friendly towards the students (high Communion), it is likely that the students act friendly towards the teacher (high Communion). Teacher behavior then elicits the same student behavior, thus, correspondence (Figure 2).

Interpersonal complementarity has hardly been studied in educational settings. Roorda (2012) studied interpersonal complementarity in interactions between teachers and kindergartners and the relation of interpersonal complementarity with externalizing and internalizing behaviors of kindergartners. De Jong et al. (2012) studied interpersonal

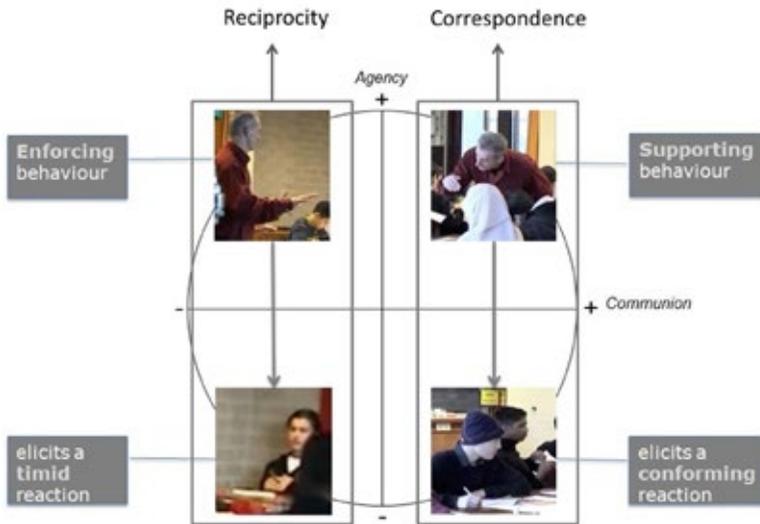


Figure 2. Interpersonal Complementarity.

complementarity in teachers' expectations of student responses, using vignettes describing teacher behavior and asking for anticipated student reactions. Mainhard et al. (2012) studied interpersonal complementarity in real-time secondary educational classroom situations, as a percentage of reciprocity and correspondence in interactions.

### The Present Study

In the past several studies on teacher-student interactions have been carried out. These studies (1) used surveys completed by the teacher or the students to measure their perceptions of the behavior of the other participant in the interaction (e.g., Buyse, Verschueren, Doumen, Van Damme, & Maes, 2008; Mainhard, Brekelmans, & Wubbels, 2011); or (2) observed when and how the teachers behaved towards the students, not what the students' behavior or reaction was (e.g., Davis & Nicaise, 2011; Pianta et al., 2008; Rubie-Davies, 2007; Yan, Evans, & Harvey, 2011); or (3) tallying the occurrence of teacher or student behavior towards teachers, students or peers (e.g., Booren, Downer, & Vitiello, 2012; Harper & McCluskey, 2003). None of these observational studies reported observing both teacher and student behavior and combining these observations to describe interactions. In the present study, we will use observations of both teacher and students' behavior to study three characteristics of interactions. Real-time interactions are the building

blocks of relationships and relationships can be improved by intervening on these characteristics. Therefore, more knowledge about these characteristics of real-time interactions is needed.

Until now interpersonal content, interpersonal structure, and interpersonal complementarity as characteristics of interactions have only been studied separately in educational settings (e.g., De Jong et al., 2012; Mainhard et al., 2012; Roorda, 2012; Thijs & Koomen, 2008). In the present study, we want to add to these studies by exploring the discriminant validity of these three characteristics in real-time teacher-student interactions together in one study. To do this, we compared the characteristics of real-time teacher-student interactions of two teachers with different relationships with their students: a teacher whose relationship with students is characterized by high Agency and low Communion according to students and a teacher whose relationship with students is characterized by low Agency and high Communion according to students.

## METHOD

### Design

For our exploration of discriminant validity of interpersonal content, interpersonal structure, and interpersonal complementarity in real-time interactions for the study of relations between real-time interactions and teacher-student relationships, we used two single subject case studies (Gast, 2010). Single subject case studies are ideal to highlight detailed descriptions of individual differences in behavior over time (Gast, 2010). We included two cases perceived as distinct in their relationship with students to explore the discriminant validity of the three characteristics of real-time interactions.

### Participants

Two teachers were selected from a larger database based on their students' scores on the Questionnaire on Teacher Interaction (QTI; Wubbels, et al., 2006). These student scores allowed us to describe the teachers in terms of their Agency and Communion behavior as perceived by their students on a developmental time level (Wubbels et al., 2006). The first teacher is a 48-year-old mid-career female French teacher and her class of 9<sup>th</sup> grade students from a pre-vocational education level. This teacher's behavior was perceived by her students as high on Agency and low on Communion. For the remainder of this article we refer to this teacher as Teacher A. The second teacher is a 36-year-old mid-career male arts teacher and his class of 10<sup>th</sup> grade students from a pre-vocational level. This teacher's behavior was

perceived by his students as low on Agency and high on Communion. For the remainder of this article we refer to this teacher as Teacher B.

## **Measures**

### ***Interpersonal Teacher and Student Behavior***

Interpersonal content, interpersonal structure, and interpersonal complementarity are characteristics of the real-time interactions between individuals. In the present study interactions between teacher and students were operationalized by the combination of individually observed teacher and student behavior. Student behavior was observed as a class composite; the class was observed as a whole and an average degree of Agency and Communion shown by the whole class was recorded.

### ***Sadler's Joystick Tracking Device***

Interpersonal behavior of students and teachers was coded continuously within the IPC following an online-scoring procedure and using Sadler's joystick tracking device (see Figure 3) (Sadler et al., 2009).

First teacher behavior and then student behavior was coded in separate observation sessions. According to Markey, et al. (2010) the joystick tracking device is designed to observe verbal and non-verbal behaviors that have clear interpersonal meaning. The observer can move the joystick to represent the teacher's or the student's ongoing interpersonal behavior, while watching a video recording of a lesson. The joystick device enabled us to observe behavior as a specific blend of Agency and Communion, instead of coding behavior separately for both dimensions. By moving the joystick in a certain direction, the behavior of the teacher or the students can be observed (a) continuously in time (online observation) and (b) represented as a degree of both Agency and Communion (Markey et al., 2010). This joystick tracking device comes with a computer program (Joymon.exe; Lizdek, Sadler, Woody, Ethier, & Malet, 2012) that numerically records the exact location (based on X- and Y-coordinates) of the joystick within a two-dimensional space, meant to represent the IPC (Markey et al.2010; Sadler et al., 2009). During the observation, a dot in the IPC (i.e., presented in a separate screen) marks the exact location of the joystick. These behavior coordinates ranged from -1000 (i.e., very low Agency/Communion) to +1000 (very high Agency/Communion). This range is a default setting of the joymon program and ensures

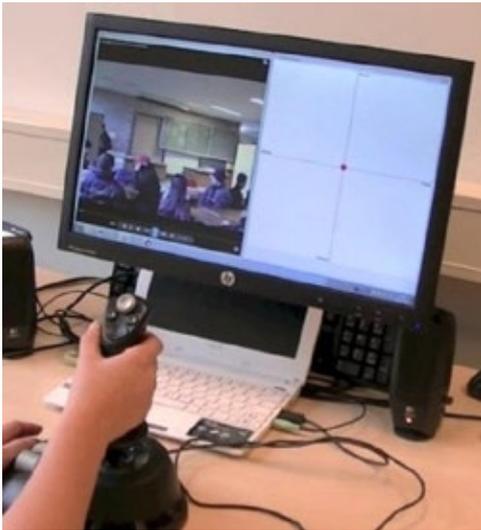


Figure 3. Interpersonal Joystick Data Gathering

maximum sensitivity of the computer joystick device. Also, by default the program is set to record the joystick location twice per second. In the current study, we also used this default setting to record teacher and student behavior twice per second.

Thus, in the present study, about 1500 behavior coordinates were provided for Agency and Communion, per teacher and class. For a more elaborate description of this computer joystick procedure see Lizdek et al. (2012).

To learn how to observe teacher-student interactions with the computer joystick one of the researchers (first observer) participated in a computer joystick training<sup>10</sup>. To establish inter-rater reliability a second observer was trained by the first observer to use the computer joystick method for the present study. By practicing and discussing how to code interpersonal teacher and student behavior reliably, together, they established some rules for coding the teachers and students in educational settings. For example, if the teacher, after whole class instruction, starts writing something on the blackboard, with his back to the classroom, the joystick movement goes down on Agency, because the teacher cannot see what is happening in the classroom. As a rule for coding students behavior was that if students engage in what the teacher asks them to do this is by definition coded as low on Agency.

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<sup>10</sup> The joystick training was provided by Pamela Sadler and Ivana Lizdek at Wilfried Laurier and Waterloo University in Canada. This training included general observations of interpersonal behavior with the joystick and was not related to the educational context.

After ten hours of training and discussing the observations, the quality of the observations was tested. To do so we calculated the Pearson correlation coefficient as a measure for inter-rater reliability for the coded Agency and Communion in all fragments of Teacher A:  $r = .68$  for Agency and  $r = .73$  for Communion.

### **Procedure**

To observe teacher and student behavior, one lesson was videotaped with two cameras. One camera was positioned in front of the classroom, the other in the back of the classroom. Consent for videotaping was in accordance with policies of the schools of the participating teachers. Most schools had written consent of parents allowing their children to participate in research and video-observation. If schools did not have such a policy teachers were provided with consent letters that parents could return if they objected to their child being filmed. Of the teachers selected for this study none of the parents objected to their child being videotaped for this study.

Another researcher selected three fragments of the recorded lesson were selected for coding: the lesson start, a situation where the teacher was dissatisfied about student behavior (e.g., the student did not listen to the teacher and the teacher sent the student out of the classroom) and a situation where the teacher seems to feel satisfied (e.g., laughing or joking). To illustrate these situations, we provided four one-minute fragments of these situations on the accompanying website<sup>11</sup>.

### **Analyses**

After coding the real-time behavior as a blend of Agency and Communion the joymon program provides the location coordinates for both dimensions separately. Thus, by using the joystick device to observe teacher and student behavior following an online-observation procedure individual time-series of behavior were generated for the teacher and the students. By aggregating the combined time-series in various ways it was possible to analyze the interpersonal content, interpersonal structure and interpersonal complementarity as characteristics of real-time interactions.

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<sup>11</sup> The video-clips provided on the accompanying website show simulations of the original scenes. Simulations were used and not the original scenes, to ensure the teachers' and students' privacy. The simulations are as close to the original scenes as possible, with the exception that the teacher and students on the original recordings spoke Dutch and the teacher and students on the simulations speak English. The original video recordings were coded to explore the characteristics of real-time interactions.

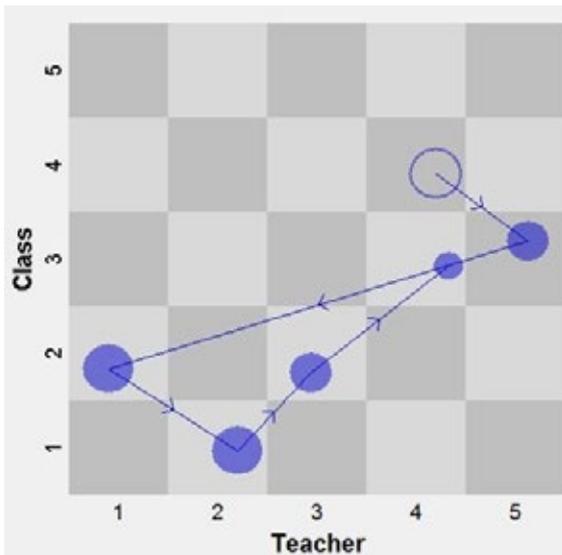


Figure 4. Example State Space Grid. That this is a hypothetical example of teacher and student Communion, and is solely designed to illustrate what a State Space Grid looks like. The X-axis represents teacher behavior and the Y-axis represents student behavior. The opaque dot represents the start of the interaction trajectory. In this example, we also included the trajectory lines and arrows to show the direction of the trajectory. On the accompanying website, a video representation of how the interaction trajectory moves through the SSG is provided.

### ***Interpersonal Content and Interpersonal Structure***

To study interpersonal content in terms of attractors and interpersonal structure in terms of variability in the teacher-student interactions we used State Space Grid (SSG) analysis (Hollenstein, 2013; Lewis, Lamey, & Douglas, 1999). To do this, teacher and student behavior coordinates were recoded into 5 categories per dimension: (1) *very low* = -1000 to -600, (2) *low* = -599 to -200, (3) *neutral* = -200 to 200, (4) *high* = 200 to 599, and (5) *very high* = 600 to 1000. On the Agency dimension the “very low” category indicates very passive, submissive or following behavior, and the “very high” category indicates very strict, dominant or leading behavior. On the Communion dimension the “very low” category indicates very hostile, irritated and angry behavior, and the “very high” category indicates very friendly, understanding and praising behavior. These combinations of teacher and student behaviors were plotted against each other in a SSG to create a visual representation of their interactional behavior (Figure 4).

The X-axis represents teacher behavior and the Y-axis represents student behavior. The cells in the grid represent states, combinations of teacher and student behavior in interaction. For example, the cell 33 means both teacher and students show neutral behavior. The duration of the interaction state is represented by the size of the dot in the corresponding cell. The larger the dot the more time the teacher-student interaction resided in this specific state. The example in Figure 4 represents teacher and student Communion. The interaction trajectory starts in cell 44, this means high student and teacher Communion, the teacher and students are friendly towards one another. The interaction then moves to cell 35, that means neutral student Communion and very high teacher Communion. Then the situation escalates and the trajectory then moves to cell 21, which means low student Communion and very low teacher Communion. Thus, both teacher and the students show unfriendly behavior in interaction with each other. The next step is cell 12, which represents very low student Communion and low teacher Communion. After some time the situation becomes more positive and gradually both the teacher and the students become friendlier. Thus the interaction moves to cell 23, which means low student Communion and neutral teacher Communion and to cell 34, which represents neutral student Communion and high teacher Communion.

### ***Interpersonal Content***

When the teacher-student interaction show specific combinations of teacher and student behavior often and if the duration of such combinations is long, this is an indication that this is an attractor for this teacher-student interaction.

### ***Interpersonal Structure***

To indicate the variability or structure of the interaction *dispersion* and *entropy* were used. Dispersion is a whole-grid measure indicating the number of visited cells, controlling for proportional duration in each visited cell (Hollenstein, 2013). Dispersion is expressed in a value between 0 (no variability) and 1 (maximum variability). Entropy is whole-grid measure that represents the number of transitions between cells. Low entropy indicates a highly-organized pattern in interactions, this means that the interaction consists of a combination of a small number of transitions between cells in the grid. High entropy means that the interaction consists of a combination of a large number of transitions between the cells in the grid, indicating that the pattern of interaction is relatively unpredictable (Dishion, 2004;

Hollenstein, 2013). Entropy is computed by the logged conditional probabilities of behavior transitions (Dishion et al., 2004).

### ***Interpersonal Complementarity***

To quantify the degree of interpersonal complementarity in real-time variation in teacher-student interactions we used detrended cross-correlations that quantitatively capture what can be seen in the visual representation of the time-series (Sadler et al., 2011) by removing the linear trend from the raw time-series data with regression analysis and correlating these detrended time-series with each other. Detrending is necessary because a regular cross-correlation procedure fails to distinguish shared trends between interaction partners over time. For example, if the degree of Communion increases over time, this trend produces a larger positive correlation (and thus higher complementarity) compared to a situation where there is no such trend.

## **RESULTS**

### **Interpersonal Content and Interpersonal Structure**

To obtain information about the interpersonal content and structure the interaction trajectories of the three fragments were combined and visualized together in State Space Grids separately for the two dimensions. The teacher-student interactions trajectory of Teacher A is presented in blue and in yellow for Teacher B (Figure 5 and Figure 6).

### ***Interpersonal Content***

In Figure 5 the two grids representing the interpersonal content of the interactions are presented. The X-axis shows real-time teacher behavior and the Y-axis shows real-time student behavior. The cells in the grid represent different types of real-time teacher-student interactions. The interpersonal content of the teacher-student interactions is visualized with the dots, the larger the dot the longer the interaction with the corresponding teacher and student behavior lasted.

In the grid for the Communion dimension (Figure 5) the teacher-student interactions of Teacher A mainly took place within the areas representing high Communion with some occasional deviations from these areas to areas where the interaction consists of a combination of very low Communion behavior for both the teacher and students. The teacher-student interactions of Teacher B mainly took place in the areas combining Neutral to Very high Communion in teacher behavior and Low to High Communion in student

behavior. Thus, on average the interactions of Teacher B seemed to show slightly more Communion than the interactions of Teacher A.

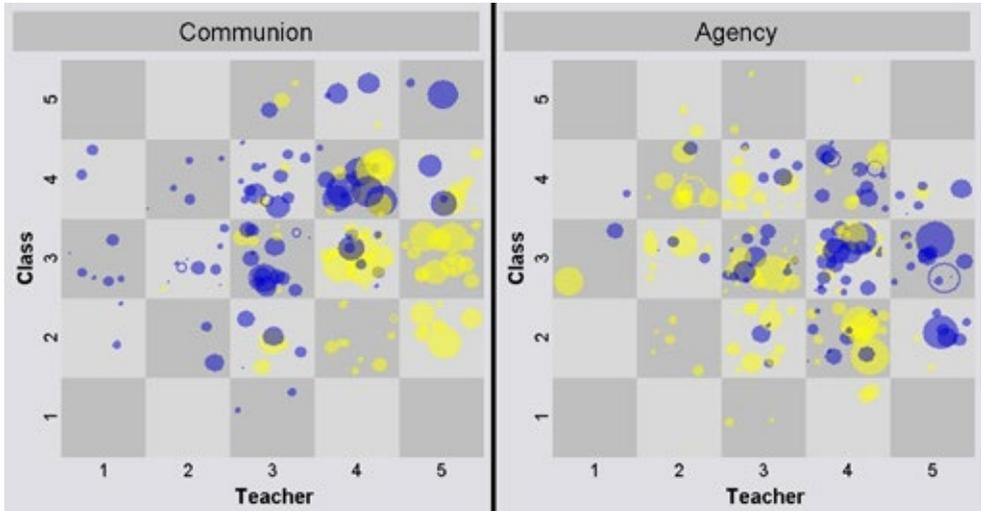


Figure 5. State Space Grids representing the interpersonal content of teacher-student interactions. Blue = Teacher A; Yellow = Teacher B.

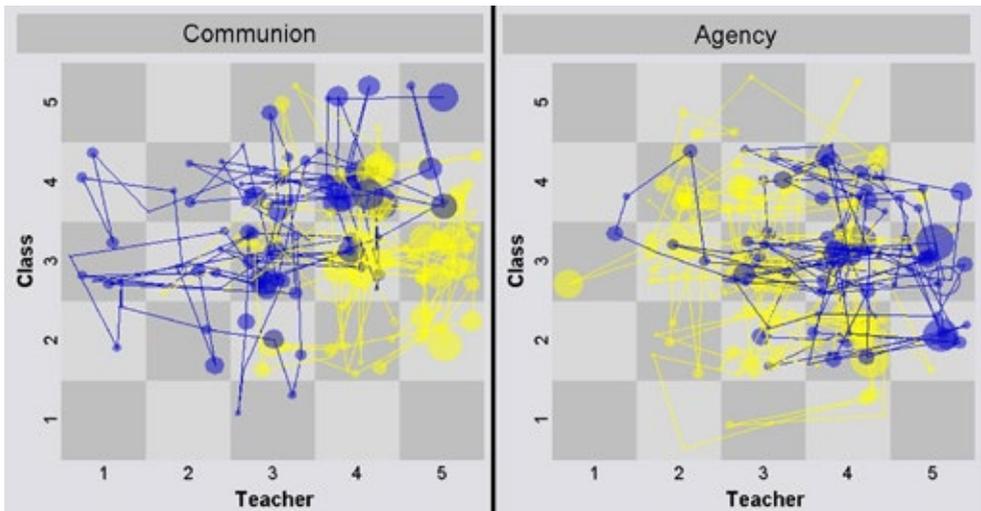


Figure 6. State Space Grid representing the interpersonal structure of teacher-student interactions. Blue = Teacher A; Yellow = Teacher B. On the accompanying website a video representation of how interpersonal structure moves in the SSG is provided.

By looking at the grid for the Agency dimension the teacher-student interactions of Teacher A mainly took place within the areas combining Neutral to Very high Agency in teacher behavior with Low to High Agency in student behavior. The teacher-student interactions of Teacher B mainly took place in the areas combining Low to High teacher and student Agency behavior. Also, a rather long interaction took place in the area with very low teacher and neutral student Agency behavior. Thus, the interactions of Teacher A seemed to show more Agency than the interactions of Teacher B.

These results show that there were differences in interpersonal content of real-time teacher-student interactions between the teachers in these three situations. Thus, by measuring interpersonal content it was possible to discriminate between two teachers who were perceived by their students as having a relationship with students with distinct degrees of Agency and Communion.

### **Interpersonal Structure**

In Figure 6 the two grids representing the variability of the interactions are presented. Again, the X-axis shows real-time teacher behavior and the Y-axis shows real-time student behavior. The cells in the grid represent different types of real-time teacher-student interactions. The lines in the grids are the transitions between interaction states and represent the variability of the teacher-student interaction trajectory.

Two grid measures were calculated to express the variability of the teacher-student interactions: Dispersion and Entropy. These measures were calculated overall, for Agency, Communion, and for the three fragments separately.

*Dispersion.* As explained in the method section dispersion was expressed in a value between 0 (no variability) and 1 (maximum variability) (Hollenstein, 2007). Total dispersion was .82 for Teacher A and .81 for Teacher B, this means that the teacher-student interactions of both teachers in general showed a rather large amount of variability. Dispersion for Teacher A's Agency was .84 and .80 for Communion. Dispersion for Teacher B's Agency was .83 and .79 for Communion, indicating that also the dispersion per dimension was rather high for both teachers.

In Table I, it can be seen that the dispersion for Teacher A was lower for Communion in the positive situation. Thus, the teacher-student interactions of Teacher A showed less variation in the positive situation than in the lesson start and the negative situation. For Teacher B it can be seen that the teacher-student interactions were less variable for Communion in the negative and the positive fragment than in the lesson start. Overall

variability for both teachers was high and the lesson start was the most variable and the positive situation the least variable. For Communion variability in the negative situation was higher for Teacher A than for Teacher B. This indicates that measuring interpersonal structure in terms of dispersion only discriminates between these two teachers with respect to Communion, mainly in the negative situation.

*Entropy.* Entropy is a grid measure that indicates how predictable interactions are based on the transitions between the visited cells (Dishion et al., 2004). Total entropy for Teacher A is 2.00 and for Teacher B entropy is 1.99. For Teacher A entropy per dimension resulted in 1.95 for Agency and 2.06 for Communion and For Teacher B entropy per dimension was 2.13 for Agency and 1.84 for Communion. Thus, for Teacher A Agency behavior was more stable than Communion and for Teacher B Communion behavior was more stable than Agency. When comparing these entropy values to the values found by Dishion et al. (i.e., values ranging from 2.2 to 3.7), these values indicate that differences in the interpersonal structure of the interactions of the teachers in this study were relatively small. Differences between teachers can also be regarded as small, because differences within teachers (between situations of one teacher) are larger than differences between teachers.

The entropy values per situation are also presented in Table I. It can be seen from these values that the positive situation showed the most predictable patterns of interactions for Teacher A: Communion was = 1.56 and Agency 1.59. Yet, for Teacher B the negative situation showed more predictable patterns: Communion was 1.33 for Teacher B. However, entropy of Agency of Teacher B in the negative situation was rather high, 2.12, thus, in the negative situation Agency in the interactions of Teacher B was less predictable, at least compared to the lesson start and Communion in the negative situation.

From the results of the dispersion measure we can conclude that variability is rather high in the teacher-student interactions of both teachers. Yet, from the results of the Entropy measure we can conclude that in comparison to the results of Dishion et al (2004) variability is small. This indicates that, although the teacher-student interaction trajectories move to a large number of cells, these are still rather predictable compared to interactions found in family or peer-relations studies (e.g., peer- or mother-child interactions). Interpersonal structure discriminates between the two teachers for Communion in the negative situation in terms of dispersion. The measure of entropy discriminates in the positive situation and to some extent in the negative situation.

### ***Interpersonal Complementarity***

In Figure 7 the time-series data are visualized<sup>12</sup>. We combined the interactions in the three situations to one time-series (start, negative fragment, positive fragment). The time-series for Teacher A are presented left and for Teacher B the time-series are presented on the right. The dark grey line shows teacher behavior and the light grey line shows student behavior. In these visualizations of the interactions one can see how the interactions between the teacher and the students fit together in time.

The upper part of Figure 7 shows the time-series of Agency as it occurs in time. The time-series of Teacher A has a higher level of Agency than her students and Teacher B's level of Agency is similar to his students' level of Agency. The level of Agency of Teacher A shows reciprocity with her students (i.e., where her level of Agency goes up, students' level of Agency goes down). For Teacher B, the level of reciprocity with his students; level of Agency is less clear.

In the middle part of Figure 7 the time-series for Communion are presented. Teacher B shows a higher level of Communion in his behavior than Teacher A. The time-series for Teacher A's level of Communion show some correspondence with her students' level of Communion especially in the middle part (i.e., negative fragment), the teacher and student time-series are also almost at the same level of Communion. For Teacher B especially in the middle part (i.e., negative fragment) the level of Communion is different. Yet, when Teacher B's level of Communion increases, his students' level of Communion also seems to increase. In the lowest part of figure 7 the combination of both Agency and Communion is presented, this is essentially a visualization of how the joystick was moved through the IPC.

Following the theory on interpersonal complementarity, we expected negative detrended correlations (reciprocity) for Agency and positive correlations for Communion (correspondence). Ten out of twelve correlations showed the expected sign (see Table 2).

The data for the positive situation in the class of Teacher A showed a negative correlation for Communion instead of the expected positive correlation. The data for the negative situation in the class of Teacher B showed a positive correlation for Agency instead of the expected negative correlation. None of the correlations showed perfect complementarity (-1.00 for Agency and 1.00 for Communion). Regarding differences in interpersonal complementarity we conclude that Teacher A (with a relationship with more Agency than

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<sup>12</sup> See the accompanying website for a 3D animation of the time series.

CHAPTER 4

Table 1.

Grid measures for the variability of teacher-student interactions per situation

	Teacher A						Teacher B					
	Communion			Agency			Communion			Agency		
	S	N	P	S	N	P	S	N	P	S	N	P
Dispersion	.84	.83	.72	.84	.86	.80	.88	.74	.75	.81	.87	.80
Entropy	2.19	2.42	1.56	2.05	2.09	1.59	2.06	1.33	2.11	1.82	2.12	2.47

Note. S = lesson start, N = negative situation, P = positive situation.

Table 2.

Detrended Cross-Correlations as an indicator for the Degree of Complementarity.

	Students											
	Lesson start				Negative situation				Positive situation			
	Agency		Communion		Agency		Communion		Agency		Communion	
Teacher A	Agency Communion		.36**		.05		-.15**		.21**		-.52**	
Teacher B	Agency Communion		-.70**		.29**		.40**		.49**		-.26**	

Note. \* = p < .05, \*\* = p < .001.

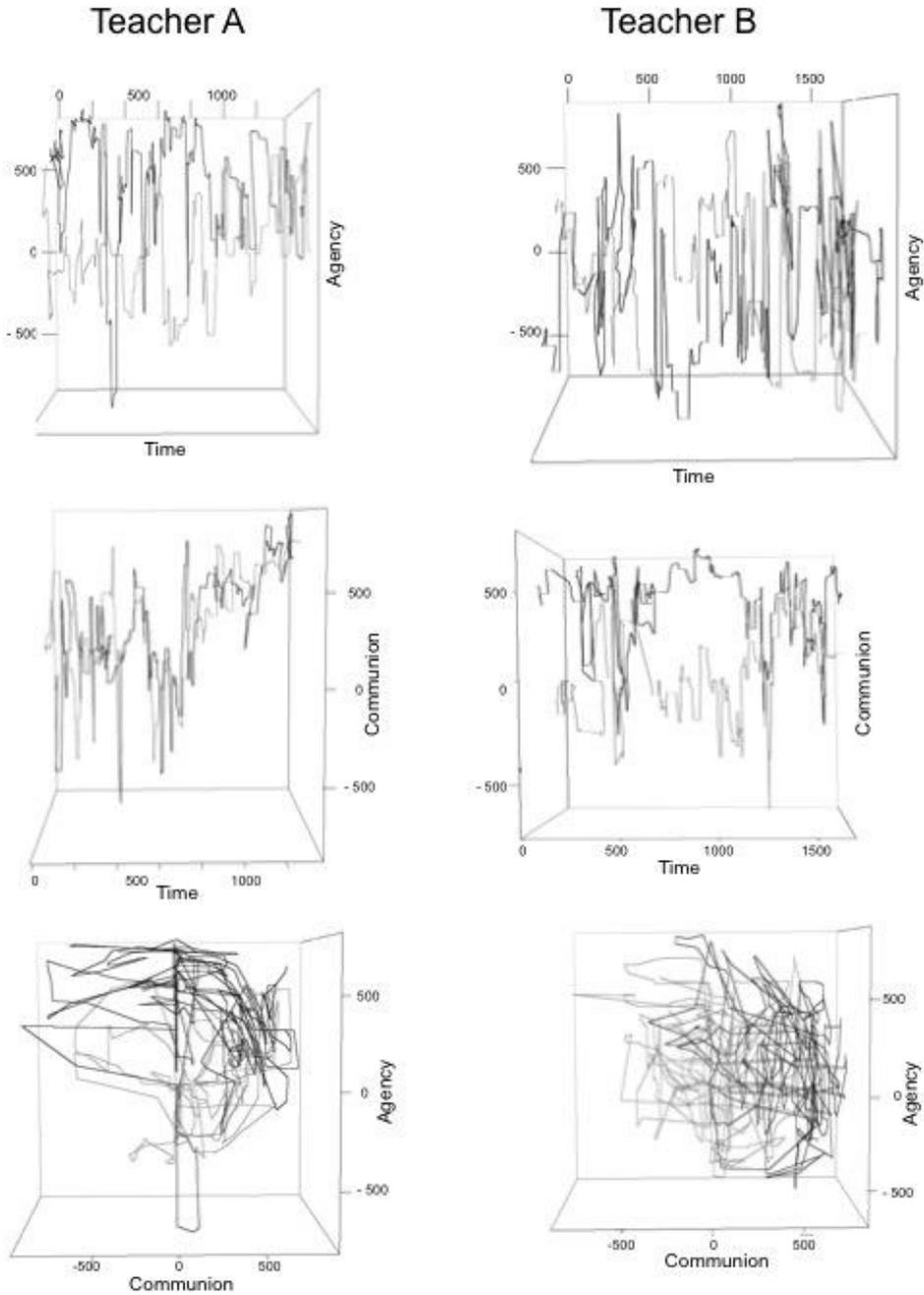


Figure 7. Time-series of real-time teacher and student behavior. Black = teacher behavior; Grey = student behavior. On the accompanying website, a video representation is provided to show how the time-series move in 3D.

Teacher B) showed less reciprocity in his real-time interactions with students during lesson start and in the negative situation, but higher reciprocity in the positive situation. But reciprocity of Teacher B was higher in the lesson start than for Teacher A. Teacher B (with a relationship with higher Communion than Teacher A) showed more correspondence in his real-time interactions than Teacher A in all three situations.

## **DISCUSSION**

The present study explored the discriminant validity of interpersonal content, interpersonal structure and interpersonal complementarity in real-time teacher-student interactions for teachers with different relationships with students. To do this, we compared these characteristics in real-time interactions of two teachers with a distinct teacher-student relationship in their classrooms.

### **Interpersonal Content**

The results of this study showed some differences in interpersonal content of real-time teacher-student interactions between the teachers. On average the interactions of Teacher A showed more Agency than the interactions of Teacher B whereas the interactions of Teacher B showed more Communion than the interactions of Teacher A. Thus, measuring interpersonal content in only a couple of minutes allowed us to discriminate between two teachers in a way that is consistent with student perceptions of the (general) relationship with these teachers. This is promising for research aiming to connect the level of relationships with the level of real-time interactions. For practice this is useful in helping teachers to understand their general relationship with students based on characteristics of their daily interactions with their students.

### **Interpersonal Structure**

Results on interpersonal structure of real-time teacher-student interactions showed that in general the differences between teachers are relatively small: differences between situations are larger than differences between teachers. This may imply that variability differentiates more between situations than between teachers. This would mean that it is important to take the situation into account when comparing variability in teacher-student interactions of different teachers.

### **Interpersonal Complementarity**

Regarding differences in interpersonal complementarity we found that the teacher-student interactions were complementary in most situations. Teacher B, with the higher Communion relationship, showed consistent correspondence in the real-time interactions with students in all three situations. For Teacher A results showed no correspondence in the positive situation. Teacher A, with the higher Agency relationship, showed consistent reciprocity in the real-time interactions with students in all three situations. For Teacher B results showed no reciprocity in the negative situation. These results indicate a connection between the level of Agency or Communion in teacher-student relationships and complementarity in the corresponding dimension in real-time interactions.

### **Limitations and Suggestions for Future Research**

We are aware that our study has some limitations that should be considered in future studies. First, this was only an exploratory study that compared two teachers with distinct teacher-student relationships. Yet, within the population of teachers there is a lot of variation in teacher-student relationships (Wubbels et al., 2006). These relationships vary in terms of Agency and Communion. To fully understand the discriminant validity of interpersonal content, structure and complementarity, we should compare these characteristics in interactions of teachers with other types of teacher-student relationships than in the present study.

Second, we analyzed teacher and student behavior separately for Agency and Communion. However, according to interpersonal theory, the relation of both dimensions can best be represented within a circular plane: the IPC (Gurtman, 2011). Gurtman (2011) described a vector-based method that considers the circular nature of the interpersonal construct. Circular statistics (Berens, 2009) is a promising technique to analyze data with a circular nature. In the future, using circular statistics will enable us to take behavior as a blend of Agency and Communion into account.

### **Practical implications**

The goal of our study was to increase understanding of how teacher-student relationships (macro-level) develop from real-time interactional processes (micro-level). We hope that such an understanding will help teacher educators create awareness among their student-teachers of, for example, the effect of teacher behavior on the interactions with students

## CHAPTER 4

and how these interactions will affect the teacher-student relationship and the classroom climate.

Teachers experience difficulties in changing routines or patterns in their behavior (Eraut, 2004). Van Eekelen, Vermunt, and Boshuizen (2006), however, contend that teachers are highly motivated to learn or change when they see the effect of their behavior on students. Video coaching and video guided training have been used in teacher professional development programs effectively to create a better understanding of the role of teacher behavior in teacher-student interactions (Brouwer, 2011; Fukkink, Trienekens, & Kramer, 2011; Tripp & Rich, 2012). Actively analyzing the role of teacher behavior in interactions and for instance zooming in on situations where knowledge of the complementarity principle could help teachers (re)gaining control of a situation, will encourage them to stay focused, view their practice from another perspective, and implement change (Tripp & Rich, 2012).

### **Conclusion**

The current study was an exploratory study on the discriminant validity of three characteristics of real-time teacher-student interactions. The results of this study suggest that interpersonal content, interpersonal structure, and interpersonal complementarity indeed discriminate between teachers with distinct teacher-student relationships. This study was a first step in studying teacher-student interactions as a micro-level process. The next step is to increase the number of teachers to study the discriminant validity of these three characteristics. Research on teacher-student relationships mainly focused on teacher behavior and less on the effect of this behavior on students. Studying interpersonal content, structure and complementarity in real-time interactions helps to increase knowledge about the effect of teacher behavior on student behavior. This provides clues to intervene and change behavior in the classroom to improve relationships and the classroom climate.





**CHAPTER 5****INTERPERSONAL ADAPTATION IN TEACHER-STUDENT INTERACTION**<sup>13,14</sup>**ABSTRACT**

We investigated how teachers' and students' interpersonal behavior patterns unfold and adapt to each other over time, during the lesson start. Using a continuous coding approach, observers rated moment-to-moment levels of Agency and Communion in teacher and student behavior during the first 10 minutes of a lesson in 35 classrooms. Based on the resulting time-series data we derived several indicators of interpersonal adaptation (e.g., entrainment of linear trends, synchronicity of rhythmic qualities). We examined to what degree the principle of interpersonal complementarity of interaction between people (sameness for Communion, oppositeness for Agency) applies to teacher-student interaction and how the specific professional role and status of the teacher would affect this.

Our expectations of interpersonal adaptation were basically confirmed in the present study. In most of the 35 classrooms, teacher and student behavior during the lesson start was consistent with the overall principle of interpersonal complementarity. The results were also in line with expectations about violations of the general principle, given the professional role of the teacher (e.g., refrainment from hostility).

Our exploration of the relation between momentary interpersonal dynamics and long-term teacher-student relationships supported our conjecture that attention to micro-processes in classrooms (e.g., pattern of variability, anticipation of behavior) adds to outcome-oriented, macro-level investigations of teacher-student relationships.

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<sup>13</sup> This chapter is based on Pennings, H. J. M., Brekelmans, M., Sadler, P., Claessens, L. C. A., Van der Want, A. C., & Van Tartwijk, J. (under review). Interpersonal adaptation in teacher-student interaction.

<sup>14</sup> Acknowledgement of author contributions: HP and MB designed the study, wrote the manuscript, and analyzed the data, LC, HP, and AvdW collected the data, PS developed the observation method and served as consultant on the analyses, PS and JvT contributed to critical revision of the manuscript, MB and JvT supervised the study.

In daily classroom interaction, teachers and students respond to each other's actions and reactions. Adaptation of the behavior patterns of teachers and students is essential for effective communication (e.g., Burgoon, Stern, & Dillman, 1995). In the present study, we explore how interpersonal behaviors of teachers and students adapt when they unfold over time during a lesson. We addressed questions like: Do students follow when the teacher takes the lead? Is the teacher able to remain friendly towards students when they are distant or hostile?

Capella (1996) characterized adaptation as “the defining characteristic of interpersonal communication” (p. 354). He drew a strong distinction between two major components, arguing that both are necessary to understand interpersonal interaction: (1) “mutual influence” referring to correlated adjustments of overall levels during interactions, and (2) “mutual adaptation”, referring to the dynamic process by which partners respond to changes in one another's behavior during interaction. We focused on the time-dependent interpersonal dynamics, as this second component is understudied in education.

With an orientation on detailed description of daily classroom interaction, we designed a process oriented, micro-level investigation (e.g., Lavelli, Pantoja, Hsu, Messinger, & Fogel, 2005), which adds to outcome-oriented, macro-level investigations of teacher-student interaction. Further, the present study concerns adaptation in the affective, social-emotional domain of educational processes, and thereby adds to the current attention to scaffolding and contingency in the cognitive domain (e.g., Van de Pol, Volman, & Beishuizen, 2010). Practical implications of the study appertain to teacher professionalization: To the diagnosis of (problematic) interactions and the underpinning of designs of effective interventions that make use of (video-taped) classroom interaction data.

To examine interpersonal adaptation in daily classroom interaction, we used a combination of insights from interpersonal theory (e.g., Carson, 1969; Horowitz & Strack, 2011; Kiesler 1983, 1996) and literature on mutual adaptation in social interaction (e.g., Burgoon et al., 1995; Capella, 1996; Warner, 1988), following Sadler, Ethier, Gunn, Duong, and Woody (2009).

### **Interpersonal Theory**

A basic principle of interpersonal theory is that the most important aspects of human behavior in interaction with other people can be captured by means of just two dimensions: *Agency*, which connotes ideas of dominance, power, status, and control, and *Communion*,

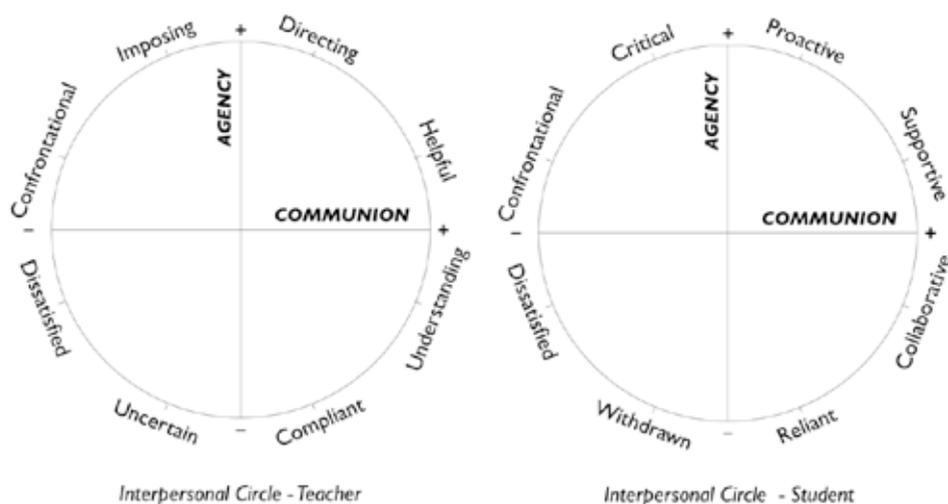


Figure 1. The Interpersonal Circle for Teachers (left, IPC-T) and Students (right, IPC-S). Words at the circumference of the circle are prototypical descriptions of interpersonal teacher and student behavior each representing a specific blend of Agency and Communion.

which suggests love, affiliation, union, and friendliness (Gurtman, 2009). Agency and Communion are used as meta-concepts to label the two interpersonal dimensions (Bakan, 1966; Fournier, Moskowitz, & Zuroff, 2011; Wiggins, 1991). In specific contexts, alternative names, such as Control/Affiliation, Dominance/Friendliness, or Influence/Proximity are used (e.g., Sadler et al., 2009; Wubbels et al., 2012). Each word to describe the behavior of a person (e.g., friendly, demanding) can be regarded a specific blend of Agency and Communion. The interpersonal meaning of the words is represented by their angular position on a circular continuum called the Interpersonal Circle (IPC; Fabrigar, Visser, & Browne, 1997; Gurtman, 2009; Horowitz & Strack, 2011; Kiesler, 1996). Figure 1 presents prototypical descriptions of classroom interpersonal behavior of teachers (IPC-T) and students (IPC-S). For example, the descriptors *helpful* and *confrontational* in IPC-T, and *supportive* and *confrontational* in IPC-S share the same Agency, but are opposite regarding Communion.

The IPC can also be used to describe features of persons at different time-scales: moment-to-moment behavior (e.g., Mainhard, Pennings, Wubbels, & Brekelmans, 2012), behavior on average over the course of an interaction (e.g., Mainhard, Brekelmans, & Wubbels, 2011), and behavior as it is generally consistent across situations and over a longer period, such as a

school year (i.e., teacher-student relationships; e.g., Brekelmans, Wubbels, & Van Tartwijk, 2005).

To study interpersonal adaptation in teacher-student interaction we used the interpersonal complementarity principle (Kiesler, 1983), which states that a person's interpersonal behavior is not random but contingent upon the interpersonal behavior of the other person(s) with whom he or she is interacting. Behavior of people in interaction includes a specific interpersonal bid that tends to initiate, invite, or invoke specific behavior from the other person(s). The direction of complementarity is specified as follows (Kiesler, 1983, 1996; see also Sadler et al., 2009): regarding Agency the expected direction is one of oppositeness, regarding Communion one of sameness. To illustrate (see Figure 1), *imposing* teacher behavior tends to invite *withdrawn* student behavior and *helpful* teacher behavior tends to invite *collaborative* student behavior.

According to Kiesler (1983) the formulated direction of complementarity applies primarily to naturally occurring, relatively unstructured interpersonal situations. The extent to which it applies in various structured situations remains to be determined. In classrooms, the specific role and status of teachers and students (e.g., Carson, 1969; Cothran & Ennis, 1997; Pomeroy, 1999) provide a specific structure to their interaction. Teachers, with far more education and experience of life than their students, have a different set of behavioral resources, and, as professional educators, also a different set of responsibilities. They are expected and trained to act in the best interest of their students. Therefore, they will be motivated to sometimes inhibit the tendency to react in complementary ways to student behavior. For example (see Figure 1), when faced with hostile (confrontational, dissatisfied) student behavior, teachers may be able to refrain from automatically responding with hostility, and instead respond with neutral, or even friendly (helpful, understanding) behavior, in the best interest of the students (Thijs, Koomen, Roorda, & Ten Hagen, 2011). Likewise, when confronted with dominant (critical, proactive) student behavior, teachers may intentionally override the more automatic submissive (uncertain, compliant) behavior, and instead react dominantly (*imposing*, *directing*), in the best interest of safeguarding the learning process of all students in the classroom.

### **Insights from Literature on Mutual Adaptation in Social Interaction**

In the literature on mutual adaptation in social interaction, interpersonal adaptation is conceptualized - as in interpersonal theory - by means of associations between both overall levels as well as dynamics over time in behavioral patterns of partners in interaction.

Especially adding to the insights from interpersonal theory is the attention to rhythmicity in behavior and the synchrony of recurrent cycles in behavior of partners in interaction. Visualize two dancers. Their dancing is perfectly synchronized when there is a highly flowing, agile and continuous rhythm with enmeshed movements of both partners, each with his or her own balance (e.g., Burgoon et al., 1995; Sadler et al., 2009). Burgoon et al. (1995) called the entrained pattern of mutual adaptation *interactional synchrony* and defined it as “similarity in rhythmic qualities and enmeshing or coordination of the behavioral patterns of both parties” (p.128).

As an overall format to study how temporal patterns in behavior of people in interaction may be interrelated, Warner (1998) proposed a threefold distinction: (a) association between (linear) trends in the time series, (b) association between *cyclical patterns*, and (c) association between *residual fluctuations* (deviating from trends and cycles). An estimate of “overall coordination – combining the contribution of any trends, cycles, and residuals” (Warner, 1998) is the *cross-correlation* between raw data of the time-series of both partners in interaction. Examining the association of trends and cycles focuses on the match of regular patterns in moment-to-moment variability in teacher and student behavior in classrooms. Examining the association of residual fluctuations focuses on a more momentary match of behavioral patterns (e.g., adaptation to “unexpected” eruptions of hostility; Warner, 1998). The three-fold distinction has been adopted in several papers investigating dyadic social interaction, particularly from the perspective of interpersonal theory (e.g., Sadler, Ethier, & Woody, 2011; Thomas, Hopwood, Woody, Ethier, & Sadler, 2014).

Studies on interpersonal adaptation in the context of education

In the context of education there are only a few studies available examining moment-to-moment teacher-student interaction with the dyadic approach needed to study interpersonal adaptation. These studies generally confirmed the principle of interpersonal complementarity.

In small scale studies (two teachers) in secondary education, Mainhard, et al. (2012), and Pennings, Van Tartwijk et al. (2014) illustrated the principle of interpersonal complementarity in momentary teacher-student interactions, and showed that interactions in the classroom of the teacher with a teacher-student relationship characterized by high levels of Agency and Communion had a higher degree of complementarity than interactions in the classroom of the teacher with a teacher-student relationship characterized by lower levels of Agency and Communion. Results of a study by Thijs et al. (2011) on individual kindergartners ( $N=69$ ) in interaction with teachers during a dyadic task outside the

classroom were also consistent with the principle of interpersonal complementarity. Thijs et al. found a positive correlation between the level of Affiliation displayed by teachers and students, and a negative correlation between their levels of Control. Roorda, Koomen, Spilt, Thijs, and Oort (2013) studied interactions between teachers ( $N=48$ ) and selected kindergartners with a variety of externalizing and internalizing behaviors ( $N=179$ ) in a small group task setting within the naturalistic classroom setting. They found that reactions of teachers and students followed the complementarity principle on the Control dimension, but not on the Affiliation dimension.

### **Present study**

With the present study, we aimed to add to the understanding of interpersonal adaptation of teachers and students by (1) studying natural classroom settings in secondary education, (2) using a relatively large sample of classrooms in view of the time-consuming data-management, and (3) examining the interrelation of time-series data of teachers and students from a moment-to-moment perspective using spectral analysis (Warner, 1998). The following research question guided the study: *What is the degree and nature of interpersonal adaptation in moment-to-moment teacher-student interaction in classrooms?*

Consistent with the complementarity principle as specified by interpersonal theory, we basically anticipated sameness regarding Communion and oppositeness regarding Agency for overall cross-correlations, linear trends, cyclical patterns, and residual fluctuations. Due to the context of the classroom with the specific role and status of students and teachers, we expected to find violations of the proposed directions.

Theoretical and practical relevance of differences between classrooms regarding the degree and nature of interpersonal adaptation increase when they relate to factors that are important for the quality of teaching and learning. In the present study, we explored this relevance with the teacher-student relationship as a criterion. The teacher-student relationship is characterized as stabilized behaviors of teachers over a longer period (e.g., a school year). Empirical evidence from earlier studies showed that the quality of teacher-student relationships is related to student cognitive and affective outcomes (e.g., Den Brok, Brekelmans, & Wubbels, 2004), and teacher job satisfaction (e.g., Brekelmans, 1989; Veldman, Van Tartwijk, Brekelmans, & Wubbels, 2013).

## METHOD

To study interpersonal adaptation in classrooms, we largely followed the approach used by Sadler and colleagues (e.g., Sadler et al., 2009; Thomas et al., 2014; Lizdek, Woody, Sadler, & Rehman, 2016). The approach captures interpersonal dynamics as a continuous, contextualized flow of behavior based on continuous coding of videotaped behaviors using a computer joystick apparatus.

In the present study, we restricted coding of interactions in all types of educational settings (teacher-individual student, teacher-small group, teacher-whole class interaction) to the class-level dynamics (cf. individual-level dynamics). We coded teacher Agency and Communion from a shared student perspective and shared Agency and Communion in students' behavior from a teacher perspective.

### Participants

Participants in the study were teachers and students from secondary schools in the Netherlands. From a larger sample of teachers who agreed to participate in a longitudinal study on classroom climate ( $N=189$ ), we selected a group of 36 teachers and their classes (restriction due to time-consuming data-management). The selection criteria for the present study included the following: (a) a video-taped lesson available; (b) data available on the relationship the teacher has with the video-taped classroom; and (c) full range of teacher-student relationships, i.e. teachers with relationships in all quadrants of the IPC-T. We had to remove one of the 36 classrooms because the video did not display interactions between teachers and students due to students taking a written test. This left us with a sample of 35 classrooms (35 teachers, 746 students, 27 schools).

Teachers in our sample (14 female, 21 male; age 22-59 years,  $M=42.4$ ,  $SD=10.7$ ) had different levels of teaching experience (1-35 years,  $M=11.3$ ,  $SD=11.4$ ) and taught different subjects (i.e., languages,  $N=6$ ; science,  $N=18$ ; history, geography, economy,  $N=8$ ; and art related subjects,  $N=3$ ). Classes were from different levels of secondary education (preparatory secondary vocational, senior general secondary, university preparatory), and different age groups (12-18 years). Figure 2 presents the combination of Agency and Communion scores characterizing the teacher-student relationships of the teachers, positioned in the IPC-T (see Figure 1) in our sample and in a large Dutch sample ( $N > 18,000$  classrooms). In line with the large Dutch sample, the teacher-student relationships in

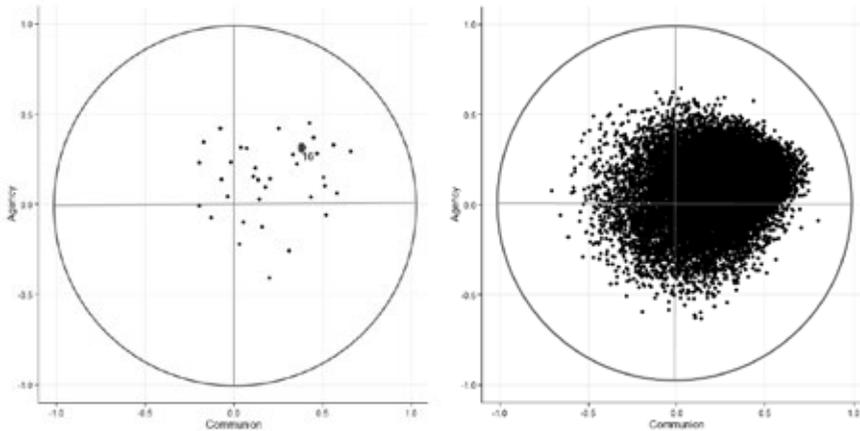


Figure 2. Teacher-student relationships presented in IPC-T, study-sample (Left, N=35, dot-16 refers to the teacher-student relationship in Classroom I6, see 2.2.1), and large Dutch Sample (Right, N > 18,000).

our sample are not equally distributed over all four quadrants (from upper right to upper left: our sample: 60%, 17%, 6%, 17%, large Dutch sample: 63%, 22%, 6%, 9%).

Parental consent was in accordance with policies of the schools of the participating teachers. Most schools had written consent of parents allowing their children to participate in research and video-observation. In schools without such a policy, teachers were provided with consent letters for parents to return when they objected to their child being filmed. After data collection was finished, teachers received the video recordings and a written report on the class perceptions of their teacher-student relationship.

### **Capturing moment-to-moment teacher-student interaction**

#### ***Continuous Coding***

To study moment-to-moment teacher-student interaction we used videos, a computer joystick apparatus, and monitoring software developed by Sadler et al. (e.g., 2009)<sup>1</sup> allowing observers to code behavior of people in interaction continuously as it unfolds over time. In the present study, we recorded for each teacher a lesson with: (a) one camera positioned in the back of the classroom, resulting in a video to code teacher behavior, and (b) one camera in front of the classroom, resulting in a video to code student behavior. The corresponding software is programmed to record, by default, behavior coordinates every half-second, and

coordinates range from -1000 = very low Agency/Communion to +1000 = very high Agency/Communion (i.e., to ensure maximum sensitivity of the computer joystick device).

Each teacher and student video was coded by two out of four trained observers<sup>2</sup>. Inter-rater reliability (intra class correlations, ICC(k=2), Markey, Lowmaster, & Eichler, 2010) indicated strong agreement between the observers (LeBreton & Senter, 2008), teacher Agency  $M=.83$  ( $SD=.09$ ), teacher Communion  $M=.73$  ( $SD=.11$ ), student Agency  $M=.88$  ( $SD=.09$ ), and student Communion  $M=.81$  ( $SD=.14$ ). Accordingly, ratings of Agency and Communion of the two observers were aggregated at each time point for both teachers and students, thus dampening idiosyncratic observations. This resulted in two behavioral trajectories for each teacher, and two trajectories for the students. Because the trajectories are exactly coordinated in time, they can be combined to study their moment-to-moment interrelation.

### ***Analysis of Time-series Data***

To examine the degree and nature of interpersonal adaptation in our sample of 35 classrooms, we first submitted each classroom to time-series analyses, and then summarized these results over the entire sample. To handle time-consuming coding of the videos, we restricted coding to the first 10 minutes of a lesson of each participating teacher with his or her class. We chose this part of the lesson, because it is (1) part of every lesson, (2) important for an effective teaching-learning environment (Van Tartwijk, Brekelmans, Wubbels, Fisher, & Fraser, 1998; Van der Want et al., 2015) and (3) with a duration sufficient to identify representative patterns of moment-to-moment interaction (Sadler et al., 2009). The 10-minute observation of the lesson start, captured by 0.5-second time points by the joystick software, resulted in 1200 data points. We removed (1) the first 20 data points (10 seconds) of observation allowing the observers to orient themselves to the interaction moving the joystick from the origin to the appropriate position, and (2) the codes after 588 seconds (9.8 minutes) to ensure an equal number of data points for all classrooms. This left us with time series of  $N=1,176$  data points.

In the remainder of this section, we will explain the time-series analysis method and illustrate its application with data of a specific teacher-class combination (Classroom 16: senior general secondary education; subject: physics; teacher: male, 27 years of age, 2 years of teaching experience, students: age group 14-15 years; teacher-student relationship see Figure 2).

Teacher and student interpersonal level and variability. The proposed indicators of interpersonal adaptation (match between trends, cycles, residual fluctuations, and overall correlation) presume variability in both teacher and student interpersonal behavior during the course of the interaction. Figure 3 presents visual information on the level and variability of agentic and communal behavior.

These graphs show time (in half-seconds) along the x-axis and the dimension of behavior along the y-axis. The top graph shows that, for the most part, the levels of teacher and student Communion tend to increase and decrease together, and for the first 410s or so, teacher Communion is greater than student Communion, which markedly increases between 310 and 470s. The bottom graph shows that typically when the teacher is higher in Agency, the students are lower in Agency, and when teacher Agency increases, student Agency tends to decrease. Variability in terms of *SD* supplements that this variability of teacher Communion was just over half of that of the students ( $SD_{teacher}=141$  and  $SD_{students}=262$ ), while variability in Agency was larger compared to Communion for both teachers and students, and for the teacher again lower than for students ( $SD_{teacher}=326$  and  $SD_{students}=458$ ). In Classroom I6 the mean level of Communion was positive for both the teacher ( $M=627$ ) and the students ( $M=485$ ). The mean level of Agency was positive for the teacher ( $M=466$ ) and negative for the students ( $M=-258$ ).

Figure 4 presents density plots of the combination of agentic and communal behavior for the teacher and students, both collapsed over time (Thomas et al., 2014). The intersection of mean levels of Agency and Communion is represented by a white plus sign, and variation around this intersection as shading with the less dense parts colored with lighter shades.

The density plots graphically show positive communal behaviors during the lesson start for both the teacher and the students in Classroom I6. It is evident that the variation does not equally spread in all directions: the behavior of the teacher and the students involves changes in dominance while maintaining friendliness.

### ***Interpersonal Adaptation***

Visual inspection of Figure 3 reveals that fluctuations in teacher and student Communion scores track each other quite closely. For Agency, there is a consistently strong inverse association in the moment-to-moment levels: peaks in one time series go together with troughs in the other. The cross-correlation of the time-series data of teachers and students was  $-.86$  for Agency and  $.71$  for Communion, both indeed representing strong associations that are consistent with the complementarity principle. Yet, cross correlations may reflect

only shared overall change rather than the smaller scale phenomena in the bivariate time series. Therefore, we removed the linear trend from the teacher and students' time series (i.e., calculating residuals from a linear regression with time as the predictor) and computed cross correlations between the residuals from the respective linear regressions (i.e., detrended cross-correlations; e.g., Sadler et al., 2009). For Classroom I6, this resulted in a detrended cross-correlation of  $-.81$  for Agency and  $.62$  for Communion. Both cross-correlations remained in the direction expected from the complementarity principle, although the effect on the Communion dimension was slightly more attenuated.

Although linear trends can confound cross-correlations by reflecting only shared overall change and not the moment-to-moment association of time series, they are also informative on their own about the dynamics of teacher-student interaction. To examine linear trends in the time series we performed ordinary least squares regression analyses with time as the predictor variable and Agency and Communion as the criterion variables (Warner, 1998). Data of Classroom I6 showed a significant ( $p < .001$ ) linear trend in teacher Communion (start=504, after 10 mins=742,  $R^2=.24$ ), student Communion (start=96, after 10 mins=847,  $R^2=.69$ ), teacher Agency (start=158, after 10 mins=753,  $R^2=.28$ ), and student Agency (start=156, after 10 mins=-644,  $R^2=.26$ ). Thus, during the first ten minutes of the lesson in this classroom teacher and student Communion increased, teacher Agency increased and student Agency decreased (for further interpretation see 3.1.2).

To quantify the cyclical nature of the time series, we performed spectral analysis (SPSS-SPECTRA, version 22). Examination of assumptions for spectral analysis (Warner, 1998; Tabachnick & Fidell, 2007) showed that the time-series data of Classroom I6 did not have extreme outliers (no standardized scores higher than 3.29) and were approximately normally distributed (based on inspection of (detrended) normal Q-Q plots; skewness and kurtosis between  $-1.17$  and  $0.63$ ). Spectral and cross-spectral analyses were smoothed using a Tukey-Hamming window with a span of 5.

As a first step, we tested the significance of recurrent cycles (periodic components) in the detrended time series of teachers and students (Fisher test,  $p < .05$ , Warner, 1998); for Classroom I6 this significance was confirmed. Because the cyclical nature of communal and agentic behavior during classroom interactions is not perfectly regular, conceptually it would not make sense to restrict the consecutive analyses to recurrent cycles with only one particular cycle length. Instead, in accordance with other work (Lester, Hoffman, & Brazelton, 1985; Warner, 1998) we based the analyses on a set of cyclical components.

CHAPTER 5

To decide on the number of cyclical components we selected the components with more than trivial contributions to the variability in the detrended Agency and Communion scores (i.e., explaining more than 1% of the variance, Sadler et al., 2009). Because the pacing and strategies used by teachers in classrooms may differ markedly, we preferred not to assume the same set of cyclical components for all classrooms (in contrast to Sadler et al., 2009), but used a classroom specific cut off to decide on the number of components.

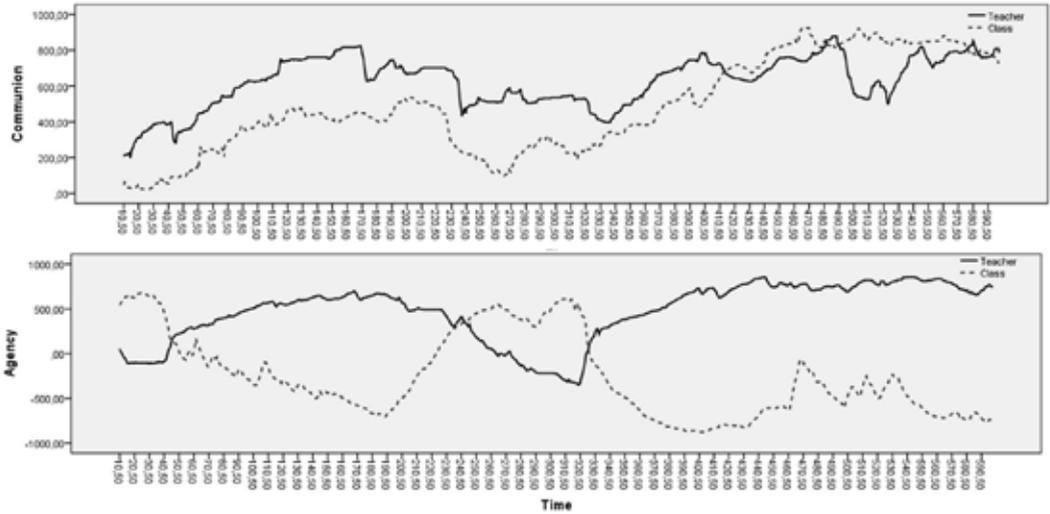


Figure 3. Bivariate time series of teacher and students (Classroom 16) for Communion (above) and Agency (below).

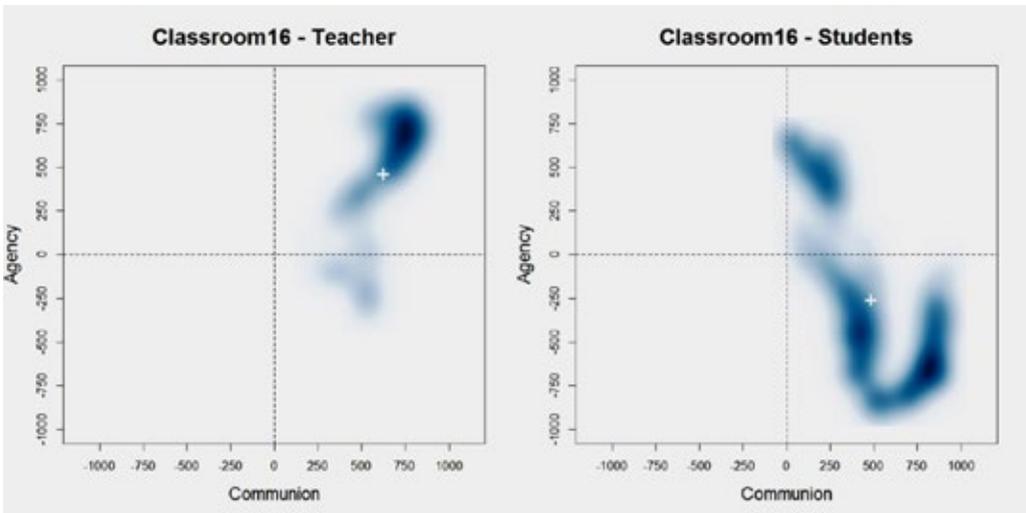


Figure 4. Density plots for the teacher (left) and students (right) of Classroom 16.

For the sake of simplicity, we chose only one cut off for all four time series of each classroom. Whenever the number of cyclical components differed for the teacher and student time series of Agency, we selected the smaller of the two, and used the same procedure for Communion. Whenever the number of cyclical components then differed for Agency and Communion, we used their rounded average. For Classroom I 6, the index of rhythmicity (i.e., the proportion of variance explained by the selected set of 7 out of 588 possible cyclical components in the detrended scores of the teacher time series) was .83 for Communion and .96 for Agency, and for the student time series, the rhythmicity was .95 for Communion and .93 for Agency. These large rhythmicity indexes (over .80, see Sadler et al., 2009) indicated reasonably regular cycles in both teacher and student behavior. These regular cycles are a prerequisite for interactional synchrony (i.e., the degree of association between cyclical patterns in behavior).

To examine interactional synchrony between teacher and student behavior, we computed the *average weighted coherence* and *average weighted phase* using cross-spectral analysis. Coherence (ranging from 0 to 1) is a non-directional measure of interpersonal adaptation and may be interpreted (like  $R^2$ ) as the estimated portion of variance shared by the two time series for a specific cycle length. To determine the coherence for the set of cycle lengths we averaged the coherence values after weighting them by the proportion of variance in the teacher's and students' univariate spectra at each cycle length. Classroom I 6 has an average weighted coherence of .65 for Communion and .78 for Agency, showing a considerable degree of entrainment of cyclical variations (compare to  $R^2$ ; Cohen, 1988). By means of phase we examined the lead-lag relationship between the cyclical patterns in the behavior of teachers and students. To determine phase for the set of cycle lengths, we averaged the phase values after weighting them by the proportion of variance in the teacher's and students' univariate spectra at each cycle length. Phase represents the degree of displacement from one person's peak in a time series to the other person's peak, which could readily be explained as a time lag familiar within the act-to-act approach (i.e., approach with segmentation of interaction into separate acts). We expressed phase as the fraction of a full cycle by which the peaks in teacher and student behavior are separated. Phase ranges from -0.5 to 0.5. A value of 0 indicates teacher and students peak at the same moment (implying sameness), and values of -0.5 and 0.5 indicate that their peaks are opposite (implying oppositeness). A positive phase indicates that the teacher tends to lead and students follow, whereas a negative phase indicates students tend to lead and the teacher

follows. For Classroom 16, average weighted phase was  $-.01$  for Communion and  $.46$  for Agency. Thus, in Classroom 16, the teacher tends to follow students with sameness regarding Communion, and to lead regarding Agency with students following with oppositeness.

To examine associations between “random” behaviors of teachers and students, we removed trends and cycles (residuals of second order autoregressive model, see Sadler et al., 2009; Warner, 1998) and computed the lagged cross correlation functions interrelating the pairs of residuals for teacher and student Agency, and teacher and student Communion, considering substantial lags in either direction ( $N=250$ ). In Classroom 16, there were no clear high points (the cross correlations for Communion and Agency at these various time lags ranged between  $-.09$  and  $.09$ ). In sum, for Classroom 16, the relations between these random fluctuations in behaviors appeared to be relatively unimportant.

### ***Capturing Teacher-Student Relationship***

To explore the relevance of differences between classrooms regarding the degree and nature of interpersonal adaptation, we related the indicators of adaptation in the first 10 minutes of one lesson to the teacher-student relationship. We measured the teacher-student relationship with class-aggregated student observations of their teacher’s interpersonal behavior across at least 6 months of classroom experience, using the Dutch 24-item Questionnaire on Teacher Interaction (QTI, Brekelmans, Den Brok, & Wubbels, 2011; Wubbels, Brekelmans, Den Brok, & Van Tartwijk, 2006; Wubbels et al., 2012). Examples of items are “This teacher has humor,” and “This teacher is dissatisfied.” Every item consists of a five-point scale (1 = never and 5 = always). We derived Agency and Communion scores by weighting the items based on their position on the Interpersonal Circle (Locke, 2011). Based on a large database, the circumplex structure (Browne’s circular stochastic process model tested with CIRCE, Grassi, Luccio, & Di Blas, 2010), showed satisfactory model fit indices for individual student perceptions ( $\chi^2(28, N=18,424$ ; of each classroom one student was chosen at random) =  $64917.46$ ;  $p < .01$ , RMSEA= $0.043$ ; CFI =  $.99$ , TLI =  $.97$ ; Pennings, Brekelmans et al., 2014). The reliability of the dimension scores in the present study was very good (Cronbach’s alpha: Agency  $.89$ , Communion  $.95$ ); ICC( $k$ =class size, Lüdtke, Robitzsch, Trautwein, & Kunter, 2009): Agency  $M=.97$ ,  $SD=.01$ ; Communion  $M=.96$ ,  $SD=.01$ ).

Given the small sample size, we compared interpersonal adaptation indices of two groups of classrooms: those with a teacher who had a more preferred teacher-student relationship,



Figure 5. IPC-T (see Figure 1) with areas of less preferred (2-5) and more preferred (1) teacher-student relationships. Radius circular area in the middle is  $0.2 \times \text{radius area IPC-T}$ .

and those with a teacher who had a less preferred teacher-student relationship. For the division we used information on teacher-student relationships as they are favored by teachers and students, and information from research on the association of teacher-student relationships with cognitive and affective student outcomes.

Specifically, an analysis of perceptions of teachers of their ideal teacher-student relationship ( $N=7,958$ ) showed that 99% favored a teacher-student relationship in the directing-helpful area of the IPC-T, excluding the area in the middle (“struggling”, see Figure 5 and see also Wubbels et al., 2006). Teacher-student relationships positioned in this part of the IPC-T have relatively high scores on both Agency and Communion. This ideal perception of teachers is also in line with how students, on average, perceive the teacher-student relationship with their best teacher, which is positioned in the same area of IPC-T. Furthermore, research on the association between student outcomes and teacher-student relationships (e.g., Den Brok et al., 2004) showed that higher teacher Agency and Communion go together with higher student cognitive and affective outcomes. We therefore qualified teacher-student relationships located in the upper right area of Figure 5 as more preferred, and the ones in the remaining four areas as less preferred.

## RESULTS

### Degree and Nature of Interpersonal Adaptation in Daily Classroom Interaction

#### *Teacher and Student Interpersonal Level and Variability*

Table 1 summarizes information on the level and variation of teacher and student Agency and Communion during the 10-minute lesson start, across the 35 classrooms. As can be

Table 1. *Summary Statistics for Level and Variation in Teacher and Student Time Series (35 Classrooms)*

	Communion				Agency			
	Teacher		Students		Teacher		Students	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Level (mean over 10 mins)	403	207	238	248	293	219	-122	247
Variation (st.dev. over 10 mins)	169	54	243	71	287	79	376	113

Note: Communion and Agency scale range from -1000 to + 1000.

seen in the first row of Table 1, during the first 10 minutes of the lesson, on average the level of Communion was positive for the teachers and students, and the level of Agency was positive for the teachers and negative for the students. Given that normatively a teacher starts a lesson in a directing and helpful manner and students follow in a reliant and collaborative way (see Figure 1), the average levels of Agency and Communion are in accordance of what we expected for an adequate lesson start in secondary education. For four classrooms (11%), the mean level of teacher Agency was negative, and for one of these classrooms so was the mean level of teacher Communion. In four classrooms (11%) both teachers and students were on the positive side of the Communion dimension during the entire first 10 minutes of the lesson. As can be seen in the second row of Table 1, on average students' variation was higher than teachers' variation for both Communion and Agency. This result makes sense in that teachers likely restrict their behavior in the classroom to be in line with professional standards and their roles as leaders, instructors, adults, and role models (e.g., so that their behavior is not too hostile nor too submissive).

### ***Interpersonal Adaptation***

On average across the 35 classrooms, the overall index of moment-to-moment interpersonal adaptation (cross-correlation between the 1,176 measurements of the teacher and the students) was .41 for Communion ( $SD=.38$ ), and -.44 for Agency ( $SD=.40$ ), which is consistent with the principle of interpersonal complementarity. For 86% of the classrooms, the cross-correlation was positive for Communion (range -.63 to .92) and for 80% of the classrooms it was negative for Agency (range -.95 to .59). For 71% of the classrooms, the overall index of adaptation followed the interpersonal complementarity principle on both dimensions. After removing linear trends, the average detrended cross-correlations of .25 for Communion ( $SD=.29$ ) and -.41 for Agency ( $SD=.41$ ) were still in the expected direction,

although the average for Communion was somewhat more attenuated by detrending than it was for Agency.

From the perspective of the professional role of the teacher, we explored the detrended correlations specifically when teachers were facing hostile and dominant behavior of students. On average, the detrended cross correlation for Communion was  $-.07$  ( $SD=.47$ ) with hostile student behavior compared to  $.28$  ( $SD=.30$ ) when student behavior was friendly. In the face of dominant student behavior, on average the (detrended) cross correlation for Agency was  $-.17$  ( $SD=.49$ ) compared to  $-.42$  ( $SD=.36$ ) in the face of subordinate behavior of students. These results are in line with our expectation that teachers would be able to refrain from hostile behavior in response to hostile student behavior and to override the interpersonal bid of submissiveness in response to dominant student behavior.

Table 2 provides information for the 35 classrooms regarding *linear trends* during the lesson start, including the level of Agency and Communion at the beginning of the lesson (intercept of the linear model) and the level after the first 10 minutes of a lesson (based on the slope of the linear model).

On average across the 35 classrooms, the linear model showed a comparable positive level of Agency for both teachers and students at the start of the lesson. Then, in the first 10 minutes of the lesson, on average, teacher Agency increased to a higher level of dominance ( $M=374$ ), while student Agency decreased to a subordinate level ( $M=-430$ ). Regarding Communion, the lesson started, on average, with a positive level for the teacher and a slightly negative level for students. Then, in the first 10 minutes of the lesson, both teachers and students increased to about the same level of Communion (teacher  $M=490$ , students  $M=473$ ). Therefore, the lesson start seems to function as a period of regulating the Agency and Communion level of students towards positive student Communion and negative

Table 2. *Summary Statistics for Linear Trends in Teacher and Student Time Series (35 Classrooms)*

	Communion				Agency			
	Teacher		Students		Teacher		Students	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Level at the start <sup>a</sup>	310	218	-14	211	206	314	208	289
Level after 10 mins <sup>a</sup>	490	309	473	425	374	416	-430	431
<i>R</i> <sup>2</sup> Linear model	.31	.28	.50	.29	.28	.26	.34	.27

Note. <sup>a)</sup> Based on linear model; For convenient reasons, we left out the decimals

student Agency, which, from the perspective of class-level dynamics, is a supportive atmosphere for teaching and learning. Correlations between the levels of Communion and Agency at the start of the lesson (i.e., the intercepts) for teacher and student time series showed a positive ( $r=.33$ ) value for Communion and a negative value ( $r= -.78$ ) for Agency. That is, if the teacher behaved more communally at the very beginning of the lesson compared to other teachers, his or her students also behaved more communally. If the behavior of the teachers was more agentic compared to teachers from other classrooms at the very beginning of the lesson, the behavior of students was less agentic. Because students and teachers knew each other from earlier lessons, some interpersonal adjustment at the beginning of the lesson start was unsurprising. Sadler et al. (2009), found that, even for unacquainted partners, quite a lot of adjustment had already occurred at the start of the coding period (which in their study was 10 minutes into the interaction).

Also, the correlations between the linear changes (i.e., slopes) in teacher and student time series were in accordance with the interpersonal complementarity principle (Communion  $r=.53$ ; Agency  $r=-.66$ ). These results suggest that further adaptation takes place after the beginning of the lesson start: Teachers' increasing communal behavior goes together with students' increasing communal behavior, and teachers' increasing agentic behavior goes together with students' decreasing agentic behavior.

Given that the role and status of both partners is different, we explored if teacher-student interactions were atypical in terms of cross-dimension correlations, which interpersonal theory expects to be small and unimportant (Sadler & Woody, 2003). Because both teachers and students will consider each other's role and responsibility for the process of adaption as different (e.g., "we do not start with the lesson until the teacher forces us to do so", "students must listen"), students' friendliness may be not only dependent on teacher friendliness, but also on teacher dominance; and students lowering their level of dominance may be dependent not only on their teacher's dominance, but also on teacher friendliness. Therefore, to examine how the combination of teacher Agency and Communion affects student Agency and Communion we performed (1) a regression analysis with student Communion as the criterion variable and teacher Agency as the predictor variable, controlling for the effect of teacher Communion, and (2) a regression analysis with student Agency as the criterion variable and teacher Communion as the predictor variable, controlling for the effect of teacher Agency. The cross-dimensional part correlations between moment-to-moment student Communion and teacher Agency (i.e., controlling for

the effect of teacher Communion) showed, on average, a positive added effect of teacher Agency on student Communion ( $M-rpart=.11$ ,  $SD=.36$ ). Part correlations between student Agency and teacher Communion (i.e., controlling for the effect of teacher Agency), showed on average a negative added effect of teacher Communion on student Agency ( $M-rpart=-.10$ ,  $SD=.20$ ). These results can be explained by assuming that higher agentic behavior of teachers is valued or even needed by students at the start of the lesson to bring along a higher level of student Communion than could be expected based merely on the Communion level of the teacher. In the same vein, higher Communion may bring along a lower level of Agency of the students than could be expected based merely on the Agency level of the teacher. Students probably more smoothly accommodate with the Agency of the teacher when the teacher displays a higher level of Communion. This result is in line with research of Thijs et al. (2011) showing that in a dyadic task of teachers and individual kindergartners outside the classroom, children reciprocated teachers' controlling behaviors more with passive behaviors when the relationship with the teacher was experienced as warm and without conflict than in a less warm relationship (see also Roorda et al., 2013).

Using (cross-)spectral analysis, we examined the degree of interpersonal adaptation of teacher and student behavior in terms of the *synchrony of their cyclical behaviors*. In Table 3 we present information on the cyclical nature of the time series in terms of the index of rhythmicity and information on the interpersonal adaptation of the cyclical patterns in terms of average weighted coherence.

For all teacher and student time series, we found significant periodic components (Fisher's test, Warner, 1998). The large amounts of variance accounted for (captured by the index of rhythmicity) showed that both teacher and student behavior strongly tended to fall in reasonably regular cycles. Sets of cycle lengths consisted, on average, of 9.5 cycle lengths ( $SD=2.2$ , range=6-14) out of 588 possible. The average weighted coherence values of .37 and .49 are considered large effects (compare to  $R^2$ ; Cohen, 1988), and show that on average a

Table 3. *Summary Statistics for Spectral Analyses of Teacher and Student Time Series (35 Classrooms)*

	Communion		Agency	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Teacher rhythmicity	.83	.08	.90	.06
Student rhythmicity	.92	.03	.94	.03
Average weighted coherence	.37	.24	.49	.29

considerable degree of entrainment of cyclical variations is present in teacher and student time series for Communion and Agency.

Results regarding phase reveal whether the cyclical patterns in the teacher's and students' behaviors are in line with the interpersonal complementarity principle (i.e., for Communion phase is expected to be 0 (sameness) and for Agency phase is expected to be  $-.50$  or  $.50$  (oppositeness)). For Communion, 63% of the classrooms had a score between  $-.10$  and  $+.10$  ( $M=-.04$ ,  $SD=.20$ ). For Agency, 63% of the classrooms had a phase score (absolute value) between  $.40$  and  $.50$  ( $M=.36$ ,  $SD=.17$ ). Results regarding the sign of the phase score showed that in 20% of the classrooms, the teacher leads on both Communion and Agency, and in 34% of the classrooms, the teacher follows students on both Agency and Communion. In 17% of the classrooms, the teacher is leading on Agency and following the students on Communion, and in 29% the teacher is following students on Agency and is leading on Communion. Thus, classrooms showed a varied pattern of who is leading the interactions in the first 10 minutes of a lesson.

To examine associations between "random" behaviors of teachers and students (*residual fluctuations*), we removed trends and cycles (residuals of second order autoregressive model, see also Sadler et al., 2009; Warner, 1998). When we computed the cross-correlation functions, interrelating the pairs of residuals for teacher and student Agency, and teacher and student Communion, we only found small correlations (in general less than  $.10$ ) with no clear high points. Therefore, across the 35 classrooms, the associations between "random" behaviors appear not to make an important contribution to interpersonal adaptation in our sample.

### **Interpersonal Adaptation and Teacher-Student Relationship**

The degree and nature of interpersonal adaptation varied considerably between classrooms. Indeed, in some classrooms, the patterns of interpersonal adaptation were very different from those expected, based on the teacher's professional role during the lesson start. To explore the associations of adaptation in daily classroom interaction with the teacher-student relationship, we compared the different indicators for interpersonal adaptation of (a) classrooms with teachers with more preferred teacher-student relationships with (b) classrooms with teachers with less preferred teacher-student relationships.

Table 4. *Level of Moment-to-Moment Behavior During the Lesson Start for Classrooms with Teachers with More (N=18) and Less Preferred (N=17) Teacher-student relationships*

	Communion		Agency	
	Less preferred	More preferred	Less preferred	More preferred
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Level of moment-to-moment teacher behavior (mean)	297 (204)	502 (157)	228 (257)	354 (160)
Level of moment-to-moment student behavior (mean)	118 (263)	351 (174)	-33 (213)	-206 (253)

On average, the class aggregated perceptions of students of the teacher-student relationship (scale -1 to +1) ranged for Agency from  $-.41$  to  $.45$  ( $M=.14$ ,  $SD=.21$ ) and for Communion from  $-.20$  to  $.66$  ( $M=.21$ ,  $SD=.25$ ). In 18 classrooms (51%), the teacher-student relationship was more preferred, and in 17 classrooms (49%) the teacher-student relationship was less preferred. In Table 4, we compare the average level of moment-to-moment teacher and student behavior for the classrooms with more and less preferred teacher-student relationships.

According to the values in Table 4, observing moment-to-moment interactions during only 10 minutes of one lesson already reveals differences between classrooms with teachers with more and less preferred teacher-student relationships. For classrooms with teachers with a more preferred teacher-student relationship, average levels are more in line with what can be expected based on the professional teacher role (i.e., higher levels of Agency and Communion: directing-helpful). Furthermore, correlations of Agency and Communion characterizing the teacher-student relationship with Agency and Communion characterizing teacher behavior in the first 10 minutes of only one lesson indicated a rather strong alignment of the more long-term time level (i.e., school year) and the moment-to-moment time level. For Agency, the correlation between the two time-levels was  $.47$ , and for Communion, it was  $.54$ .

In Table 5, we compare classrooms with more and less preferred teacher-student relationships regarding linear trends during the first 10 minutes of a lesson. On average, in classrooms with a more preferred teacher-student relationship, the level 10 minutes after the very beginning of the lesson was more in line with the prevailing standard (directing-helpful teachers with students following in a reliant and collaborative way) compared to classrooms with a less preferred teacher-student relationship. In classrooms with a more preferred teacher-student relationship, teachers were better able to raise the Communion

level of students ( $M_{\text{change}}=646$  vs. 319) and reduce the Agency level of students during the first 10 minutes of the lesson ( $M_{\text{change}}=-756$  vs. -513).

In Table 6, we compare classrooms with more and less preferred teacher-student relationship regarding the cross-correlational indicators of interpersonal adaptation. Table 6, the overall index of moment-to-moment interpersonal adaptation (cross-correlation), shows that classrooms with more preferred teacher-student relationships were, on average, more consistent with the interpersonal complementarity hypothesis of sameness. After removing linear trends, the mean differences were much smaller, indicating the importance of the contribution of linear trends to discriminate between classrooms with more and less

Table 5. *Interpersonal Adaptation (Linear Trend) for Classrooms with Teachers with More (N=18) and Less Preferred (N=17) Teacher-Student Relationships*

	Communion		Agency	
	Less preferred	More preferred	Less preferred	More preferred
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Level at the start - teacher <sup>a)</sup>	221 (192)	393 (212)	218 (388)	194 (235)
Level at the start - students <sup>a)</sup>	-47 (204)	16 (219)	232 (307)	185 (277)
Level after 10 mins – teacher <sup>a)</sup>	368 (331)	604 (243)	236 (453)	503 (340)
Level after 10 mins - students <sup>a)</sup>	272 (456)	662 (296)	-281 (389)	-571 (431)

<sup>a)</sup> Based on linear model; For convenient reasons, we left out the decimals

Table 6. *Interpersonal Adaptation (Cross-Correlations) for Classrooms with Teachers with More (N=18) and Less Preferred (N=17) Teacher-Student Relationships*

	Communion		Agency	
	Less preferred	More preferred	Less preferred	More preferred
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Cross-correlation	.33 (.40)	.49 (.34)	-.44 (.42)	-.45 (.39)
Detrended cross-correlation	.24 (.30)	.26 (.30)	-.43 (.39)	-.39 (.43)

Table 7. *Interpersonal Adaptation (Spectral indicators) for Classrooms with Teachers with More (N=18) and Less Preferred (N=17) Teacher-Student Relationships*

	Communion		Agency	
	Less preferred	More preferred	Less preferred	More preferred
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Teacher rhythmicity	.84 (.08)	.83 (.08)	.88 (.08)	.92 (.04)
Students' rhythmicity	.92 (.03)	.93 (.04)	.93 (.03)	.94 (.03)
Average weighted coherence	.39 (.22)	.35 (.25)	.50 (.26)	.48 (.32)

preferred teacher-student relationships. Regarding Agency, mean differences in non-detrended cross correlations between both groups were already small.

We also compared (a) classrooms where teachers were less able to refrain from responding with hostile behavior when facing hostile student behavior (positive detrended correlation,  $N=14$ ) with (b) classrooms with no hostile behavior of students ( $N=6$ ) and classrooms where teachers were able to react with less hostile or to react with friendly behavior (negative detrended correlation in the event of student hostile behavior,  $N=15$ ). In the classrooms with more preferred teacher-student relationships, 67% of the teachers were able to refrain from the hostile student bid during the first 10 minutes of a lesson, whereas in classrooms with less preferred teacher-student relationships, 53% of the teachers did so. The number of teachers responding with a higher level of dominant behavior when facing dominant behavior of students was higher in classrooms with more preferred teacher-student relationships (44% compared to classrooms with less preferred teacher-student relationships: 29%).

Table 7, shows the comparison of rhythmicity of teacher and student behavior in classrooms with more and less preferred teacher-student relationships. Neither the rhythmicity nor the average weighted coherence values differed appreciably in classrooms with these two types of teacher-student relationships.

Results regarding phase showed that in classrooms with a more preferred teacher-student relationship the teacher was more often leading in Agency (44% versus 29%), but differences in Communion were much smaller (50% versus 47%).

In summary, in classrooms with a more preferred teacher-student relationship during the first 10 minutes of a lesson the moment-to-moment interpersonal behavior of teachers and the adaptation to the behavior of their students was in general more in accordance to professional standards compared to classrooms with a less preferred teacher-student relationship: higher levels of momentary teacher Agency and Communion, higher raise of student Communion and decrease of student Agency, more teachers with refraining from hostility and subordinate behavior, more teachers leading in Agency.

## DISCUSSION

In the present study, we explored interpersonal adaptation in daily interaction in 35 classrooms. We delved into micro-processes with the goal of gaining a better understanding of teaching and learning outcomes. We examined to what degree the interpersonal complementarity rules for interaction between people (sameness for Communion,

oppositeness for Agency) apply to the educational setting and how the specific professional role and status of the teacher would affect these rules. To explore the theoretical and practical relevance of the attention to these micro-processes, we used as a criterion the association with the teacher-student relationship, which was shown to be important for student cognitive and affective outcomes and teacher wellbeing.

Our expectations of interpersonal adaptation were basically confirmed in the present study. In most of the 35 classrooms, teacher and student behavior during the lesson start was consistent with the overall principle of interpersonal complementarity (sameness with regard to Communion, oppositeness with regard to Agency). The results were also in line with violations of the general rules that we expected, given the professional role of the teacher. Our exploration of the relation between momentary interpersonal dynamics and long-term teacher-student-relationship supported our conjecture that attention to micro-processes in classrooms has added value. In the remainder of this section, we highlight some contributions of the present study to research on teacher-student interaction, present limitations, and lines of future research.

### **Variability**

One of the major advantages of continuous coding is that it promotes explicit consideration of the dynamic variation that occurs in momentary interactions between people. Our study illustrates that not only the level of interpersonal behavior, but also the variability *within* students and teachers, and *across* classrooms contributes to the understanding of classroom micro-processes. For example, in Classroom I 6, the mean levels of Agency and Communion do not tell the whole story. In accordance with the white sign in the density plot in Figure 4, we may have concluded that the teacher always behaved in a directing-helpful manner with students following in a reliant and collaborative way; however, these mean levels do not adequately capture that there are periods of time when the students were considerably more agentic and less communal. The pattern of variability in Classroom I 6 also demonstrates that reduction of student dominant behavior is realized without hostile behavior. Another example of the informative value of variability are the linear trends in teacher and student behavior. For example, in the present study we found that in classrooms with a more preferred teacher-student relationship there was a substantial reduction of student Agency and a rise in student Communion during the lesson start.

### **Teacher Professional Role**

We expected teachers to be able to refrain from hostility and subordinate behavior in classrooms. We indeed found a substantial number of teachers to be able to refrain from responding with hostility when confronted with student hostility (60%), as well as refrain from reacting subordinately to dominant student bids (37%). These refraining teacher reactions were more prominent in the classrooms with teachers with more preferred teacher-student relationships. Regarding the leading role of the teachers in the coordination of the entrainment of the cyclical patterns in teacher and student behavior (“Who is following whom?”), we found a varied pattern of leading, but teachers with a leading pattern on Agency were more prominent in classrooms with a more preferred teacher-student relationship. Perhaps this varied pattern of leading connects with the educational debate on whether it is better for the teacher to act as “sage on the stage” or as a “guide on the side” (e.g., King, 1993). In classrooms, teachers can be viewed the central figure, the ones who have the knowledge (“sage on the stage”) which they transmit to students. In the constructivist view of learning, students are placed at the center of the process and actively participate in thinking and discussing ideas to help them understand the new material with the teacher as a “guide on the side,” facilitating learning in less directive ways.

To further understand the specific mechanisms underlying the interpersonal lead-lag relationship and refrainment of hostility, additional research is needed. From the perspective of the teacher as a professional, these studies can be guided by questions like: To what degree do teachers themselves view leading/following or friendliness/hostility as defining components of an effective classroom atmosphere?; To what degree do teachers apply leading/following, or friendly/hostile behavior as a specific strategy given the educational setting of the lesson start?; To what degree are teachers able to apply their desired strategy, taking into account that their interpersonal expertise develops during their professional career (Brekelmans et al., 2005)?

### **Adaptation as a Process of Anticipation**

The question of “Who is following whom?” connotes a stimulus-response perspective, i.e., individual acts that are driving each other. This conception of adaptation does not fully acknowledge the findings of the present and other studies. Rather than simply responding to the immediately preceding behavior, partners respond also to each other’s anticipated behavior (Pincus, 1994). “The process may be akin to music improvisation, in which

musicians must anticipate where their partners are going before they get there. Music is full of cyclical structures that facilitate such anticipations. Arguably, social interaction is similar” (Sadler, Woody, McDonald, Lizdek, & Little, 2015, p. 539). Also the results in the present study suggest, and for similar results see e.g., Sadler et al. (2009), that an underlying process of anticipating interaction partner’s behaviors may be occurring, as is apparent from (a) the size of the cross-correlations (with no time lag), (b) the existence of cyclical patterns (recurrent behavior, which inherently includes the possibility of predicting future behavior), and (c) the size of the correlations between teacher and student behavior at the very beginning of the lesson start. The concept of anticipation as one of the components contributing to interpersonal adaptation adds to the understanding of the complexity of teacher-student interaction and teacher interpersonal expertise, but at the same time makes interpretation of results regarding phase more complex.

### **Interrelating Time Scales**

In the present study, we made a connection between moment-to-moment behavior of teachers and students, and long-term teacher-student relationships. The interrelations between micro- and macro-level time scales are the primary focus of Dynamic Systems Theory when studying development (e.g., Granic & Patterson, 2006; Steenbeek & Van Geert, 2013). Moment-to-moment interactions are the building blocks of development of teacher-student relationships, while stabilized teacher-student relationships not only function as outcomes of previous micro-processes but also constrain subsequent moment-to-moment interactional processes. For example, moment-to-moment teacher friendliness contributes to a directing-helping teacher-student relationship. A directing-helping teacher-student relationship may prevent disruptive student behavior during the lesson, which then makes teacher moment-to-moment friendliness easier. Interrelating micro-processes to macro-level concepts adds to the understanding of teacher and student learning, and may thereby contribute to the design of interventions.

### **Limitations**

Because participation in this study was limited to those classrooms where teachers agreed to video recording in the classroom and with data available on teacher-student relationships, one may wonder about the generalizability of the results from this sample. Comparing the teacher-student relationships of the sample of 35 classrooms with a large Dutch sample ( $N > 18,000$  classrooms) revealed that distribution of the teacher-student relationships over the

four quadrants of the IPC-T was not too different (see Figure 2). Furthermore, in the large sample 56% of the teachers had a more preferred teacher-student relationship compared to 51% in our sample. Mean scores of Agency and Communion were in the large sample, on average, respectively .09 (SD=.18) and .22 (SD=.22), compared to .14 (SD=.21) and .21 (SD=.25) in the sample of the present study. However, although the teacher-student relationships in our present study were not very different from the larger database, generalization should be treated with caution. Restrictions also apply to generalization of the results on interpersonal adaptation to all educational situations as we only studied the first 10 minutes of a lesson. In this part of the lesson whole class interaction is in most classrooms an important component. In this educational setting the group of students can generate more agentic power than an individual student in a one-to-one interaction with a teacher. Combined with the perspective of class-level dynamics as used in the present study, this may have generated results different from a study on educational settings with mainly teacher-individual student interactions and even more different when combined with a perspective of individual-level dynamics.

Although time-series analyses of Agency and Communion separately are informative, analyses would have profited from analyzing quantitative measures that present the blended character of interpersonal behaviors, in line with the interpersonal circumplex model. Unfortunately, circular statistics is, currently, still in its infancy. We did include the blended character of Agency and Communion in teacher-student relationship when we associated momentary interpersonal adaptation with the teacher-student relationship, but only by making a qualitative distinction in two groups of teacher-student relationship due to the still small sample size of 35 classrooms.

In the present study, we held to a descriptive approach with the aim of a first exploration of interpersonal adaptation in the educational context with just a small sample size. Bayesian estimation in conjunction with informative prior distributions would have been an alternative option (e.g., Van de Schoot, Broere, Perryck, Zondervan-Zwijenburg, & Van Loey, 2015) that we however leave for future research.

### **Lines of Future Research**

As we explored the rather new domain of micro-processes in classrooms there is a lot of work left. Besides future studies to be directly inferred from the limitations of the present study, we suggest some other research lines that may contribute to further understanding of the dynamic interplay of teacher and student behavior.

(1) Because professional teachers may be expected to realize an adequate adaptation pattern in every classroom, it is interesting to study the same teachers with different classes and the same classes of students with different teachers (in cross classified educational settings) to get a more complete insight in teacher's adaptive expertise. For example, which teachers are more interpersonally adept at entraining with, and managing, a wide variety of classrooms? Likewise, are certain classrooms harder to manage overall, and what sorts of teacher entrainment and micro-processes seem to contribute?

(2) Because teacher-student interaction comprises teacher-whole class, teacher-small group, and teacher-individual student interaction, each can be investigated from an individual and a group-, or class-level dynamics perspective. Studies that compare different combinations of settings and perspectives may add to insights in the differentiated effects of settings on teacher-student interactions.

(3) Although we delved into micro-processes in the classroom by describing patterns in variation during the lesson start, studies can add by taking a closer and qualitative look at special or deviant moments (e.g., hostile and/or dominant student behavior), for example by transcribing and analyzing the specific verbal and non-verbal interaction sequences. These moments can be identified in the stream of behavior with use of the joystick approach (for a description, see Pincus et al., 2014, p. 70), and later, together with previous and subsequent behavior, tested for specific hypotheses (e.g., regarding ruptures and repairing of the classroom equilibrium). Further, windowed cross correlations and peak picking (Boker, Xu, Rotondo, & King, 2002) can be used to examine whether there are important changes over the course of the interaction in the size of the cross correlation and time lags (Sadler et al., 2009).

### **Practical Implications**

We are aware that formulating practical implications based on the results of the correlational design of the present study presuppose causality, and that this is not evidenced. We still think some points of action can be identified for designing teacher education and in-service professional developmental trajectories. As interaction of teachers with students in classrooms is intentionally strategic but also automatic, becoming aware of potential (in)effective interaction patterns and possible directions to change may be a first step in improvement. Results of the present study can inform teacher professionalization regarding the diagnosis of (problematic) teacher-student relationships and contribute to the design of effective interventions that make use of (video-taped) daily classroom interaction. Looking at

classrooms from the perspective of interpersonal adaptation promotes an explicit focus on the classroom system, rather than just on the teacher, and may make the (student-)teacher mindful of variation in behavior and its cyclical nature. Aspects of the continuous coding procedure and indicators of interpersonal adaptation could be useful for (student-)teachers and their educator and supervisors. Together with annotations of specific moments (e.g., critical incidents), quantitative indicators can be used to diagnose the classroom micro-processes in and across students and educators in a comparable and more complete way. See also Pincus et al. (2014) who applied the joystick approach during clinical supervision to teach therapists-in-training. The combination of behavioral analyses with teacher's interpersonal knowledge (e.g., Claessens et al., 2016) and appraisals of interpersonal classroom processes (e.g., Van der Want et al., 2015) may also contribute to a more effective intervention (Claessens et al., 2014).

## **Conclusion**

(1) We consider the present study an illustration of the applicability of continuous coding for describing interpersonal dynamics in the educational context. We consider continuous coding not only suitable for investigating teacher and student behavior, but also for investigating teacher and student emotions and knowledge, both in the affective and cognitive domain of education. (2) We consider the present study an illustration of the added value of attention to micro-processes, both at the level of individual and multiple classrooms. Conceptualizations and results can contribute to theory on teacher-student interaction as well as the practice of teacher professional development.



## **CHAPTER 6**

### **GENERAL DISCUSSION**

The present dissertation is part of an interlinked research project entitled '*Development of teacher competence during the professional career: An interpersonal perspective*' funded by the Netherlands Organization for Scientific Research [Grant number NWO/NRO 411-07-360]. The goal of this interlinked research project was to gain more understanding of how the micro-level or daily classroom processes are related to the macro-level variable of teacher interpersonal competence which becomes manifest in the quality of teacher-student relationships. As one criterion for a positive development of teachers' interpersonal competence, teachers' job satisfaction in terms of burnout and work engagement is used. This dissertation, which consists of four studies, focuses on the interpersonal dynamics of teacher-student interactions (micro-level) and its associations with the teacher-student relationship (macro-level). One study examined how teacher-student relationships are related to teacher burnout (Chapter 2). The other three studies focused on how the macro-level teacher-student relationship is associated with the dynamics in micro-level teacher-student interactions (Chapter 3, 4, and 5). Before discussing the findings, limitations, future research, and practical implications of the dissertation, I briefly summarize the findings of each of the studies.

## **Overview of the Findings per Study**

### **Study 1 (Chapter 2)**

In Study 1, we examined the importance of teacher-student relationships for teacher burnout. We answered the following research questions: (1) *How do teachers' feelings of burnout vary across five years?* and (2) *How is teacher burnout associated with teacher-student relationships?* The findings of our study both strengthened and expanded upon previous finding reported in the literature (e.g., Capel, 1991; Hultell et al., 2013; Hoglund et al., 2015). In line with this literature, results of the present study did not support the view on teacher burnout as a process of erosion, not even over a time span of five school years, nor for teachers with high levels of burnout scores. A pattern of fluctuations in feelings of burnout seemed a more adequate representation across the five-year period. Findings of Study 1 empirically demonstrated the (often only postulated) association between teacher burnout and teacher-student relationship; The findings of this study also refined this association, because we found that the level of Communion in teacher interpersonal behavior more important to predict differences between teachers in their feelings of burnout, more so than the level of Agency. Levels of Agency can account for within-teacher fluctuations across

school years in teacher feelings of burnout. Teacher-student relationships in randomly selected classes showed predictive power for *between-teacher variation* in burnout similar to that of relationships in classes that were relatively negative. Classes with relatively negative relationships seemed to be stronger in predicting *within-teacher variation* in burnout.

### **Study 2 (Chapter 3)**

In the second study, we examined the interpersonal content and interpersonal structure in micro-level teacher behavior by observing eight teachers during a 30-minutes part of a lesson. We answered the following research question: *Are there differences in the content and structure of micro-level interpersonal behavior of teachers with different macro-level teacher-student relationships?* We found that micro-level interpersonal teacher behavior was related to the quality of macro-level teacher-student relationships. The content of micro-level interpersonal teacher behavior was associated with the macro-level teacher-student relationship in two ways: (1) correlations between the averaged micro-level level of Agency and Communion in the teacher behavior and the macro-level Agency and Communion characterizing the teachers-student relationship were very high; (2) for teachers with more desirable teacher-student relationships, attractors were identified, and these were located in the same or adjacent area (octant) that characterized the quality of their teacher-student relationship. For teachers with less desirable teacher-student relationships, we could not identify attractors.

Results for interpersonal structure, in terms of number of behavior changes (variability) and predictability, indicated that interpersonal behavior of teachers with a less desirable teacher-student relationship showed more variability than behavior of teachers with a more desirable teacher-student relationship. Also, behavior of teachers with a less desirable teacher-student relationship was less predictable compared with teachers with a more desirable teacher-student relationship. Variability and predictability in micro-level interpersonal teacher behavior were only related to the level of Communion that characterizes the teacher-student relationship.

In this second study, we took a one-sided approach to study micro-level interpersonal teacher behavior. In the following studies, described in chapter 4 and 5, we took a two-sided approach, and included observations of interpersonal student behavior as well. Hence, we could study the association of adaptation in teacher-student interactions with the quality of macro-level teacher-student relationships.

**Study 3 (Chapter 4)**

In the third study, we conducted an exploratory case study. We selected two teachers with distinct teacher-student relationships: a teacher with a repressive style (i.e., high Agency, Low Communion) characterizing the teacher-student relationship and a teacher with a tolerant style (i.e., low Agency, high Communion) characterizing the teacher-student relationship. We studied how interpersonal content, interpersonal structure, and interpersonal complementarity, as three dyadic characteristics of teacher-student interactions, were related to these differences in style.

The results for interpersonal content, showed that micro-level behaviors of both teachers in the study were similar to how their behavior was characterized on the macro-level (i.e. repressive vs. tolerant). Differences were found in the variability of their interactions with students. In the classes of both these teachers, the students' behaviors were rather stable and comparable in their variation in Agency, but in the negative situation, the repressive teacher's students fluctuated more in their level of Communion shown towards the teacher. Interactions of the tolerant teacher were less predictable than those of the repressive teacher in the positive situation, but more predictable in the lesson start and the negative situation. Results concerning adaptation largely showed patterns following the complementarity principle. Except in the cases of the tolerant teacher's interactions in the negative situation, which showed sameness in Agency, and of the repressive teacher's interactions, in the lesson start and positive situation, we found non-complementarity and oppositeness, respectively.

**Study 4 (Chapter 5)**

In Study 4, we observed teacher-student interactions of 35 teachers during the start of one of their lessons with a fine-grained method to study adaptation in teacher-student interactions. The following research question guided this study: *What is the degree and nature of interpersonal adaptation in moment-to-moment teacher-student interactions in classrooms?* During the first ten minutes of most of the 35 observed lessons, teacher and students' behavior was consistent with the principle of interpersonal complementarity (sameness regarding Communion, oppositeness regarding Agency). Patterns of teacher and students' behavior tended to fall into reasonably regular cycles, and showed, on average, a considerable degree of entrainment. Classrooms had a varied pattern regarding who was leading the interactions during the lesson start; in one-fifth of the classrooms, the teacher was leading on both Communion and Agency.

Interpersonal behavior of teachers and students with more preferred teacher-student relationships showed in general a pattern that is more in accordance with due to the professional roles is expected. In such classrooms, we found that teachers showed higher levels of Agency and Communion, an increase in student Communion, and a decrease in student Agency, throughout the first ten minutes of the lesson. Also, teachers in such classrooms, we better able to refrain from hostility and subordinate behavior (when facing hostile respectively dominant student behavior).

### **Contribution to Research on Teacher-Student Relationships**

The specific added value of each of the four studies is described in the designated chapter. In this section, I will describe how the studies together contribute to the literature, based on three topics: (1) the added value of incorporating a time aspect, (2) the added value of taking a dyadic (two-sided) approach to study interactions, (3) the added value of studying both micro-level interactions and macro-level relationships.

#### ***Time Aspect in Teacher-Student Interactions and Relationships***

To examine the interpersonal dynamics of teacher-student interactions and its associations with the teacher-student relationship, we used coarser, yearly, measurements (Study 1), and very fine-grained continuous measurements, every half-second (Study 2,3,4).

With the year-to-year measurements of teacher-student relationships and teachers' feelings of burnout, we answered Chang's (2009) call for longitudinal studies on teacher burnout, and additionally could provide empirical evidence for the claim that teacher-student relationships are an important predictor for between and within teacher variation in burnout (e.g., Chang, 2009; Friedman, 1995; Taris et al., 2005). With the fine-grained continuous measurements, we could deal with the dynamic variation occurring in moment-to-moment interactions between teachers and students. Time-series analysis of these continuous data gave us new insights in the degree and nature of the match of teacher and students' behavior, of the existence of cyclical patterns in these behaviors, of how these cyclical patterns were entrained, and of who was leading or lagging in the interaction.

#### ***Dyadic Approach to Interaction***

There have been numerous studies focusing on interactions between teachers and students, which have mostly taken a one-sided approach to describe the quality of interactions, i.e. focused on the behavior of only one of the partners, mostly the teacher

(e.g. Davis & Nicaise, 2011; Pianta, et al., 2008; Rubie-Davies, 2007; Yan, Evans, & Harvey, 2011). However, in order to study how the behavior of teachers and students adapt to each other, it is fundamental to take a two-sided, dyadic approach, which means taking student behavior as well as teacher behavior into account. There are only a few studies that took a dyadic approach to study teacher-student interaction; besides the studies presented in this dissertation, to our knowledge, the only other examples are the studies of Roorda, Koomen, Spilt, Thijs, and Oort (2013) and Roorda, Koomen, Thijs, and Oort (2013). By taking a dyadic approach, we thoroughly studied the claim of, for example, Kiesler (1996) and Oullier et al. (2008) that behavior of a person is always affected by the behavior of others. By taking a dyadic approach we showed (especially in Study 4) that how a teacher behaves in interaction with students indeed relates to how students behave and vice versa.

### ***Relating Micro-Level Interactions and Macro-Level Relationships***

According to dynamic systems theory, interactions are the building blocks of relationships (Granic & Patterson, 2006), but relationships, in turn, also constrain interactions (Hollenstein & Lewis, 2006). The research described in this dissertation contributes to the empirical knowledge base underpinning this theory, by showing how content, structure, and adaptation in micro-level interactions between teachers and students are associated with the quality of the teacher-student relationship. These three aspects separately provide important information, but in combination they provide a more complete picture. For instance, we could not identify attractors for teachers whose behavior showed a lot of variability and unpredictability. This dissertation, however, only examined the association between multiple measurements of behaviors in interaction and one measurement of the teacher-student relationships. To reveal how this relationship develops from micro-level interactions, longitudinal research with multiple measurements of both interactions and the teacher-student relationship is needed.

### **Limitations**

The studies in this dissertation have several limitations. Besides limitations already addressed in the previous chapters, I want to highlight two general restraints here.

The first general restraint is related to the most important premise of interpersonal theory, that every interpersonal behavior can, and must, be described in terms of the two dimensions of the Interpersonal Circle, i.e. Agency and Communion. Although we observed both Agency and Communion in teacher and student behavior, we should preferably have

analyzed behaviors of teachers and students as a blend of these two dimensions in the four studies. In the study described in chapter 3 we combined Agency and Communion scores in a State Space Grid Analysis by reducing the numerical data to categories, thereby not using the data to its fullest potential. Using circular statistics (Batschelet, 1981; Berens, 2009) would have been better. However, this method is still in its infancy, and needs further development (Berens, 2009). In the future, we want to explore the possibilities of circular statistics to analyze interpersonal behavior as a one-score combination of Agency and Communion.

A second limitation is related to how we operationalized micro-level behavior. The time series data consisted of numbers, representing the degree of Agency and Communion in behavior. Capturing behavior in numerical time series and analyzing those accordingly, means that certain qualitative aspects of behavior are neglected (e.g., Holmes & Poole, 1991). For example, the numerical level of Communion in teacher behavior alone does not tell us anything about the kind of behavior the teacher is displaying at that moment, or about its context. Whether teachers are communicating Communion by smiling when chatting with students who enter the classroom, or by smiling when they are in front of the classroom and ask students questions (see Van Tartwijk, 1993; Van Tartwijk, Brekelmans, Wubbels, Fraser, & Fisher, 1998), cannot be retrieved from the numerical representation of the degree of Communion, or the combination of Agency and Communion. With such information added, we could possibly explain why teachers and students sometimes refrain from the complementarity principle. For example, in a situation where the teacher asks students a question and leaves some room for them to answer, their Agency decreases but remains at a certain positive level, even though simultaneously the students' agency increases.

### **Suggestions for Future Research**

Based on the studies described in this dissertation, we have several suggestions for future research. Besides the suggestions related to each of the four studies specifically (see Chapters 2-5), I want to highlight two potential lines of research here.

Firstly, within the interlinked research project we followed a group of about 180 teachers longitudinally for five years and collected more data than we could include in the studies presented in this dissertation. In the (near) future, several other research questions, e.g. questions including teacher self-efficacy and personality as variables, will be answered using these data. The longitudinal design of the database will allow the detection of both between-

and within-teacher associations over time, and address issues of reciprocity and causality by using, for example, cross-lagged panel analysis.

It would be especially interesting to combine the results of the three part-projects of the interlinked research project. We already published a multiple case study ( $N=4$ ) in which we compared aspects of teacher interpersonal behavior, teacher interpersonal knowledge, and teacher interpersonal identity (see Claessens et al., 2014). This study could be expanded by (1) including a larger group of teachers, (2) differentiating between early-, mid- and late-career teachers, and (3) the interrelation of the three aspects of interpersonal competence, which were studied by each of the part projects, over time.

Secondly, in the studies described in chapter 4 and 5, we chose to observe the whole class to address dynamics at the class level, instead of observing students individually or in small groups. The teacher-class interaction is a typical example of a one-with-many interaction (Kenny, Kashy, & Cook, 2006). Observing individual students would have provided us with additional information about individual teacher-student dynamics in the classroom. We could for example observe within-classroom interactions of the teacher and individual students with whom they indicate they have either a positive or a problematic relationship (c.f. Claessens, 2016). Alternatively, we could again code the videos, now based on observations of behaviors of individual students or small groups, for example, in the event of a student initiating an interaction with or reacting to the teacher. Such information would provide an extra information about the classroom dynamics.

My final suggestion is somewhat related to this latter suggestion. In the studies in this dissertation we took a two-sided approach to studying teacher-student interactions, but we did not use a two-sided approach to study the macro-level teacher-student relationship: we did not ask teachers about their macro-level perceptions of the students' interpersonal behavior, as is suggested by Carson (1969). Future research could study all dyadic relationships between teachers and students in a classroom, by assessing how the variance in interpersonal perceptions is divided between as well as within dyads in classrooms using the actor-partner interdependence models (APIM; Cook & Kenny, 2005). Such analysis requires round robin data on interpersonal behavior of each member of the classroom system (i.e., the teacher's perceptions of all individual students' behavior in addition to the students' perceptions of the teacher, as well as their self-perceptions).

## Practical Implications

I am aware that formulating practical implications based on the results of the correlational designs of the four studies presupposes causality, and that this is not evidenced. Therefore, I here formulate some general suggestions that might aid in designing teacher education and in-service professional developmental trajectories, especially when video guided coaching is used. As interaction of teachers with students in classrooms is intentionally strategic but also automatic, the becoming aware of potential (in)effective interaction patterns and possible directions to change may be a first step in improvement. For teachers, observing both teacher and student behavior in interactions provides opportunities to analyze their own behavior and the behavior of students, and understand how these behaviors affect each other. This may help them understand why they experience problems in establishing positive relationships with students. Here, I will provide some more specific suggestions for the designing of these learning activities.

A first suggestion is related to the *selection of classes* for observation. Often in professional development and coaching trajectories, teachers are asked to select a class for observation (e.g., Brouwer, 2011; Fukkink, Trienekens, & Kramer, 2011; Tripp & Rich, 2012), which often becomes the class in which the teacher experiences problems. However, choosing these problematic classes may be threatening for teachers, which may undermine the effect of coaching. Findings of the first study showed that regarding differences between teachers, the randomly selected class or the class with the relatively higher Communion score could explain at least the same amount of variance as the negative class. Regarding the differences within teachers, the predictive power of classes with a relatively negative relationship seems somewhat stronger than the power of the other type of classes. Teachers might feel more comfortable videotaping a lesson, observing their interactions with students, and changing their behavior, in a randomly chosen class or in a class with a relatively positive relationship. Interactions in such classrooms may already provide a lot of useful information for coaching or professional development.

A second suggestion concerns the *selection of situations* to observe. Study 3 (described in chapter 4) showed that differences two teachers' micro-level teacher-student interactions showed more differences between the three situations studied than between the two teachers themselves. Differences were most apparent between negative and positive situations. Study 4 (described in chapter 5) showed that observing only the interactions in the first 10 minutes of a lesson was already indicative for the quality of the teacher-student

## CHAPTER 6

relationship. Thus, for coaching or professional development programs it does not seem necessary to specifically zoom in on negative situations, which may be regarded as more threatening than other situations.

A third suggestion is that coaching and professional development trajectories may focus on *improving predictableness* of teacher behavior and teacher-student interactions. As, consistent with the findings of Mainhard, Pennings, Wubbels, and Brekelmans (2012), the findings of Study 2 and 3 showed that unpredictable teacher behavior in teacher-student interactions is associated with less desirable teacher-student relationships, improving predictableness of teachers' own behaviors may provide opportunities for improving relationships.

### **Conclusion**

All in all, the four studies described here contributed to our understanding of how teacher-student interactions are associated with the quality of relationships, and provided new insights and future directions in furthering this understanding, as well as implications for practice.





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**NEDERLANDSE SAMENVATTING**  
**(SUMMARY IN DUTCH)**

De kwaliteit van docent-leerling relaties is belangrijk voor cognitieve leeropbrengsten en motivatie van leerlingen (e.g., Cornelius-White, 2007, Den Brok, 2001; Roorda, Koomen, Spilt, & Oort, 2011), maar ook voor het welbevinden van docenten (e.g., Friedman, 2006; Spilt, Koomen, & Thijs, 2011). De interacties die in de dagelijkse lespraktijk plaatsvinden tussen docenten en leerlingen, vormen de bouwstenen voor docent-leerling relaties (Granic & Patterson, 2006). Er is echter nog maar weinig onderzoek gedaan naar het verband tussen deze interacties en relaties. Drie studies, die in deze dissertatie worden beschreven in de hoofdstukken 3, 4 en 5, richten zich op de interpersoonlijke dynamiek in deze interacties en het verband met relaties. In een vierde studie, beschreven in hoofdstuk 2, werd het verband tussen docent-leerling relaties en burn-out van leraren onderzocht.

### **Theoretisch Kader**

Bij het beschrijven van interacties en relaties wordt in deze dissertatie gebruik gemaakt van de Interpersoonlijke Theorie (e.g., Carson, 1969; Fournier, Moskowitz, & Zuroff, 2011; Horowitz & Strack, 2011; Kiesler, 1996; Leary, 1957; Wiggins, 1991). Gedrag, interacties, en relaties worden in deze theorie gekarakteriseerd met behulp van twee onafhankelijke dimensies die zowel voldoende als noodzakelijk zijn voor het beschrijven van de interpersoonlijk betekenis van gedrag, interacties en relaties: *Invloed* en *Nabijheid* (e.g., Bakan, 1966; Carson, 1969; Fournier, Moskowitz, & Zuroff, 2011; Kiesler, 1996; Leary, 1957; Wiggins, 1991). De positie op de Invloed-dimensie wordt bepaald door de mate waarin een persoon macht of controle uitoefent, terwijl de positie op de Nabijheid-dimensie wordt bepaald door de mate waarin een persoon vriendelijk en begrijpend is in de communicatie met anderen (Horowitz & Strack, 2011; Gurtman, 2009).

Interpersoonlijk gedrag en interacties worden bestudeerd aan de hand van drie aspecten: (1) interpersoonlijke inhoud, (2) interpersoonlijke structuur, en (3) interpersoonlijke adaptiviteit. Interpersoonlijke inhoud wordt gerepresenteerd door (a) de gemiddelde mate van Invloed en Nabijheid in gedrag en interacties en door (b) attractoren (e.g., Granic & Hollenstein, 2003; Mainhard, Pennings, Wubbels, & Brekelmans, 2012). Attractoren zijn gedragingen of interacties (dat wil zeggen: series van elkaar onderling beïnvloedende gedragingen) waarvoor mensen in een sociaal systeem (bijvoorbeeld leerlingen en docent in een klas) een “voorkeur” lijken te hebben (e.g., Thelen & Smith, 2006) of waarin ze blijven “hangen” (Lunkenheimer & Dishion, 2009). Interpersoonlijke structuur wordt gerepresenteerd door de variabiliteit en voorspelbaarheid van gedrag en interacties (Dishion, Nelson, Winter, & Bullock, 2004; Hollenstein & Lewis, 2006). Het derde aspect,

interpersoonlijke adaptiviteit, wordt gerepresenteerd door de mate waarin gedragingen van twee partners in interactie matchen (Capella, 1992; Sadler et al., 2009; Warner, 1998) en geeft weer hoe beide partners (bijvoorbeeld docent en leerlingen) hun gedragingen aan elkaar aanpassen. De mate en aard van deze aanpassing in de dagelijkse klaspraktijk hebben we bestudeerd aan de hand van het principe van complementariteit (Kiesler, 1983). Volgens het complementariteitsprincipe roept het gedrag van docenten bepaald gedrag op bij leerlingen, en vice versa. Als een docent bijvoorbeeld met streng gedrag erg veel *Invloed* uitoefent, is complementair gedrag van leerlingen juist gedrag dat daaraan *tegenovergesteld* is. Een voorbeeld van leerlinggedrag dat complementair is met streng docentgedrag is *dociel* gedrag. Als een docent veel *Nabijheid* vertoont (bijvoorbeeld leerlingen helpt), is het complementaire gedrag van leerlingen juist *gelijksortig* gedrag, dus ook gedrag met veel *Nabijheid* (bijvoorbeeld collaboratief gedrag).

### **Instrumenten en Methoden van Analyse**

*Burn-out* van docenten hebben we gemeten met de 22-item versie van de Utrechtse Burn-Out Schaal voor Leraren (UBOS-L; Schaufeli & Van Dierendonck, 2000).

De *docent-leerling relatie* hebben we in de studies in deze dissertatie gemeten met de 24-item versie van de Vragenlijst Interpersoonlijk Leraarsgedrag (VIL; Wubbels et al., 2006).

*Interpersoonlijk gedrag van docenten en leerlingen* hebben we elk afzonderlijk geobserveerd aan de hand van de Continuous Assessment of Interpersonal Dynamics-techniek (CAID; Lizdek, Woody, Sadler, & Rehman, 2016; Sadler et al., 2009). Met deze observatietechniek wordt interpersoonlijk gedrag met behulp van een computer-joystick door een codeur continue geregistreerd. Registratie vindt plaats in een assenstelsel met *Invloed* en *Nabijheid* als X- en Y-coördinaten. Daardoor kunnen gedragingen tegelijkertijd als een combinatie van beide dimensies worden gekarakteriseerd. Bijbehorende software levert de numerieke gegevens over de mate van *Invloed* en *Nabijheid* in het geobserveerde gedrag. De inhoud, structuur en adaptiviteit van het geobserveerde gedrag en het verband met docent-leerling relaties hebben we geanalyseerd met verschillende conventionele statistische analyses, zoals *regressieanalyse*, en *Pearson correlaties*, maar ook met minder conventionele methoden als tijdsreeks analyses, zoals *State Space Grid analyse* (Lewis, Lamey, & Douglas, 1999; Hollenstein, 2013) en *spectraalanalyse* (e.g., Warner, 1998). Voor het onderzoek naar verbanden tussen docent-leerling relaties en burn-out is gebruik gemaakt van *multilevel regression analyse*.

## Overzicht van de Resultaten

### Studie 1

In de eerste studie (beschreven in hoofdstuk 2 van dit proefschrift) hebben we onderzocht of en hoe docent-leerling relaties gerelateerd zijn aan burn-out gevoelens van docenten. Om zowel verschillen in burn-out tussen docenten te kunnen verklaren, als ook verschillen binnen docenten over een bepaalde periode, hebben we gebruik gemaakt van een design met herhaalde metingen (vier meetmomenten, in een periode van vijf schooljaren). 178 docenten en een of meer van hun klassen zijn in deze studie gevolgd. De volgende onderzoeksvragen waren leidend: (1) *Hoe variëren burn-out gevoelens van docenten over vijf schooljaren?* En (2) *Wat is het verband tussen burn-out gevoelens van docenten en docent-leerling relaties?*

We vonden geen negatieve lineaire trend in de burn-outgevoelens van docenten over tijd; ook niet wanneer we uitsluitend docenten met hoge burn-out scores meenamen in de analyses. Onze bevindingen zijn in lijn met de resultaten van eerder onderzoek (e.g., Capel, 1991; Hultell et al., 2013; Hoglund et al., 2015). Wel vonden we dat de burn-outgevoelens van docenten over tijd fluctueerden. Dit maakt onderzoek naar factoren die deze fluctuaties kunnen verklaren relevant. In deze dissertatie hebben we de docent-leerling relatie als een van die potentiële factoren bestudeerd. In onze studie bleek de docent-leerling relatie inderdaad een belangrijke voorspeller voor de burn-outgevoelens van docenten zijn. Dit gold met name voor de mate van Nabijheid in de relatie. De mate van Invloed was in onze studie niet voorspellend voor verschillen in burn-out tussen docenten, maar wel voor fluctuaties in burn-out van individuele docenten gedurende de vijf jaar waarin wij ze hebben gevolgd. Dit laatste was het sterkst het geval, wanneer van elke docent de klas met de meest negatieve relatie in het onderzoek werd betrokken (selectie op basis van niveau van Nabijheid). Om verschillen tussen docenten te voorspellen, konden net zo goed willekeurig gekozen klassen of de klassen met de meest positieve relatie worden geselecteerd.

### Studie 2

In de tweede studie (beschreven in hoofdstuk 3) zijn we nagegaan of de interpersoonlijke inhoud en structuur van microlevel docentgedrag gerelateerd zijn aan de macrolevel docent-leerling relatie. We hebben in deze studie bij acht docenten, met interpersoonlijke relaties die verschilden wat betreft de mate van invloed en nabijheid van de docent, dertig minuten van een les geobserveerd. We wilden daarmee de volgende onderzoeksvraag beantwoorden:

*Zijn er verschillen in de inhoud en structuur van microlevel interpersoonlijk docentgedrag tussen docenten met een verschillende macrolevel docent-leerling relatie?*

Uit de resultaten bleek dat de inhoud (dat wil zeggen, de mate van Invloed en Nabijheid en de attractoren) van het microlevel docentgedrag overeenkwam met de mate van Invloed en Nabijheid die de macrolevel docent-leerling relatie karakteriseerde. Voor docenten met een minder goede docent-leerling relatie was het onmogelijk om attractoren te identificeren. Dit heeft mogelijk te maken met de structuur van het docentgedrag. Uit de resultaten bleek namelijk dat gedragingen van docenten met een minder goede docent-leerling relatie veel veranderingen lieten zien en dat hun gedragingen daarmee minder “voorspelbaar” waren dan de gedragingen van docenten met een meer wenselijke docent-leerling relatie. Deze bevinding is in lijn met een eerdere casestudie van Mainhard, Pennings, Wubbels, en Brekelmans (2012).

We hebben in deze tweede studie alleen naar docentgedrag gekeken en niet naar het leerlinggedrag. Dit betekent dat we een eenzijdige benadering van interactie gebruikt hebben. Om daadwerkelijk het verband tussen interacties (microniveau) en docent-leerling relaties (macroniveau) te kunnen onderzoeken was het van belang om ook observaties van leerlinggedrag mee te nemen en dus een tweezijdige benadering van interacties te hanteren (zie Studie 3 en 4).

### **Studie 3**

De derde studie (Hoofdstuk 4) was een exploratieve casestudie met twee participanten. In deze studie hebben we zowel observaties van docentgedrag als van leerlinggedrag gebruikt om de discriminerende validiteit van de drie aspecten van interacties (dat wil zeggen, interpersoonlijke inhoud, structuur en adaptiviteit) te bestuderen. De docent-leerling relatie van de eerste docent werd gekarakteriseerd door een repressieve interpersoonlijke stijl (hoog in Invloed, laag in Nabijheid) van de docent, de docent-leerling relatie van de tweede docent werd gekarakteriseerd door diens tolerante interpersoonlijke stijl (laag in Invloed, hoog in Nabijheid). Tevens keken we naar verschillen tussen drie lessituaties: de lesstart, een negatieve situatie (e.g., als de leerlingen niet luisteren naar de docent) en een positieve situatie (e.g., wanneer docent en leerlingen samen lachen).

Ook in deze studie bleek dat de interpersoonlijke inhoud, in termen van de mate van Invloed en Nabijheid in het gedrag van de docenten, overeenkwam met de mate van Invloed en Nabijheid die hun relatie met leerlingen karakteriseerde. Daarnaast was de mate van Invloed en Nabijheid in het leerlinggedrag voor de interacties van beide docenten

vergelijkbaar en vonden we met name verschillen in de structuur van het leerlinggedrag. In interactie met de repressieve docent, varieerde de mate van Nabijheid van leerlingen ten opzichte van de docent in de negatieve situatie sterker. Interacties van de docent met de tolerante interpersoonlijke stijl waren minder voorspelbaar in de positieve situatie en juist meer voorspelbaar tijdens de lesstart en in de negatieve situatie dan de interacties van de docent met de repressieve stijl. Wat betreft adaptiviteit bleek dat beide interactiepatronen voornamelijk het complementariteitsprincipe volgden.

#### **Studie 4**

In de vierde studie (Hoofdstuk 5) hebben we de groep participanten uitgebreid naar 35 docenten met hun klas. We hebben van deze docenten alleen de lesstart geobserveerd aangezien deze situatie bij elke docent gegarandeerd aanwezig is. Met een fijnmazige analysetechniek hebben we de volgende vraag onderzocht: *Wat is de mate en aard van interpersoonlijke adaptiviteit in docent-leerling interacties in de klas?* Hiervoor hebben we ons onderzoek gefocust op verschillende aspecten van interpersoonlijke adaptiviteit: (1) de algehele (gemiddelde) mate van Invloed en Nabijheid in docent en leerlinggedrag (i.e., Interpersoonlijke inhoud) (2) (detrended) correlaties als een overall maat voor complementariteit, (3) het verband tussen lineaire trends in docent en leerlinggedrag, (4) de overeenstemming tussen cyclische patronen in docent- en leerlinggedrag (in termen van *coherence* en *phase*), en (5) overeenstemming in fluctuaties in resterende ruis (nadat de lineaire en cyclische patronen uit de data verwijderd zijn).

In de meeste klassen volgde de onderlinge aanpassing van docent- en leerlinggedrag het complementariteitsprincipe (overall correlatie, lineaire trends). Daarnaast bleek dat docent- en leerlinggedrag cyclische patronen vertoonden, die elkaar in sterke mate volgden (hoge *coherence*). Wie volgend en wie leidend was in de interacties (*phase*) verschilde aanzienlijk tussen de klassen; in slechts 20% van de klassen leidde de docent en volgden de leerlingen met betrekking tot zowel Invloed als Nabijheid.

Uit nadere analyse bleek, dat in klassen met een meer gewenste docent-leerling relatie het interpersoonlijke gedrag van docenten en de afstemming met het gedrag van leerlingen meer in overeenstemming waren met normen die vanuit het beroep gelden dan in klassen met een relatie die minder wenselijk is: In de klassen met de meer gewenste relatie was de Invloed en Nabijheid van docenten gedurende de start van de les in het algemeen op een hoger niveau. Bovendien nam de Nabijheid van de leerlingen gedurende de lesstart relatief sterker toe, en nam de Invloed van de leerlingen relatief sterker af. En waren in deze groep meer docenten

in staat om niet met vijandig gedrag te reageren op vijandig gedrag van leerlingen en niet met volgbaar gedrag als leerlingen veel gedrag hoog in Invloed lieten zien.

### **Bijdrage aan Onderzoek naar Docent-Leerling Relaties**

De bijdrage die de vier studies in deze dissertatie hebben geleverd aan de kennis over en het onderzoek naar docent-leerling relaties zijn geordend aan de hand van drie thema's: (1) de meerwaarde van het meenemen van meerdere tijd niveaus, (2) de meerwaarde van de tweezijdige benadering van interacties ten opzichte van een eenzijdige benadering van interacties en (3) de meerwaarde van het bestuderen van zowel microlevel interacties als macrolevel relaties.

### ***Tijd niveaus***

Om de dynamiek in docent-leerling interacties en relaties te onderzoeken hebben we gebruik gemaakt van metingen op verschillende tijd niveaus: de grovere jaarlijkse metingen in Studie I en de fijnmazige continue metingen met CAID-techniek in de overige drie studies.

Met de jaarlijkse metingen konden we voldoen aan de oproep van Chang (2009) om meer longitudinale studies naar burn-out bij docenten uit te voeren. Tevens konden we daardoor empirisch aantonen dat docent-leerling relaties inderdaad een belangrijke rol spelen in verschillen in burn-outgevoelens tussen docenten, maar ook binnen docenten over langere tijd.

Met de fijnmazige metingen was het mogelijk om de dynamiek in docent-leerling interacties te onderzoeken. Tijdsreeks-analyses van deze data leverden nieuwe inzichten op wat betreft de mate en aard van de afstemming in de interactie tussen docenten en leerlingen, de complementariteit van hun gedragingen, de aanwezigheid van een bepaald ritme in hun gedrag, hoe die ritmes op elkaar afgestemd zijn, en wie daarin een leidende rol vervult.

### ***Dyadische aanpak***

De meeste beschikbare onderzoeken naar docent-leerling interacties maakten gebruik van een eenzijdige benadering. In die studies werd bijvoorbeeld alleen gekeken naar docentgedrag, of werd bij het coderen de reactie van de leerlingen meegenomen om het gedrag van de docent te duiden in één score (e.g., Davis & Nicaise, 2011; Pianta, et al., 2008; Rubie-Davies, 2007; Yan, Evans, & Harvey, 2011). Om daadwerkelijk te kunnen onderzoeken hoe docenten en leerlingen hun gedrag aan elkaar aanpassen is het nodig om een tweezijdige benadering te hanteren. Bij een dergelijke tweezijdige benadering worden observaties van

docentgedrag en observaties van leerlinggedrag afzonderlijk meegenomen in de analyses. Tot op heden zijn er nog maar weinig studies waarin een tweezijdige benadering wordt toegepast om onderwijsinteracties te onderzoeken (i.e., Mainhard, Pennings, Wubbels, & Brekelmans, 2012; Roorda, Koomen, Spilt, Thijs, & Oort, 2013; Roorda, Koomen, Thijs, & Oort, 2013).

Volgens Kiesler (1996) en Oullier, Guzman, Jantzen, Lagarde en Kelso (2008) wordt gedrag van een persoon altijd beïnvloed door gedrag van anderen. Met de tweezijdige benadering van docent-leerling interacties was het mogelijk om een dergelijke claim in de onderwijscontext te onderzoeken. Vooral in studie 4 hebben we kunnen laten zien dat het gedrag van docent inderdaad effect heeft op het gedrag van leerlingen en andersom.

### ***Relatie tussen micro- en macroniveau***

Volgens de Dynamische Systeemtheorie zijn interacties de bouwstenen van relaties (Granic & Patterson, 2006), maar relaties bepalen op hun beurt ook interacties (Hollenstein & Lewis, 2006). De studies in dit proefschrift dragen bij aan de empirische basis voor deze theorie in de onderwijscontext. We hebben laten zien dat de inhoud, de structuur en adaptiviteit in microlevel docent-leerling interacties inderdaad gerelateerd zijn aan de docent-leerling relatie. Wat we echter nog niet hebben kunnen onderzoeken is hoe de interacties bijdragen aan de ontwikkeling van relaties. Hiervoor is onderzoek nodig met designs met herhaalde metingen niet alleen van interacties, maar ook van relaties.

### **Beperkingen**

De studies in dit proefschrift hebben diverse beperkingen, de meeste zijn beschreven in de betreffende hoofdstukken. Hier worden nog twee, wat meer overkoepelende, beperkingen van gerapporteerde onderzoek naar voren gehaald.

Volgens de Interpersoonlijke Theorie moet de interpersoonlijke betekenis van gedrag beschreven worden als een specifieke combinatie van Invloed en Nabijheid. Met uitzondering van Studie 2, waar we de continue data gereduceerd hebben tot combinaties van Invloed en Nabijheid in State Space Grids, hebben we Invloed en Nabijheid echter als aparte variabelen gehanteerd in de analyses omdat de benodigde technieken (nog) niet beschikbaar waren. Dat zien we als een belangrijke beperking van die analyses. In de nabije toekomst is het gebruik van circulaire statistiek (Batschelet, 1981; Berens, 2009) een goede optie om Invloed en Nabijheid in gedrag, interacties en relaties wel als gecombineerde score in analyses te hanteren. Echter, deze analysetechniek is op dit moment nog in ontwikkeling.

In onze studies hebben we de betekenis van gedrag en interacties gemeten door die te scoren als de mate van Invloed- en Nabijheid in interpersoonlijk gedrag. Door gedrag te vatten in getallen worden echter bepaalde aspecten van dat gedrag niet meegenomen (Holmes & Poole, 1991). De mate van Nabijheid in docentgedrag vertelt ons bijvoorbeeld niets over de context of de aard van het gedrag. Zo kunnen we uit een getal dat de mate van Nabijheid uitdrukt bijvoorbeeld niet opmaken of de docent lacht of op een vriendelijke toon praat tegen de leerlingen, terwijl die informatie wel kennis en begrip kan verschaffen over de dynamiek in interacties (zie bijvoorbeeld de onderzoeken van Van Tartwijk, 1993; Van Tartwijk, Brekelmans, Wubbels, Fraser, & Fisher, 1998). Door in toekomstig onderzoek zowel de numerieke weergave van de mate van Invloed en Nabijheid mee te nemen als de kwalitatieve beschrijvingen van gedrag, is het mogelijk om een completer beeld van de gedrag en interacties te geven. Dit zou bijvoorbeeld informatie kunnen opleveren waarom in sommige klassen of in sommige situaties interacties niet verliepen volgens het complementariteitsprincipe.

### **Suggesties voor Verder Onderzoek**

Behalve de suggesties op basis van de afzonderlijke studies (zie de betreffende hoofdstukken), leveren de studies als totaal ook suggesties voor verder onderzoek.

De studies in dit proefschrift waren onderdeel van een aandachtsgebied met als focus de ontwikkeling van de interpersoonlijke competentie van docenten. Voor dit aandachtsgebied hebben we ongeveer 180 docenten, vijf jaar lang gevolgd. We hebben daarbij meer gegevens verzameld dan we in dit proefschrift (en de andere twee proefschriften) al konden analyseren, dus in de toekomst kunnen nog verschillende onderzoeksvragen beantwoord worden. Bijvoorbeeld hoe docent-leerling relaties gerelateerd zijn aan self-efficacy, persoonlijkheid, bevoegenheid en andere aspecten van werk. Daarnaast is het mogelijk om met deze longitudinale data ook te kijken naar reciproque en causale verbanden tussen variabelen, bijvoorbeeld door middel van cross-lagged panel analyses. In 2014 hebben we al een artikel gepubliceerd waarin we aan de hand van een meervoudige casestudie met vier docenten beschrijven hoe de verschillende aspecten uit de drie projecten van het aandachtsgebied (interpersoonlijke kennis, identiteit en gedrag) van belang zijn voor docent-leerling relaties (zie Claessens et al., 2014). We zouden dit onderzoek kunnen uitbreiden met gegevens over meer docenten en hun klassen en bijvoorbeeld het verband tussen de kennis, de identiteit en het gedrag van docenten en de ontwikkeling daarvan over de tijd kunnen analyseren.

Een tweede suggestie heeft te maken met het observeren van leerlinggedrag. We hebben ervoor gekozen om de interpersoonlijke dynamiek op klasniveau te onderzoeken en niet op het niveau van individuele of groepen leerlingen. Interacties in de klassensetting zijn een typisch voorbeeld van *one-with-many* interacties (Kenny, Kashy, & Cook, 2006). Toch zou ook het observeren van individuele leerlingen belangrijke informatie kunnen bieden over interactieprocessen in de klas. We zouden bijvoorbeeld kunnen kijken hoe de docent interacteert met individuele leerlingen waarmee de docent een positieve of problematische relatie zegt te hebben (vergelijk Claessens, 2016). Dit soort observaties bieden een extra laag aan informatie over interactieprocessen in de klas.

We hebben in dit onderzoek een tweezijdige benadering van docent-leerling interacties gebruikt, maar hebben (nog) geen tweezijdige benadering van docent-leerling relaties gehanteerd. We hebben alleen aan de leerlingen gevraagd wat zij van het interpersoonlijk docentgedrag vinden. Voor een tweezijdige benadering van relaties, die volgens Carson (1969) een volledig beeld geeft van het geheel aan relaties in de klas, zouden we ook docenten moeten vragen of zij de interpersoonlijk stijl van hun leerlingen willen beoordelen.

### **Praktische Implicaties**

Voor het formuleren van implicaties is inzicht in causale verbanden tussen de variabelen belangrijk. De vier studies in dit proefschrift waren correlatief van aard en uitspraken over causaliteit kunnen daarmee niet worden gedaan. We formuleren hier enkele algemene suggesties voor de praktijk, die opleiders en trainers kunnen overwegen bij (onderdelen van) lerarenopleidingen en professionele ontwikkelingstrajecten voor docenten op het gebied van interpersoonlijke relaties waarbij bijvoorbeeld gebruik wordt gemaakt van video-coaching.

Docentgedrag in interacties met de klas zijn vaak intentioneel en strategisch, maar soms ook onbewust en automatisch. Door docenten zowel hun eigen gedrag als het gedrag van leerlingen te laten observeren krijgen ze meer inzicht in hoe hun eigen gedrag en het gedrag van de leerlingen elkaar wederzijds beïnvloedt.

In professionele ontwikkeling voor docenten gaat de aandacht vaak uit naar klassen of situaties waarin de docent problemen ervaart. Docenten wordt dan gevraagd om deze klassen of situaties te selecteren ter observatie (e.g., Brouwer, 2011; Fukkink, Trienekens, & Kramer, 2011; Tripp & Rich, 2012). Het kiezen van een dergelijke problematische klas ter bespreking met collega's of een coach zou als bedreigend ervaren kunnen worden, wat het leerproces van de docent mogelijk belemmert. Op basis van de resultaten van Studie I, zou, vanuit het perspectief van relevantie voor teacher burn-out, even goed een klas random

gekozen kunnen worden, of juist een klas met een relatief positieve relatie. Docenten voelen zich mogelijk prettiger bij video-opnames in dit type klassen en daardoor wellicht meer open voor veranderingen in hun gedrag.

Hetzelfde geldt voor de selectie van het type fragment dat gekozen wordt ter bespreking in coaching sessies. Uit de resultaten van studie 4 bleek dat alleen al het observeren van de eerste tien minuten indicatief is voor het beschrijven van de kwaliteit van de docent-leerling relatie. Voor coaching en professionele ontwikkelingstrajecten is het dus niet per definitie nodig dat de docent een negatieve situatie selecteert.

Aangezien is gebleken dat docenten waarvan het gedrag en de interacties minder voorspelbaar zijn vaak ook een minder goede relatie hebben met hun leerlingen, zou coaching in professionele ontwikkelingstrajecten ook kunnen focussen op de structuur van gedrag en interacties in termen van variabiliteit en voorspelbaarheid.

## **Conclusie**

Al met al hebben de vier studies in dit proefschrift bijgedragen aan onze kennis en begrip van het verband tussen docent-leerling interacties en relaties. We hebben hierdoor nieuwe inzichten gekregen die zowel in de praktijk als in toekomstig onderzoek toegepast kunnen worden.



## DANKWOORD

Op de middelbare school wist ik niet goed wat ik wilde, leren was niets voor mij, ik zat op het vwo, maar aan een universiteit studeren, dat leek mij niets. Achteraf realiseer ik me dat er op mijn school maar weinig aandacht besteed werd aan wat de verschillen tussen universitaire- en hbo-opleidingen zijn. In mijn ogen studeerden alleen slimmen mensen aan de universiteit en voor mijn gevoel was ik dat niet. Waarom zou ik een jaar langer naar de middelbare school gaan als ik ook een hbo-opleiding kon gaan doen en een jaar eerder kon gaan werken. Hoe anders liep het toen ik er tijdens mijn opleiding tot danstherapeut erachter kwam dat dat “praktische gedoe” helemaal niet aan mij besteed was. Ondanks de twijfels over mijn eigen kunnen waagde ik de stap naar de Universiteit.

Binnen twee maanden na de start van mijn opleiding viel eindelijk het kwartje, onderzoek doen en artikelen schrijven, dat was wat ik leuk vond. Tegen mijn ouders zei ik: “ik word later professor! Maar dan moet ik wel eerst mijn eerste tentamen nog even halen”. Het eerste jaar was moeilijk voor mij, de gedachte dat ik niet slim genoeg was om onderzoeker te worden stak soms (en nog steeds) weer de kop op, maar na twee jaar hard werken kreeg ik uiteindelijk de kans om te starten met de RMBS, studeerde ik cum laude af en werd ik uiteindelijk, nog voordat ik afgestudeerd was, aangenomen als AIO in Utrecht. Blijkbaar kon ik het toch allemaal wel, ik had alleen mensen om me heen nodig gehad die me het vertrouwen en de kansen gaven om dat in te gaan zien. Zonder hen bij naam te noemen, wil ik deze mensen dan ook graag als eerste bedanken, zonder hen stond ik hier nu niet.

De grootste ontwikkelingen heb ik in daaropvolgende jaren gemaakt. De mensen die me in die periode hebben gesteund wil ik graag in het bijzonder bedanken. Jullie hebben mij gemaakt tot wie ik nu ben.

Mieke, met jou had ik een ‘instant’ klik, ik kon de afgelopen jaren alles bij je kwijt, of het nu over werk ging of over privé, niets was voor jou te gek, altijd was daar jouw luisterend oor. We hebben samen gelachen en gehuild (al was ik dat dan wel in het laatste geval). We hebben samen op de fiets gezeten (lees: Mieke deed het zware werk en ik zat achterop), de Niagara Falls getrotseerd en o.a. Toronto onveilig gemaakt. Ik herinner me nog goed dat in mijn eerste week als AIO er een afdelings-barbecue werd georganiseerd, beneden in de tuin van het Langeveld gebouw. Daar werd muziek gedraaid en samen met Anna hoorde ik je roepen “Waar zijn mijn AIO’s? Jullie moeten komen dansen!”, maar Anna en ik hebben ons

stiekem snel uit de voeten gemaakt, maar tijdens mijn promotiefeest zal ik er zeker niet meer voor terugdeinzen om een dansje met je te doen hoor.

Jan, jouw eerste woorden op 1 september 2009: “welkom in deze IPP-familie, we zijn soms een beetje een incestueus clubje, maar het is wel heel gezellig!”. Je kunt je wel voorstellen dat ik me toen wel een beetje afvroeg waar ik in godsnaam terecht gekomen was... maar, het werd me al gauw duidelijk dat het vooral lollig bedoeld was. Jij bent altijd de vrolijkheid zelve, altijd optimistisch en jouw positieve energie straalt je op iedereen uit, althans op mij in ieder geval. Je bent van het pragmatisch denken, wat voor het naderende einde van mijn promotie traject wel heel goed uit kwam. Jij was de enige die ervoor kon zorgen dat Mieke en ik een beetje werden afgeremd in onze neiging naar perfectie. Ook daarvoor dank, anders was het nu nog niet af geweest.

Luce schreef in haar proefschrift “samen is het leuker”, en dat is het zeker weten! Mijn ADG-vriendinnetjes, Anna en Luce, samen waren we echt HAL, met onze roze vesten, de meisjes van het aandachtsgebied. Naast alle serieuze aangelegenheden hebben we ook veel lol gehad. De ontbijtjes na de dataverzamelingssavonden, de bioscoop avondjes met als hoogtepunt de Twilight marathon, met z'n drieën tussen de gillende tieners, zullen me altijd bij blijven. Ik denk dat we met trots mogen zeggen dat wij toch wel het allerbeste aandachtsgebied ooit waren!

Theo, bedankt voor je betrokkenheid en samenwerking. Bedankt dat je samen met Hans het Model voor Interpersoonlijk Leraarsgedrag hebt ontwikkeld, anders was mijn onderzoek er waarschijnlijk niet geweest. Ik ben blij dat ik je heb leren kennen en ik zal altijd aan je blijven denken als “the godfather van de IPP-familie”.

Tim, jouw promotie was de eerste in mijn leven die ik bijwoonde. Eigenlijk durfde ik daarna niet meer... ik dacht, dat ga ik toch nooit kunnen! Ik kon altijd bij je aankloppen voor advies en slimme ideeën, daar ben ik dankbaar voor. Een “Ouw ho\*r hey”!, “hubse al un carnavals pekske”?, “aufwiederschnitzel” en “tschüss!” schalden wel eens door de gang. Bedankt voor het introduceren van State Space Grids in jouw onderzoek en al helemaal voor het bezoeken van de SITAR in Zürich, anders was er misschien wel geen interpersonal dynamics- of joystick-onderzoek geweest. Tof dat je mijn paranimf bent!

I would like to thank Pam Sadler, first and foremost, for presenting your research at SITAR in Zürich and for letting Mieke and me visit Wilfrid Laurier University to participate in the

joystick training. Thank you, for your kindness, enthusiasm, and your intelligence. Wandering through Amsterdam and Berlin with you was a joy! I hope we will keep working together in the future.

For my colleagues at Michigan State University, Chris Hopwood, thank you for letting me stay at your house during the first week of my visit. I loved to “babysit” your cat and dog (you never told me the stories about their names though...).

Kate and Matt thank you for letting me stay with you in your cozy apartment. I had so much fun, and I know, “I was such a lovely house guest”, I am wondering whether you are still talking about me in the third person?

I learned a lot from all of you guys at MSU!

Ivana, thank you for teaching me to joystick, for sharing a room in New Haven, for all the skype (therapy) sessions, and for being such a lovely person. We both had our ups and downs the past years, but we made it! You are an inspiring person and I consider you one of my friends now! I will try and visit you in Edmonton, as promised.

Ik wil alle 189 docenten bedanken die mee hebben gedaan aan ons onderzoek. Zonder jullie had mijn promotieonderzoek niet kunnen slagen. Hopelijk komen we elkaar in de toekomst nog eens tegen.

Ik wil alle 40 Bachelor studenten, 9 Master studenten en de 3 student-assistenten bedanken die mij geholpen hebben met het verzamelen van data en het analyseren van video's, jullie waren de soldaten in mijn “video en joystick army”. In het bijzonder wil ik nog een aantal van hen bedanken:

Irene van der Meij, je hebt in jouw masterjaar veel meegemaakt, maar altijd was je bereid om mij te helpen, zelfs nadat je was afgestudeerd, daar ben ik je erg dankbaar voor. We hadden zeker de X-factor!

Rosanne bedankt voor je hulp bij het observeren van de eerste batch video opnames.

Kristel en Eva, jullie hebben destijds bijna al jullie vrije tijd besteed met joysticks in jullie handen, starend naar computerschermen. Zonder jullie hulp was ik nu misschien nog steeds aan het coderen... Thanks!

Verder wil ik al mijn collega's, zowel binnen al buiten de UU, bedanken. Dat zijn er heel erg veel, ik noem dus geen namen want ik wil niemand vergeten, wie zich aangesproken voelt,

top! Ik ben blij dat ik jullie heb leren kennen en dat veel van jullie nog steeds mijn collega's zijn.

Mijn "AIO-kamer"-genootjes, Ada, Anouschka, Luce, Marloes, en soms ook Romi en Anna. Ik vond het fijn met jullie op de kamer en eindelijk zijn we nu allemaal klaar!

Mijn huidige kamergenootjes, Lisette en Barbara, eindelijk kunnen jullie mij nu serieus nemen als onderzoeker.

Ik wil al mijn vrienden bedanken voor de toffe vakanties, weekendjes weg, gezellige avonden en dagjes uit de afgelopen jaren. Het is fijn om zulke leuke vrienden te hebben.

Eef en Iulia, jullie waren er "every step of the way", jullie zijn er altijd voor mij. Bedankt dat jullie in mijn leven zijn.

Etienne, je hebt ervoor gezorgd dat ik niet in een ivoren toren zou belanden. Hoewel wij niet meer samen zijn, probeer ik die gedachte nog altijd ter harte te nemen. Ik ben blij dat we elkaar hebben kunnen helpen om het beste in onszelf naar boven te brengen, ook al had het een andere uitkomst dan we misschien in de afgelopen 13 jaar gedacht hadden. Op een mooie toekomst, niet meer voor ons samen, maar voor jou en voor mij en de wegen die we allebei zullen gaan bewandelen, als vrienden.

Martin, jij bent de nieuwste belangrijke persoon in mijn leven. Ik ken je nog maar kort, maar vanaf het eerste moment leek het wel alsof we elkaar al 10 jaar kenden. Zo veel leuke dingen die we al samen gedaan hebben, onze spontane reis naar Curaçao en Sint Maarten, ons tripje naar Parijs en onze reis naar de VS waren om nooit te vergeten! Samen ijsjes eten bij Luciano's, indoor skydiven, phantasialand, 100x naar Ikea (jouw favoriete bezigheid)... we zullen zien wat de toekomst verder nog voor ons in petto heeft!

Marjon, mijn zusje ;-), bedankt voor je steun en in interesse in mijn onderzoek, en je mening over de cover, ik vind 'm super mooi geworden! Super tof dat je mijn paranimf wil zijn!

Pap en mam, ik heb geleerd dat je het misschien niet altijd eens bent met wat ouders zeggen (Naerse waerse he), maar dat zij stiekem toch wel vaak gelijk hebben. Bedankt dat jullie dit alles mogelijk hebben gemaakt en onvoorwaardelijk achter me staan. Jullie waren

het misschien ook niet altijd eens met mijn keuzes, maar toch respecteerden jullie die, en stonden achter me op de momenten dat mijn leven toch iets anders liep dan ik had verwacht. En wie had ooit gedacht dat ik zou gaan promoveren? Zonder jullie had ik dit zeker niet kunnen doen. Ik weet dat jullie, ondanks dat jullie dit proefschrift niet hebben gelezen (denk ik), erg trots op me zijn.



**CURRICULUM VITAE**

Helena (Heleen) Pennings studied Dance Movement Therapy at Zuyd University of Applied Sciences (BA, 2001-2005), Pedagogical and Educational Sciences at the Radboud University (BSc., 2005-2008), and the Behavioral Science Research Master in 2009 (Cum Laude) also at the Radboud University. In September 2009, she started her PhD project at Utrecht University focusing on Interpersonal dynamics in teacher-student interactions and relationships.

She presented her work at several national and international conferences. She visited international experts in her research field, Prof. dr. Pamela Sadler (Wilfrid Laurier University, Waterloo, Canada), Dr. Chris Hopwood, and Dr. Kate Thomas (Michigan State University, East Lansing, United States).

She was general board member of the VOR Promovendi Overleg (VPO) from January 2011 to September 2013, and was involved in organizing events and symposia.

Alongside and after her PhD studies, she gained teaching experience as a lecturer and coordinator in several bachelor and pre-master courses, and as bachelor's and master's thesis supervisor. She also trained several students and research assistants to use Sadler's joystick procedure.

She collaborated with other researchers to obtain various research grants. She also, collaborated with Oberon on a project, monitoring large scale collaboration project between schools and teacher education. From October 2014, she continued her research as a postdoc position at the department of Educational Sciences at Utrecht University. From October 2015 until September 2016, she also worked (part-time) as a postdoc researcher in an interrelated research project at the Eindhoven University of Technology. Currently, she works as a postdoctoral researcher at the department of Educational Sciences of Utrecht University. Where she will keep studying data gathered during her PhD project.



## LIST OF PUBLICATIONS

### Peer-reviewed Publications

- Claessens, L. C. A., Pennings, H. J. M., Van Der Want, A. C., Brekelmans, M., Den Brok, P., & Van Tartwijk, J. (2014). De docent en het sociaal klimaat in de klas: een benadering vanuit interpersoonlijk perspectief. *Pedagogische Studiën*, *91*, 300-315.
- Claessens, L. C. A., Van Tartwijk, J., Pennings, H. J., M., Van Der Want, A., Verloop, N., Den Brok, P., & Wubbels, T. (2016). Beginning and experienced secondary school teachers' self- and student schema in positive and problematic teacher-student relationships. *Teaching and Teacher Education*, *55*, 88-99. doi:<http://dx.doi.org/10.1016/j.tate.2015.12.006>
- Claessens, L., van Tartwijk, J., van der Want, A., Pennings, H. J. M., Verloop, N., den Brok, P., & Wubbels, T. (2016). Positive teacher-student relationships go beyond the classroom, problematic ones stay inside. *The Journal of Educational Research*. Advanced online publication. doi:<http://dx.doi.org/10.1080/00220671.2015.1129595>
- Mainhard, M. T., Pennings, H. J. M., Wubbels, T., & Brekelmans, M. (2012). Mapping control and affiliation in teacher-student interaction with state space grids. *Teaching and Teacher Education*, *28*(7), 1027-1037.
- Pennings, H. J. M., Brekelmans, M., Wubbels, T., Van Der Want, A. C., Claessens, L. C. A. & Van Tartwijk, J. (2014). A nonlinear dynamical systems approach to real-time teacher behavior: Differences between teachers. *Nonlinear Dynamics, Psychology, and Life Sciences*, *18*(1), 23-45.
- Pennings, H. J. M., & Mainhard, T. (2016). Analyzing teacher-student interactions with State Space Grids. In M. Koopmans, & D. Stamovlasis (Eds.), *Complex dynamical systems in education: Concepts, methods and applications* (pp. 233-271). New York: Springer. doi:[10.1007/978-3-319-27577-2\\_12](https://doi.org/10.1007/978-3-319-27577-2_12)
- Pennings, H. J. M., Van Tartwijk, J., Wubbels, T., Claessens, L. C. A., Van Der Want, A. C., & Brekelmans, M. (2014). Real-time teacher-student interactions: A dynamic systems approach. *Teaching and Teacher Education*, *37*, 183-193. doi:<http://dx.doi.org/10.1016/j.tate.2013.07.016>
- Van Der Want, A., Den Brok, P., Beijaard, D., Brekelmans, M., Claessens, L. C. A., & Pennings, H. J. M. (2015). Teachers' interpersonal role identity. *Scandinavian Journal of Educational Research*, *59*(4), 224-442. doi:[10.1080/00313831.2014.904428](https://doi.org/10.1080/00313831.2014.904428)
- Van Der Want, A., Den Brok, P., Beijaard, D., Brekelmans, M., Claessens, L. C. A., & Pennings, H. J. M. (Accepted for Publication). Changes over time in Teachers' Interpersonal Role Identity. *Research Papers in Education*.

### **Manuscripts Submitted for Publication**

Claessens, L. C. A., Janssen, E., Van Tartwijk, J., Mainhard, T., Pennings, H. J. M., Van der Want, A. C., Verloop, N., Den Brok, P., & Wubbels, T. (Under review). Teacher characteristics and Interpersonal perceptions of students in positive, neutral and problematic teacher-student relationships.

Claessens, L. C. A., Van Tartwijk, J., Van der Want, A. C., Pennings, H. J. M., Verloop, N., Den Brok, P., & Wubbels, T. (Under review). Principles of attraction in positive teacher-student relationships: A teacher's perspective.

Pennings, H. J. M., Brekelmans, M., Sadler, P., Claessens, L. C. A., Van der Want, A. C., & Van Tartwijk, J. (Revisions). Interpersonal Adaptation in Teacher-Student Interaction.

Pennings, H. J. M., Van Tartwijk, J., Van der Want, A., Claessens, L. C. A., & Brekelmans, M., (Soon to be submitted for publication). Teachers' feelings of burnout and the relationships with students: Between and within teacher differences across five years.

Van Der Want, A., Den Brok, P., Beijaard, D., Brekelmans, M., Claessens, L. C. A., & Pennings, H. J. M. (Under review). The relation between teachers' interpersonal role identity and their well-being.

### **Invited Presentations**

Pennings, H. J. M. (2015). *Using Sadler's joystick method to observe behaviour of teachers and students*. Invited presentation at the 2<sup>nd</sup> seminar of the Network on Intrapersonal Research in Education, June 11: Oxford, UK. A video recording of this presentation can be watched via <http://www.education.ox.ac.uk/network-on-intrapersonal-research-in-education-nire/seminar-2-oxford-june-2015/helena-pennings/>

### **Conference Papers (as presenter)**

Pennings, H. J. M. (2016, September). *Momentary assessment of interpersonal adaptation in teacher-student interactions*. Paper presented at the Conference on Complexity Systems (CCS), Amsterdam, The Netherlands.

Pennings, H. J. M., Brekelmans, M., & Van Tartwijk, J. (2014, March). *A nonlinear dynamical systems approach to real-time teacher behavior: Differences between teachers*. Paper presented at the 6<sup>th</sup> International Nonlinear Science Conference, Nijmegen, The Netherlands.

Pennings, H. J. M., Brekelmans, M., Claessens, L. C. A., Van der Want, A. C., & Van Tartwijk, J. (2015, June). *Het verband tussen docent-leerling interacties en de kwaliteit van de docent-leerling relatie* [The association between teacher-student interactions and the quality of the

- teacher-student relationship]. Paper presented at the Dutch Educational Research Days, Leiden, The Netherlands.
- Pennings, H. J. M., Brekelmans, M., Sadler, P., & Van Tartwijk, J. (2016, July). *Who is following whom? Interpersonal adaptation in daily teacher-student interaction*. Paper presented at the 19th annual meeting of the Society for Interpersonal Theory and Research (SITAR), Berlin, Germany.
- Pennings, H. J. M., Mainhard, T., & Brekelmans, M. (2015, April). *Analyzing interpersonal content and structure of teacher-student interactions with State Space Grids*. Paper presented at the annual conference of the American Educational Research Association (AERA), Chicago, USA.
- Pennings, H. J. M., Mainhard, T., & Brekelmans, M. (2015, May). *Momentary teacher-student interactions and teacher interpersonal styles*. Paper presented at the 18th annual meeting of the Society for Interpersonal Theory and Research (SITAR), Toronto, Canada.
- Pennings, H. J. M., Van der Meij, G. I., Brekelmans, M., Van Tartwijk, J., & Wubbels, T. (2014, June). *Alignment between real-time teacher-student interactions and the teacher-student relationship*. Paper presented at the 17th annual meeting of the Society for Interpersonal Theory and Research (SITAR), New Haven, CA, USA.
- Pennings, H. J. M., Van Tartwijk, J., Vermunt, J., & Brekelmans, M. (2012, June). *Leren en ontwikkeling van competenties van aanstaande, beginnende en ervaren docenten: Interpersoonlijk docentgedrag en leerlingbetrokkenheid [Learning and development of competencies of novice and expert teacher: Interpersonal behavior and student engagement]*. Paper presented at the Dutch Educational Research Days, Wageningen, The Netherlands.
- Pennings, H. J. M., Van Tartwijk, J., Vermunt, J., & Brekelmans, M. (2012, April). *Teacher interpersonal behavior and student engagement: A microgenetic study*. Paper presented at the International Conference on Interpersonal Relationships in Education (ICIRE), Vancouver, Canada.
- Pennings, H. J. M., Van Tartwijk, J., Vermunt, J., & Brekelmans, M. (2011, April). *Teacher interpersonal behavior: A contrasting case study*. Paper presented at the annual conference of the American Educational Research Association (AERA), New Orleans, USA.
- Pennings, H. J. M., Van Tartwijk, J., Claessens, L. C. A., Van der Want, A.C., Wubbels, T., & Brekelmans, M. (2012, November). *Characteristics of interactions between teachers and students*. Paper presented at the ICO International Fall School, Girona, Spain.





