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The Effectiveness and Effects of Collaboration among Teachers in German Schools

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Abstract

Teacher collaboration (TC) has been deemed as a factor which can positively impact the school community. In this dissertation, the influence from different forms of TC on student achievement (SA) is investigated through three publications which analyzed specific aspects regarding TC in Germany. Secondary analyses of the German datasets of the Programme of International Student Assessment (PISA) from 2012 (publications A and B) and 2015 (publication C) were carried out as follows: publication (A) analyzed the frequency of three different forms of TC namely instruction-, project-, and organization related and their differences for school type and gender of the teachers, publication (B) their relationship with student achievement, and publication (C) by analyzing two forms namely exchange and coordination of teaching, and professional collaboration their role as mediator between principal leadership and student achievement. Publication (A) showed that overall TC is weak, and that significant differences among all three forms of collaboration proposed by PISA in 2012 exist for school type, whereas teacher gender showed significant differences only in the organizational form which encompasses elements regarding student performance. Results from Publication (B) provided an indication that while the association of all three forms of TC with SA were non-significant, the organizational form was the only one yielding a positive direction. Publication (C) provided additional indications that the exchange form of collaboration which is the form requiring less effort is not related to SA, as it yielded negative and significant correlations to it, which was also the case for the indirect relationship between IL and SA. The findings of the studies illustrate the underlying complexity of teacher collaboration when studied as a construct with several forms, its differentiated role for student achievement and the difficulty to measure the relationships of teacher collaboration with other variables. Implications, limitations, and directions for further research and practice are presented in detail at the end of this dissertation.

Keywords: Teacher Collaboration, PISA 2012, PISA 2015, Structural Equation Modeling, Instructional Leadership, School Differences, Teacher Gender, Student Achievement, Mathematics, Reading

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Dedication

Para Ana, por ser el motor que me mantiene andando... mi razón de existir.

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1. Introduction

Seen from a broader perspective, collaboration is an ability that has allowed humans to reach goals which would otherwise be impossible or too difficult to reach. This has been pointed out as a possible main reason to explain our success as a species (Melis, 2013). Arguably, it can be said that the benefits of collaboration among humans as a species, apply as well to specific forms such as collaboration among teachers which is part of a school culture. After all, as Schein (1985) argues: the culture of a school reflects what its members value and their beliefs about the world and their place in it. Throughout the years, research on teacher collaboration has consistently depicted it as a key element for the development of the school (Burns & Darling-Hammond, 2014), as through the direct interaction teachers have with their students, they play a major role in their lives and their achievement (Hattie, 2012). Student achievement and learning will be ultimately influenced by teaching quality (Blömeke et al. 2016) which is arguably influenced by teacher collaboration.

However, reaching effective teacher collaboration is not an easy task as it requires among others, commitment, trust, and support from all parties involved. There are numerous factors that can influence it, that can predict its frequency or its perception from the part of teachers, principals and/or stakeholders, and that can be influenced by it (cf. Scheerens, 2016; Vangrieken et al. 2015). The complexity of teacher collaboration, the benefits that can be extracted from it as well as the inherent challenges that surround it, make it a very interesting topic of choice as it offers research with vast opportunities to investigate one aspect that may play a positive role in the life of the whole school community, marking a difference in the way it is investigated and in the way it is applied.

The overarching objective of this dissertation, which is presented through three publications in peer-reviewed journals, is to study the extent to which teacher collaboration influences student achievement. Given the complexity of the subject and taking into account that teacher collaboration does not occur in an empty space, this overarching objective cannot be reached by only studying the direct effects that teacher collaboration has on student achievement, which is done in publications (B) and (C), it is also necessary to provide context which in this dissertation was done by investigating the state of teacher collaboration in terms of its frequency as well as the extent to which school type and gender influence it, providing also the differences between these constructs (publication A). Furthermore, this dissertation studied preconditions that are necessary to ensure that teacher collaboration is being

implemented. Concretely it investigated the influence that principals have on it by means of use of instructional leadership (publication C). However, the main objective of this dissertation remains the study of the effects that teacher collaboration has on student achievement. The reason for this can be summarized in the impact that these two factors have in the school. The importance of collaboration among teachers was well summarized by Hattie: “The biggest effect in our business is expertise of the teachers. It’s the teachers who work together. I say it again: collectively, collaboratively, to understand their impact. And that’s probably the biggest single most factor in this business” (Hattie, 2013). Meanwhile, the significance of student achievement can be outlined in the fact that almost all educational reforms in history have put it at its center and also that student achievement might become a high-stakes predictor or criterion for important educational decisions, for example, judgements about entry or exit from programs or institutions (Willingham et al. 2002, p. 1).

In order to fulfil the overarching objective, the present dissertation provides theoretical background on teacher collaboration as it relates to the focus of this dissertation (chapter 2) and secondary analyses (chapter 4) of the representative German PISA data of the years 2012 (Prenzel et al. 2015) and 2015 (Reiss et al. 2019). An overview of the variables used from these instruments will be presented in chapter 3. In the fourth chapter of this dissertation, the three publications will be summarized in order to provide the reader with an overview of what has been done and achieved. In the fifth chapter the results, limitations and directions for future research and practice will be discussed.

2. Theoretical Background

Before presenting the summary of the articles that were published in the context of this dissertation (chapter 4), the main concepts associated to it are presented in this chapter; specifically teacher collaboration itself, (section 2.1.1), including its benefits and difficulties (sections 2.1.2 and 2.1.3). Later the state of collaboration among teachers in Germany (section 2.1.4). Subsequently, a summary of impact of teacher collaboration on student achievement will be presented (section 2.2), and the relationship between leadership in schools and teacher collaboration will be discussed (section 2.3).

2.1. Teacher Collaboration

2.1.1. What is Teacher Collaboration

Narrowly defined, in the educational context, collaboration describes a set of practices voluntarily initiated between two or more educators, the main purpose of which is the improvement of educational processes and outcomes at both the individual and collective level (cf. DuFour, 2003; Esslinger, 2002; Friend & Cook, 2009; Mora-Ruano et al., 2018). Cook and Friend (1993) provided one of the first set of characteristics for teacher collaboration, stating that: “It is voluntary, it is based on parity, it requires a shared goal, it includes shared responsibility for key decisions, it includes shared accountability for outcomes, it is based on shared resources and it has emergent properties” (p. 420). One of the first differentiations of the construct originates from Little (1990), who described four different forms of collaboration including: storytelling and scanning for ideas, aid and assistance, sharing, and joint work. In the German speaking world, the two most popular postulated models of teacher collaboration were introduced by Gräsel et al. (2006), and Steiner et al. (2006). Gräsel et al. (2006) differentiate between three forms of collaboration ranging from simple to more structured: exchange, shared work and co-construction whereas Steinert et al. (2006) proposed a classification of the intensity of collaboration embedded into 5 categories ranging from low to high: fragmentation, differentiation, coordination, interaction and integration.

However, a definition of teacher collaboration is mostly lacking (cf. Aldorf, 2016; Kelchtermans, 2006) which eventually leads to a problematic regarding the conceptualization and consequently operationalization of the construct (cf. Bauer, 2008; Soltau, 2007). Consequently, in the first article of this dissertation in order to contribute to the research field and to provide a framework for our studies, we proposed the following definition: “teacher

collaboration [is] a voluntary activity between two or more teachers who, based on relational trust and respect, through collaborative leadership and school administration, coordinate efforts, reconcile different approaches and exchange ideas and materials in order to increase teaching effectiveness as well as affective and cognitive job satisfaction" (Mora-Ruano et al. 2018, p. 4).

2.1.2. Benefits of Teacher Collaboration

Across the literature there is consensus about the positive role teacher collaboration plays in the school. Its importance as a central factor for the development and quality of schools is supported by a vast amount of school researchers and empirical studies, which underscore that teacher collaboration cannot be understood as an end in itself, but could serve as a means for the benefit of the students by improving schools and teaching (cf. Fend, 2009; Fussangel & Gräsel, 2011; Gräsel et al., 2006; Kullmann 2010; Rosenholtz 1991; Rutter et al., 1980; Steinert et al., 2006; Terhart & Klieme, 2006). The improvement of these two factors can be achieved through teacher collaboration, as it enables teachers to get on a professional and competence development path (cf. Altrichter, 1996; Keller-Schneider et al., 2013; Köker, 2011) which might comprise activities regarding, for example, the collaborative design of lessons (cf. KMK, 2014, Wake et al., 2016). Furthermore, empirical studies have found that collaboration among teachers leads to increased job satisfaction (cf. Ahlgrimm, 2010; Johnson et al. 2012; Mostafa & Pál, 2018; OECD, 2014a), as well as reduction of stress and burnout (cf. Carle, 1995; Fussangel & Gräsel, 2012; Hargreaves, 1994; Kullmann, 2010) which in the end benefits teachers emotionally and psychologically (Johnson, 2003), so that teaching becomes more satisfying (Burns & Darling-Hammond, 2014; Fussangel & Gräsel, 2012). This, in turn, leads to the promotion of teacher retention and enhancement of teacher quality as teachers feel supported by their colleges (Darling-Hammond et al., 2012; Hopkins & Spillane, 2014; Kraft et al., 2016; Warren & Sorges, 2013).

The benefits that can be extrapolated from collaborative activities between teachers are not restricted just to the teaching staff, empirical findings show that they extend to other groups within the schools, such as students, as teacher collaboration is also recognized as a decisive factor that positively influences student achievement (cf. Bondorf, 2013; Goddard et al., 2010). A longer overview of the relationship between teacher collaboration and student achievement can be found later in this chapter, on section 2.2. Furthermore, Rieber and Robinson (2004) argue that people develop and improve their reasoning skills when they engage in collaborative activities, which also allow them to grow by sharing experiences and

by communicating with each other. Quality and effectiveness of schools can also be positively influenced by teacher collaboration as several empirical studies have shown (cf. Bondorf, 2013; Goddard et al., 2007; Williams, 2010). Moreover, Papay et al. (2020) found that teachers working together in skill-matched pairs, improved their job performance, measured by their students' test score growth (p. 360).

2.1.3. Difficulties of Teacher Collaboration

Although the benefits of collaboration among teachers continue to be established in the literature and there is a consensus about its importance and its advantages, getting to collaborate can be difficult. There is a myriad of reasons behind this, from the nature of the activity to the way it is set in motion to its outcomes. For instance, Vankriegen et al. (2015) argue that "teacher collaboration should not be seen as a magic solution that solves all problems as it can entail negative consequences" (p. 36). It must be put in context that although in the education sector the divergence between what is demanded and what reality allows to deliver is often large, the gap for teacher collaboration is notably significant (Terhard & Klieme, 2006). In this chapter some of the difficulties associated to teacher collaboration are presented.

2.1.3.1. Isolation

Although having clear interpersonal components, the nature of teaching is also self-centered (Evans, 2012), therefore it is not surprising that isolation may be predominant in schools which ultimately leads to low levels of collaboration. It has been argued that schools, when studied as workplaces, are characterized by segmented and cellular structures that make isolated work the norm (cf. Altrichter, 1996; Lortie, 1975, Weick, 1982). For instance, Weick (1976) argues that educational organizations with traditional structures can be described as "loosely coupled systems" (p. 5). Interactions in such systems are not intensive, irregular, time-delayed and formal mechanisms of control and coordination cannot be located. Therefore, in such systems there is almost no need to collaborate and arguably teacher isolation is fostered. Furthermore, teachers' tendency to work individually rather than collectively might also be explained through the autonomy and parity pattern (Lortie, 1972) which can be described as a series of norms where there is no interference between colleagues' teaching and their own (autonomy) but at the same time there is a culture of mutual acceptance and interaction (parity). The consequence of this is what Lortie (1975) called "egg-crate isolation" which delimitates not only the physical location where instruction

takes places but also isolates teachers' actions within that space (p. 41). "When schools are organized like egg crates, important information about the challenges that teachers encounter, the problems that puzzle them, and the expertise they might offer their peers remains limited by the confines of the classroom." (Johnson, 2015, p. 119). Isolation is also fueled by a "unhealthy and unrealistic sense of what constitutes professional autonomy" (DuFour, 2003, p. 39), leading to a misplaced notion that by interacting professionally with others the teachers' autonomy will be transgressed, for example in the form of negative criticism (Altrichter & Eder, 2004). This misplacement leads to a state of confusion, where what some might consider as isolation may be seen as individual autonomy by others, which will ultimately hinder collaboration, as interactions are at the very core of collaboration. This differentiation is very important for the exploration and conceptualization of the construct because, as Hargreaves (1994) argues, autonomy does not necessarily need to have negative connotations in the same way that collaboration does not need to always be valued as something inherently positive.

2.1.3.2. Lack of Leadership

A lack of leadership in schools may likely also lead to low levels of collaboration, because through leadership the necessary structures allowing and fostering collaboration can be constructed. DuFour et al. (2016) argues that alongside lack of time, another central aspect hindering collaboration is a lack of leadership. As Friend and Cook (2009) contend, without leadership it would be impossible for collaboration to take place, since the specification of goals and outcomes as well as the allocation of time are central to creating thriving collaboration communities. The latter aspect is of critical importance because the amount of time teachers dedicate to, for example, create a module and its content focus, is one of the primary challenges they have to face (Rabidoux & Rottmann, 2017). As Leithwood and Day (2007) argue, principals are a key element to implement change in schools successfully.

If the creation and implementation of collaborative structures are not properly carried out, collaboration might be hindered. For instance, there are school leaders who create and boost teacher collaboration as an initiative of their own, risking the creation of what Hargreaves (1994) labeled as "contrived collegiality" (p. 191) instead of creating and fostering authentic cultures of collaboration. Five key features of contrived collegiality are identified: administratively regulated, compulsory, implementation-oriented, fixed in space and time, and predictable (ibid, p. 193). This results in leaders which only engage teachers in collaborative activities for strategic reasons, most notably as a way to enforce their policies

(Datnow, 2011), usually through Professional Learning Communities (PLCs), by prioritizing, under a high accountability climate, their agendas on short-term achievement gains in order to show success (Daly et al. 2011). Invasion of collaborative efforts, that is engaging teachers in activities that are not initiated by the teachers themselves do not empower them through collaboration and the pressure associated to these unauthentic settings leads teachers to suppress their trust, their participation and even to leave the schools or the profession (Hargreaves, 2019). For instance, Muckenthaler et al. (2020), when identifying and comparing patterns of perceived collaboration with their associated perceived benefits, found that "teachers who perceive pressure from their principal neither collaborate more nor perceive more benefit" [from collaboration activities] (p. 12). Furthermore, they found that when teachers perceive less pressure, they are able to engage in more complex forms of collaboration, and the other way around (ibid).

2.1.4. The Situation in Germany

In Germany, previous studies of teacher collaboration show that although being considered a key element for the development of the school (KMK, 2003), the extent of how much it is exercised in schools is low overall, independent of the school form. But it has also been found that the higher the school track the less collaboration activities take place and that women tend to collaborate more than men (cf. Helmke & Jäger, 2002; Klieme et al. 2008; Mora-Ruano et al. 2018; Richter & Pant, 2016; Soltau, 2011;). Additionally, in the (few) international comparisons, Germany is in the midfield of collaboration (Gräsel, 2008). Terhard and Klieme (2006) sustain that "teacher collaboration either does not take place at all, does not take place to the necessary extent, or does not take place in demanding and effective forms" (p. 163). Research of teacher collaboration in Germany consistently supports this notion; it indicates that although almost all teachers consider it important to collaborate with others, they prefer to engage in forms of collaboration that place the lowest demands on collegiality and interaction, that is forms strongly related to individual activities, such as exchange of teaching materials, whereas activities that require actually to sit together in teams or in pairs to for example carry out the planification of projects, is not so strong (cf. Fussangel & Gräsel, 2012; Gräsel et al., 2006; Morgenroth, 2015).

One possible reason which can explain why teacher collaboration is overall low, comes from research suggesting that the autonomy-parity pattern (briefly explained in section 2.1.3.1. of this dissertation) which has so far been primarily located and studied in the profession, appears first in a part of the student teachers (*Lehramtstudierende*) (Rothland et al.

2017), presumably as a coping strategy to hide individual weaknesses and deficits in personal areas related to professional collaboration (Drossel, 2015). So as Eder et al. (2011) argue, it is plausible to think that if thought and behavior habits related to the autonomy-parity pattern, which eventually shape strategies of isolation, are already present in the training stage of future teachers, it might be too late to counteract them because "the pre-professional socialization effect in school cannot be circumvented" (p. 215).

Although it has already been mentioned earlier in this dissertation, it must be emphasized that effective collaboration among teachers requires appropriate structures as it does not occur in the void. Kelchtermans (2006), for example, argues that first a structure that supports a culture of collaboration must be in place and (Hallinger, 2018) complements this view as he argues that schools principals are ultimately the ones responsible for providing teachers and the school community with such structures. This is mentioned again in this section of the dissertation, since in Germany the topic of school leadership can be particularly problematic, on the one hand because of the pedagogical freedom (*Institut der pädagogischen Freiheit*) teachers possess and the enormous influence the staff conference (*Schulkonferenz*) and the teacher conference (*Lehrerkonferenz*) have, so decision-making power from principals is very limited (Huber, 2016). However, it must not go unnoticed that as stated in the ASD (2005) report: "without good school management, there is not good school" (p. 9). Teacher collaboration frequency, practices and effects may be a direct result of the implemented policies and leadership of principals. In Germany, this might be partly difficult because formal academic training in matters of leadership is not a prerequisite for becoming a principal, making the situation more complicated as they find themselves in a position of leadership without proper training (Tulowitzki, 2015).

2.2. Teacher Collaboration and Student Achievement

Student achievement is an important characteristic for measuring school effectiveness. Its measurement in the current research encompasses more than simply a broad performance measurement as it now involves the consideration of competencies (Holt et al. 2010). It is deemed a key indicator of the quality not only of the schools but also of the systems they are embedded in, as well as a criterion for assessing processes in the schools (cf. Klieme et al. 2010). Findings regarding the effects of teacher collaboration on student achievement are to some extent inconsistent, probably because of the "difficulty of capturing both the effects of teacher collaboration and student achievement in their various dimensions in terms of research methodology" (Trumpa et al. 2016, p. 84). Empirical studies have however found

some positive effects of teacher collaboration on student achievement (cf. Borko, 2004; Bryk et al. 2010; Darling-Hammond et al., 2017; Goddard et al., 2007; 2010; Lara-Alecio et al., 2012; Louis et al., 2010; Vincent-Lancrin et al., 2017). For instance, Zeichner and Liston (2010) found that when teachers take part in programs of collaboration such as active problem solving, student achievement is increased as a result of the teamwork teachers do to enhance student engagement. Research from the US has also shown how through collaboration, student achievement has increased. As an illustration, Kraft and Papay (2014) carried out analyses covering 10 years of data from 2000 to 2010, from schools in the urban district of Charlotte Mecklenburg in North Carolina, the 18th largest in the country. Their results show that students' standardized test scores in the subjects of mathematics and reading increased more when teachers had supportive professional environments which promoted a culture of collaboration. Another example comes from (Ronfeldt et al. 2015) who also found higher gains in math and reading achievement when teachers reported extensive and helpful collaboration practices among their instructional teams in the span of two years.

In the last decades researchers have been studying teacher collaboration as a multifaceted construct, perhaps as a consequence of critic received regarding how indistinctly it was measured before (cf. Bauer, 2008; Cook & Friend, 1993) and suggestions that in order to properly evaluate it, research should distinguish between different forms (cf. Kelchtermans, 2006). This differentiation is of critical importance when studying the construct because as Hargraves (1994) states: "What matters is not that there are many different kinds of collaboration and collegiality but that the characteristics and virtues of some kinds of collaboration and collegiality are often falsely attributed to other kinds as well, or perhaps to collaboration and collegiality in general" (p. 188). As a consequence, it has been suggested that the influence teacher collaboration might have on student achievement depends heavily on its form (cf. Mora-Ruano et al. 2019, 2021). Research has also shown that the effectiveness in improving student achievement varies depending on the approach which can take different forms such as mentoring, co-teaching, or peer observation to mention some. For instance, Papay et al. (2020) found in their study in 14 schools in a low-income Tennessee school districts, that mentoring had a significant positive impact on student achievement under mentored teachers and across the schools overall where mentoring took place. The evidence for the effectiveness of mentoring at improving student achievement is, however, mixed (cf. Glazerman et al. 2010).

Yet findings on the effects of teacher collaboration on student achievement are to some extent contradictory. For instance, Scheerens (2016), in his meta-analysis, came to the overall conclusion that collaboration among teachers appears to be an insignificant variable in explaining variations in achievement, making the clarification that the low effect they found "may be due to the superfluous way collaboration is often measured, for example, in terms of the frequency of staff meetings" (p. 193). This last interpretation has been to some extent already present in the literature, as in their study Scheerens and Bosker (1997) justify the lack of effects of teacher collaboration mainly by an insufficient conceptualization of the construct. Furthermore, Shen et al. (2020), by analyzing data from the *Progress in International Reading Literacy Study* (PIRLS) 2011, found that teacher collaboration was not a significant predictor of student achievement in Taiwan, Hong Kong, and Singapore.

2.3. School Leadership as a prerequisite for Teacher Collaboration and Student Achievement

As a general construct, there is little doubt that leadership is an indispensable and arguably the most essential part of any organization (Saiti & Stefou, 2020). In the educational sector this is also the case. As a matter of fact, the UNESCO has set the goal of strengthening school leadership to improve teaching and learning, in order to achieve one of the targets of their Education 2030 Agenda, which addresses the need to increase the supply of qualified teachers. Six reviews commissioned by the UNESCO (2018) have shown that school leadership has the second largest impact on student learning outcomes, although classroom teaching has the bigger impact. School leaders, particularly principals, play a key role in several factors within the school. By way of illustration, in the Federal State of Bayern, principals' functions as per law (*Lehrerdienstordnung*) (see KMK, 2019) include among others: the admission and allocation of pupils to classes and groups, allocation of classrooms, distribution of teaching and other official duties among the teaching staff, and they have to take into account the professional and personal suitability of the teachers. They define the vision, values and direction of schools, are responsible for the improvement of the conditions for teaching and learning, redesign the organization, distribute roles and responsibilities, and enact measures to enhance teacher quality.

By means of this example and description, it becomes apparent that the responsibilities of principals are not to be underestimated neither in their complexity nor in the impact they have on the schools. Furthermore, it illustrates that the role of principals is not only one of administrative and managerial nature, but one that can promote improvement. They are

regarded as the central element for the implementation of policies and fulfilment of external accountability objectives (Hallinger & Walker, 2017). Research consistently demonstrates the impact principal leadership has on the organization of the school, its culture, teachers' work among others (cf. Leithwood & Jantzi, 1999, 2008; Hallinger & Huber, 2012). This impact can be demonstrated by taking into account, for example, that principals "play a crucial role in staff selection and development, and thus [their leadership] is closely related to a school's success" (Saiti, 2012, p. 114). However, it is necessary that schools have enough autonomy to make decisions on aspects influencing their daily activities (OECD, 2017b). This level of autonomy can only be reached if leadership is considered as a part of official educational policies. In England, for example, the importance of school leadership has been underscored by a notably strong policy which places leadership at the core of educational improvement. This is evident in the creation of a National College for the Leadership of Schools and Children's Services and in the focus on qualification and professional development for school leaders within a national professional qualification framework (NPQs) (see Department of Education UK, 2020). Furthermore, Duyar et al. (2013) found that specific aspects of principal leadership as well as practices of collaboration among teachers, significantly predicted teachers' self-efficacy and job satisfaction within and across schools. Sims (2017) came to similar conclusions as school leadership, along with other factors, was identified as a significant correlate of teacher satisfaction.

When discussing the influence principals can exert on student achievement by their involvement in matters of instruction, Robinson et al. (2009) argue that "the more leaders focus their influence, their learning and their relationships with teachers on the core business of teaching and learning, the greater their influence on student outcomes" (p. 28). This has received some critic, as some argue it is not realistic to expect principals to be experts in matters of teaching (cf. Spiellane & Lous, 2002). For the German context, however, a condition for individuals to be able to work as school principal is having completed a teacher training qualification (*Lehramtstudium*) and a minimum period of professional teaching experience, so arguably they already have enough knowledge to engage in matters of instruction. But there is a consensus that the influence principals have on student achievement is of a more indirect nature (Bruggencate et al. 2012; Hallinger, 2003; Leithwood et al., 2008; Robinson et al., 2008). For instance, Dumay et al. (2013) showed a long-term indirect effect of leadership on student achievement in the subject of mathematics in a period of 6 years. Hou et al. (2019), however, in their study about the influence of instructional leadership on high

school students' academic achievement in the China, found both direct and indirect effects. According to these results, "principals' overall instructional leadership significantly moderates the relationship between high school entrance scores and college entrance scores for students in both the liberal arts and science" (p. 554). The results from the Teaching and Learning International Survey (TALIS) 2018, have shown that although the frequency of the use of instructional leadership varies from country to country, teachers were more likely to engage in collaboration when principals adopted this leadership method (OECD, 2019b). Moreover, Goddard et al (2010) found that by using shared instructional leadership, principals exerted a positive indirect effect on student achievement mediated by teacher collaboration, which in turn showed positive direct effects on student achievement.

3. Sampling and Instruments

In this dissertation three articles were published by using the representative datasets of PISA in the years 2012 (Prenzel et al. 2015) and 2015 (Reiss et al. 2019). One reason to have used this data, lies on the fact that the PISA study gives schools and countries the possibility to determine where their strengths and weaknesses lie (OECD, 2009a). Teacher collaboration being a central aspect of the school and the impulse the topic has gained in the last decade, it is of great interest to gather an overall impression of the state of teacher collaboration in Germany, through a representative sample. Furthermore, in addition to the official reports from the OECD no previous studies have used PISA datasets to assess different characteristics of teacher collaboration associated to it in Germany or how teacher collaboration influences student achievement. In order to examine the latter, the data of 2012 used the reported students' grades in the first half year of the academic period 2011/2012 in the subjects of mathematics, German language, biology, physics and chemistry (Publication B). The data of 2015 (Publication C) used the test scores of the PISA 2015 study. Using both datasets enable us to gather two different perspectives on the relationship between TC and SA.

This section should serve as a brief description of how teacher collaboration was measured in each of the data sets and how they differ. A detailed description of the data sets, as well as the actual items used, will be presented in the fourth chapter of this dissertation and the articles cited at the end of it.

3.1. Forms of Teacher Collaboration

Between the PISA 2012 and 2015 studies the number, wording, and classification of items related to teacher collaboration, as well as the number and description of the scales varies. The 2012 dataset differentiated three forms with 17 items and the 2015 dataset two forms with 8 items. Although in both studies the answer format remains the same, the categories change. This discrepancy can be explained by noting that while the questionnaire of 2012 had been used since PISA 2006 and remained relatively unaltered, the PISA 2015 questionnaire adapted questions from TALIS and other sources (OECD, 2017a). While the naming of the TALIS subscales (OECD, 2010) was adopted, items of the TALIS questionnaire were only partially integrated in the PISA 2015 study and no explanation behind this rationale was given. The literature each question is based on also differs between both studies. Table 1 provides a comprehensive summary.

	PISA 2012	PISA 2015
Forms of TC*	3	2
Description of the Forms	IRC: Instructional-related PRC: Project-related ORC: Organization, performance, and problems	EXCHT: Exchange and coordination of teaching PROFCOLT: Professional collaboration
Number of Items	17	8
Answer Format	Rating Scale	Rating Scale
Categories	1 = never 2 = once in a year 3 = several times in a year 4 = every month 5 = every week 6 = every day	1 = Never 2 = once a year or less 3 = 2-4 times a year 4 = 5-10 times a year 5 = 1-3 times a month 6 = Once a week or more
Literature	Bosker and Hendriks (1997). Adaptation by the IPN.	Klingebiel and Klieme (2016); OECD (2009b); OECD (2010).

Table 1. Summary of the forms of teacher collaboration in PISA 2012 and 2015
*TC: Teacher Collaboration

In PISA 2012 three forms of teacher collaboration from the questionnaire developed by Bosker and Hendrick (1997) were proposed and investigated. These forms were: instruction-related (IRC), project-related (PRC), and organization, performance and problems related (ORC), whereas in PISA 2015 only two forms based on the constructs by Klingebiel and Klieme (2016) were investigated, namely exchange and coordination of teaching (EXCHT) and professional collaboration (PROFCOLT).

As already mentioned at the beginning of this section, a more detailed description of each form can be found in the following section of this dissertation. At this stage would be appropriate to see briefly how the items changed from one study (2012) to the other (2015). First, it must be considered that the items used in the 2012 study were exclusively developed for the German sample, whereas in PISA 2015 for the first time information about collaborative teacher practices were addressed in the international questionnaire. Second, attention should be drawn to some similarities in the wording. As already stated, the number and description of the forms as well as the wording of the items vary. Nevertheless, as the bigger construct remains “teacher collaboration”, it seems useful to examine how some of the items changed from one study to the other. To do this, Table 2 includes all the items used in

both studies, organized in the categories they belong to for the reader to gather a view of them.

One of the items that basically remained unaltered is the very first one, “exchange of teaching materials”, which belong to the IRC subscale; its equivalent in the EXCHT subscale would be “exchange of teaching materials with colleagues”. The same is applicable to the “peer observation” item from the PRC subscale, as it finds its equivalent in the PROFCOLT scale with the wording “observe other teachers’ classes and provide feedback”, which is basically a short description of peer observation. However, other items have been combined into a single one; for example, the items “joint promotion of slow pupils” and “joint promotion of high-performance students” from PRC subscale arguably are now measured in the EXCHT subscale with the wording “engage in discussions about the learning development of specific students”. Other items of the 2012 study do not appear to have been transferred into the 2015 study and apparently, they were discarded, like “exchange of examination questions”, “preparation of written exams”. In terms of subscale transformation, it appears that IRC is more related to EXCHT; PRC is more to PROFCOLT whereas items (or similar items) of ORC were either integrated in one of the two subscales of 2015 or simply omitted.

Although it is beyond the scope of this dissertation to provide an in-depth analysis of the transformation of the scales and subscales used in both studies, it is necessary to draw attention to a big change in the measurement of the construct because these changes in the instrument have a considerable impact in the measurement models used to investigate relations with teacher collaboration.

Table 2 starts in the next page.

PISA 2012	PISA 2015
IRC: - Exchange of teaching materials - Exchange of examination questions - Preparation of individual lessons - Follow-up lessons - Monitoring and advising new teachers	EXCHT: - Exchange teaching materials with colleagues - Engage in discussions about the learning development of specific students - Work with other teachers in my school to ensure common standards in evaluations for assessing student progress - Attend team conferences
PRC: - Joint planning of entire lessons or projects - Planning interdisciplinary lessons - Joint implementation of lessons - Testing new teaching ideas and methods - Peer observation - Preparation of written exams	PROFCOLT - Teach jointly as a team in the same class - Observe other teachers' classes and provide feedback - Engage in joint activities across different classes and age groups (e.g. projects) - Take part in collaborative professional learning
ORC: - Reconciliation of dealing with homework - Interdisciplinary discussion of student performance - Preparation of replacement hours - Joint promotion of slow pupils - Advice on the assessment of student performance - Joint promotion of high-performance students	

Table 2. Items used to measure teacher collaboration in PISA 2012 and 2015, separated by form. IRC: Instructional-related collaboration; PRC: Project-related collaboration; ORC: Organization, performance and problems-related collaboration; EXCHT: exchange and coordination of teaching; PROFCOLT: professional collaboration.

3.2. The Sampling in PISA

In order to be able to make generalizations about the population of all fifteen-year-old students in Germany on the basis of a sample, PISA follows very strict and exact statistical rules regarding the collection of data. In PISA, a suitable sample of fifteen-year-old students

is drawn and then a systematic partial survey is implemented. Regarding the specificity of the German educational system, although the sampling follows the same procedures as intended from PISA, some characteristics have to be taken into account, such as the structure in the different federal states. PISA uses a multi-layered (stratified) probability sample from a list of all schools provided by the 14 Länder's Statistical Offices in Germany. PISA utilizes two types of stratification: explicit and implicit. In the first type, schools are grouped into a strata that will be treated independently from one another whereas the second type, sorts the schools uniquely within each explicit stratum by a set of designated implicit stratification variables that are provided by the National Project Manager of each country. The use of these two types of stratification ensures a proportional sample distribution of schools across strata which may lead to better reliability of survey estimates. This can be quantified by establishing the magnitude of the error that any given measurement may have by employing a variety of methods, such as internal consistency checks or concretely for the case of PISA, Balanced Repeated Replication. Measurement error in questionnaires may be influenced by several factors such as wording of the questions or length of the questionnaire. PISA attempts to find the sources of the measurement error, that is also the source of variance in order to properly estimate measurement accuracy and reliability (OECD; 2014b). After this stratification is conducted, the stratified sample design follows two stages where first, schools are randomly selected, and then within each selected school, classes, students or teachers are randomly selected (Sälzer & Reiss, 2016). By using this two-stage sample procedure, the estimates are more accurate. In educational large-scale assessments, a two random sampling is almost always used because it is considerably more affordable than simple random sampling. It is practical and makes it possible to link student variables to school, class and/or teacher variables, which from a statistical perspective is favorable (OECD, 2009a p. 51).For a detailed report of the design and sampling methods used in PISA 2012 and PISA 2015 as well as the TALIS report (see ibid; Heine et al. 2016; OECD, 2009b, 2010, 2014a, 2014b, 2017a; Sälzer & Prenzel, 2013; Sälzer & Reiss, 2016).

To put it in a nutshell the *Programme for International Student Assessment* (PISA) on the one hand assesses hundreds of thousands of fifteen-year-old students in the subjects or reading, mathematics, and science, and on the other hundreds of teachers and principals who are instructed to respond to questions about their collaboration practices. Being a study comprising a representative sample following the most rigorous quality assurance mechanism of sampling and data collection, PISA delivers data with high levels of reliability and validity

which in turn provides a very good opportunity to look into the state of teacher collaboration (TC) in Germany and its possible effects on student achievement (SA), as well as to investigate the role that principal leadership (IL) plays for both TC and SA. This could eventually contribute to research, educational policy, and practice, as both collaboration between teachers and principal leadership belong to school organizational aspects that are fundamental for the improvement of teaching and learning, which ultimately may result in higher student achievement (OECD, 2013).

Taking all this into account, the studies in this dissertation examine the state of teacher collaboration in German schools as well as its effects on student achievement as measured in the PISA studies of 2012 and 2015. Additionally, the effect instructional leadership has on teacher collaboration is also analyzed. The studies measure the frequency of collaboration and the effects that school type and gender of the teachers have on it (publication A), its direct effects on student achievement (publication B) and the role that principals' leadership play on teacher collaboration (publication C).

4. Methods and Results of the Studies

In order to study the state of teacher collaboration (TC) in Germany and its effects on student achievement, this dissertation analyzes several factors across the datasets of the PISA study from 2012 (Prenzel et al. 2015) and 2015 (Reiss et al. 2019) in three articles that are interconnected to one another. In publication (A) the concept of TC was defined, and different statistical analyses were conducted to gather further understanding of its state in Germany. Descriptive statistics were performed to evaluate its frequency, and multivariate analyses to draw an image of the differences between school type and gender. Building upon these results, in publication (B) the effects of TC on student achievement were examined, depending on the form of collaboration, by using the reported students' grades in the first half year of the academic period 2011/2012 in the subjects of mathematics, German language, biology, physics and chemistry. Additionally, the factorial validity of the instrument was tested. Finally, in order to expand the findings of the first two publications, in publication (C) the inclusion of principal instructional leadership (IL) as a variable that can influence TC was included and direct effects of TC as well as indirect of IL on student achievement, measured in the mathematics and reading test scores of PISA 2015, were examined. The following subsections outline the corresponding research interests, methodological approaches, and main findings.

4.1. Publication (A): School and Gender differences of TC in German schools

The initial interest in the study was raised by the first author. Definition of the construct, performance and interpretation of the analysis and the structuring along with the writing of the manuscript were also carried out by the first author. The two co-authors advised on the framing of the article, edited the manuscript and discussed the data analyses. Strategic decisions such as the target journal were also weighted by the co-authors. The manuscript was submitted to Teacher Education, a section of the journal Frontiers in Education in March 26, 2018 and accepted in June 19, 2018. It was published online in July 09, 2018.

Mora-Ruano J. G., Gebhardt, M., & Wittmann, E. (2018). Teacher Collaboration in German Schools: Do Gender and School Type Influence the Frequency of Collaboration Among Teachers? *Frontiers in Education, 3*(55). doi:10.3389/feduc.2018.00055

Context and related work

Research consistently shows how through teacher collaboration several aspects of the school can be positively influenced such as teacher job satisfaction, self-efficacy or teaching

effectiveness (Bondorf, 2013; Ahlgrimm, 2010).The importance of the role that teachers play on student achievement has also found support (Hattie, 2003; 2015). The paper provided a deeper analysis of the phenomena of TC in Germany, specifically with regard to its tiered system and the role gender plays by providing not only a descriptive analysis of the data but also by exploring differences according to school type and gender as well as the influence that these two variables have on the frequency of the three postulated collaboration forms proposed by PISA: 1. instruction related (IRC), 2. project related (PRC), and 3. organizational, problems and performance related (ORC). PISA relies on a highly representative data sample and the reliability and validity which can be derived from it.

A definition of teacher collaboration

Considering the inconsistencies regarding the definition of teacher collaboration (Aldorf, 2016, Soltau, 2007), the conceptual confusion concerning the term teacher collaboration (Vangrieken et al. 2015) and the need to define the construct in order to be able to study it properly (Kelchtermans, 2006), in the paper a new definition specifically for the school context has been proposed. It expands on previous definitions which have been used in the context of school studies (e.g. Gräsel et al. 2006) but were written to suit other contexts like organizational psychology (Spieß, 2004) or political education (Reinhardt, 2000). The new proposed definition considers several aspects of the school context, its core function of teaching, as well as a cultural and a micro-political perspective. We define teacher collaboration "as a voluntary activity between two or more teachers who, based on relational trust and respect, through collaborative leadership and school administration, coordinate efforts, reconcile different approaches and exchange ideas and materials in order to increase teaching effectiveness as well as affective and cognitive job satisfaction".

Forms of teacher collaboration

One key aspect to successfully study teacher collaboration is to understand that due its complexity it will inevitably manifest in varying forms. This is reflected in the fact that several studies have differentiated operationalizations of TC. For instance, Esslinger (2002) differentiates between two forms, namely structural collaboration and integrative collaboration. Gräsel et al. (2006) propose three forms: exchange, shared work, and co-construction. In PISA 2012, three forms of teacher collaboration were studied: instruction-related (IRC), project-related (PRC), and organization, performance and problems related (ORC). *IRC* refers to aspects that occur prior to the actual teaching which are related to the

common development of didactic and methodological skills, such as the exchange of teaching materials or the preparation of individual lessons, *PRC* include elements like joint implementations of curricula in the classroom from the planning of entire lessons to the preparation of written exams, and *ORC* focuses on aspects such as discussion how to help students depending on their performance.

School, gender differences and the overall collaboration in Germany

In Germany, teacher collaboration has been studied mainly to provide insight into school differences, but not gender differences (Bos et al. 2004). Not too many studies have examined differences on teacher collaboration frequency and/or attitudes between genders. In one of the first analyses, Schümer (1992) found that women collaborate more than men. This result remains consistent across other studies (Ulich, 1996; Soltau, 2011; Richter & Pant, 2016). Additionally, regarding attitudes towards collaboration depending on gender Maag Merki et al., (2010) found that women ascribe more importance to specific aspects than men such as exchange of expertise and/or recognition of school management and authority.

Regarding the school level, research consistently shows that, despite the attributed importance of teacher collaboration, it is barely practiced in German schools. For instance, Esslinger (2002) found in her study that only 11.5% of teachers in *Realschulen* (secondary schools) practice joint implementation of lessons and that the form of collaboration most used is the exchange of materials, although its frequency is low. Equivalent results were also found in studies by Helmke and Jäger (2002) and Klieme et al. (2008). Meanwhile, Steinert et al. (2008) and Gräsel et al. (2006) showed that the most basic forms of collaboration, such as exchange of materials, are the ones preferred by the teachers.

Participants and analysis

The paper analyzed n = 2084 responses from the teacher German sample of the PISA 2012 study. Section 3.2. of this dissertation provides a description of the collection methods employed by PISA; and a detailed sample description can be found in Prenzel et al. (2013). In PISA 2012, three forms of collaboration were investigated: Instruction-related (IRC), project-related (PRC), and organization, performance and problems related (ORC). Because of the low number of participants regarding vocational schools as well as schools for students with special needs, they were not included in the analyses. A two-way MANCOVA (school type * gender with age and experience as covariates) was run to investigate the differences between the aforementioned forms of collaboration and to identify main and interaction effects.

Research questions

In order to establish whether school type and gender influence collaboration and to what extent the frequency of various forms of collaboration among the different school types as well as between genders varies, we intended to answer the following research questions:

1. To what extent does the school type influence the frequency of teacher collaboration?
2. To what extent does gender influence the frequency of teacher collaboration?
3. Are there significant interaction effects between school type and gender with regard to the frequency of teacher collaboration?

Result Highlights

Regarding the type of school, a significant difference for all three forms of collaboration was found. The mean comparison revealed that teachers in *Gymnasium* (grammar schools) collaborate less than their peers in other school tracks. Women collaborate minimally more than men, however, the frequency of collaboration depending on gender differs statistically significantly only for the third form of collaboration (ORC). Additionally, our analyses showed that there is no interaction effect between the three studied forms of collaboration and gender.

4.2. Publication (B): The Influence of TC on Student Achievement

The study was initiated by the first author in the context of the dissertation. The analyses, and the structuring along with the writing of the manuscript were carried out by the first author as well. The two co-authors provided expertise on data analysis and its interpretation, and advised on strategic decisions, such as the presentation of the manuscript. The manuscript was submitted to Teacher Education, a section of the journal Frontiers in Education in June 03, 2019 and accepted in July 29, 2019. It was published online in August 13, 2019.

Mora-Ruano, J. G., Heine, J-H., & Gebhardt, M. (2019). Does Teacher Collaboration Improve Student Achievement? Analysis of the German PISA 2012 Sample. *Frontiers in Education, 4*(85). doi: 10.3389/feduc.2019.00085

Context and related work

The paper expanded the findings of publication (A) by analyzing the influence that three forms of TC proposed by PISA have on student achievement (SA) which was analyzed with the retrieved students' grades in the first half year of the academic period 2011/2012 in the subjects of mathematics, German language, biology, physics and chemistry, which were

available in the representative German dataset from PISA-2012 (Prenzel et al., 2015). As mentioned in the previous chapter, PISA data have a high degree of validity and reliability of methods of data collection and, hence, results.

The purpose of the paper as stated in the opening paragraph of this section will be to study the influence of TC on SA. One reason for this is the stable evidence that shows teachers as "the major players in the education process" (Hattie, 2012, p. 25). Previous research has shown the positive impact that TC has on SA (Louis et al., 2010; Ronfeldt et al. 2015; Schmoker, 2004). There is, however, a tendency to investigate the effects of TC on teachers and not its influence on variables outside the teacher domain such as student achievement (Goddard et al. 2010), making studies investigating these type of relationships to a certain extent insufficient (Desimone, 2009; Kullman, 2013). Consequently, in this paper we provide a view of the effects of teacher collaboration on student achievement in German schools.

Participants and analysis

Two datasets (teacher and student) from the German PISA-2012 data were combined in order to investigate the effect of TC on SA. The resulting subsample consisted of 869 schoolteachers (44.5% female, 55.5% male) with a mean age of 47.3 and in a corresponding subsample of 869 students. A detailed sample description can be found at Prenzel et al. (2013). Three forms of collaboration were investigated: Instruction-related (IRC), project-related (PRC), and organization, performance and problems related (ORC). Because of the low representation in the samples regarding vocational schools as well as schools for students with special needs, they were not included in the analyses. The factorial validity of the instrument was tested by conducting a confirmatory factor analysis, which showed an ill-fitting model. Consequently, an exploratory factor analysis was carried out to properly establish the number constructs that should be retained as well as for the items and their organization within said constructs. In a later stage of the analyses, another confirmatory factor analysis was conducted to test the factorial validity of the re-specified instrument. Finally, a structural equation model was run to investigate the direct effects that teacher collaboration has on student achievement.

Research questions

Our analysis of the relationship between teacher collaboration and student achievement is guided by the following questions:

4. To what extent does teacher collaboration influence student achievement, measured in the subjects of mathematics, German language, biology, physics and chemistry, and to which extent does this dependent on the form of collaboration?

Result Highlights

The structural equation model used to assess the effect that three different forms of collaboration have on student achievement, showed that only for the third form (ORC) the direction of the relationship was positive with student achievement (standardized coefficient = 0.06). The other two forms, instruction-related (IRC) and project-related (PRC) collaboration, did not show a positive effect on student achievement (standardized coefficients = -0.03 and 0.00 respectively). However, all these effects were non-significant.

4.3. Publication (C): The effects of Instructional Leadership on TC and SA

The initial interest in the research matter was brought up by the first author in the context of the dissertation. The analyses, and the structuring along with the writing of the manuscript were carried out by the first author. The two co-authors provided expertise on data analysis and its interpretation, and advised on strategic decisions, such as the presentation of the manuscript. The manuscript was submitted to Leadership in Education, a section of the journal Frontiers in Education in July 13, 2020 and published in February 25, 2021.

Mora-Ruano, J. G., Schurig, M., & Wittmann, E. (2021). Instructional Leadership as a Vehicle for Teacher Collaboration and Student Achievement. What the German PISA 2015 Sample Tells Us. *Frontiers in Education, 6*. doi: 10.3389/feduc.2021.582773

Context and related work

The paper expanded the findings of publications (A and B) first by using the German sample of the representative data from PISA 2015 (Reiss et al. 2019) and second by investigating not only the relationship between teacher collaboration (TC) and student achievement (SA) but by including an explanatory aspect of TC in the form of instructional leadership (IL). This allows to investigate both the direct effects of IL on TC and from TC to SA as well as the indirect effects of IL on SA.

Across the literature it has been consistently found a decisive role that principals play at the school, being for instance the main source for the successful implementation of change in the school (Leithwood & Day, 2007). Reid (2011) found that support from principals is a significant predictor of teacher collaboration. Moreover, their leadership style is a core

component of schools wanting to increase their effectiveness when it comes to educating and forming their students, mainly because principals are able to influence a variety of characteristics of the teachers such as their motivation and abilities which ultimately will have a positive impact on student outcomes (Pont et al. 2008). However, it must be stressed that principals' leadership style is not a single construct. While several forms have been identified, like transformational, transactional, or instructional, the latter has been consistently associated with increased student achievement (cf. Bush, 2013; Hallinger, 2003; Robinson et al., 2008). The main reason for this is that instructional leadership's focus lies on the improvement of teaching and learning as well as the improvement of teachers' qualities (Hallinger, 2003).

Participants and analysis

Three datasets (school, teacher and student) from the German PISA-2015 data were combined in order to investigate the effect of IL on TC and from TC on SA. As we are working with aggregated data at the school level, it must be noted that both the teacher sample (3569 non-science teachers, 67.2% female, 31.3% male, 1.5% no answer, with a mean age of 44.9), and the student sample (6504 students) are effectively averaged. A detailed report of the participating schools, sample and methods can be found in Heine et al. (2016) and a detailed report of the items, forms and constructs can be seen on the section 3.2 of this dissertation. As already mentioned in the first and third chapter of this dissertation, PISA 2015 uses a different instrument to gather information about TC than the one used in 2012, therefore the number of items and abbreviations of the form of TC vary, however retaining the core of the construct. The two constructed forms from PISA to measure TC are: exchange and coordination of teaching (EXCHT, 4 items) and professional collaboration (PROFCOLT, 4 items). This new instrument is partly derived from TALIS 2008. We tested the factorial validity of the teacher questionnaire by conducting a confirmatory factor analysis, which resulted in the rejection of one of the forms of teacher collaboration that was measured in PISA 2015 (PROFTCOLT), as it was contributing to a misspecification of the model. This meant that some information loss could not be avoided, and the second research question could not be investigated. With the remaining information, we investigated the direct effects of principal instructional leadership (IL) on teacher collaboration (TC), and of TC serving as a mediator on student achievement (SA), as well as the indirect effects of IL on SA.

Research questions

In conducting the analyses, we want to answer the following research questions:

5. To what extent does instructional leadership influence teacher collaboration (measured in the form ‘exchange and coordination of teaching’ EXCHT)?
6. To what extent does instructional leadership influence teacher collaboration (measured in the form ‘professional collaboration’ PROFCOLT)?
7. To what extent do these forms of teacher collaboration influence student achievement (measured in the scores of mathematics and reading from PISA 2015)?

Result Highlights

Instructional leadership was significantly and positively related to the remaining form of teacher collaboration. However, as expected, the remaining form of teacher collaboration (EXCHT) yielded a negative relationship with student achievement which was measured with the scores from mathematics and reading. Consequently, a negative relationship was also found for the indirect effects of instructional leadership to these two achievement scores. All these effects were significant.

5. Discussion

The following discussion disentangles and reflects the results of this dissertation. In the first section (section 5.1), the central results of the three published studies are discussed and then linked together. After that, the implications of this dissertation are presented (section 5.2) followed by its limitations with concrete suggestions for future research (section 5.3).

5.1. Discussing and Linking the Main Findings

As stated in the introduction, the overarching objective of this dissertation is to investigate the extent to which teacher collaboration influences student achievement in German schools as measured with the representative PISA datasets of 2012 (Prenzel et al. 2015) and 2015 (Reiss et al. 2019). On the one hand this overarching objective has been approached by analyzing the proposed forms of teacher collaboration from the PISA studies, in 2012: 1. instruction related (IRC), 2. project related (PRC), and 3. organizational, problems and performance related (ORC), and in 2015: 1. exchange and coordination of teaching (EXCHT) and 2. professional collaboration (PROFCOLT). On the other hand it has been addressed by linking these forms to two measures of student achievement, in 2012 the reported grades in the first half year of the academic period 2011/2012 in the subjects of mathematics, German language, biology, physics and chemistry, and in 2015 the test scores of the PISA study in the subjects of mathematics and reading. Context surrounding this overarching objective was delivered first, by providing insight into the frequency in which TC occurs, as well as to establish to what extent this frequency is influenced by school type and gender of the teachers. Second, as established in the theoretical background of this dissertation (chapter 2), appropriate structures are needed for teacher collaboration to take place. Consequently, information about the role principal instructional leadership plays with regard to both teacher collaboration and student achievement was investigated on the basis of the data of 2015.

Prior to publication (A), the study of teacher collaboration in Germany, specifically regarding aspects such as the influence of school type and gender has proved to be scarce, as not too many studies can be found. A central goal of this dissertation is to support the improvement of collaborative practices of teachers in German schools by providing first a definition of a term that has proved to be elusive, inconsistently applied and according to some authors a term that lacks a precise definition (cf. Kelchtermans, 2006), and second by providing empirical evidence that gives an overall picture of teacher collaboration in

Germany, which eventually may allow teachers to reflect on their collaborative practices in order to improve them.

5.1.1. Frequency of Collaboration

The findings of this dissertation regarding the frequency of teacher collaboration in German schools revealed that the preferred form of collaboration across school type and gender (publication A) is the exchange form which, on the one hand, is considered the starting point for lasting professional learning communities (Steinert & Klieme, 2004), but at the same time is the form that requires less effort, less commitment than other forms, and is consistently placed at the lowest level of interaction among teachers (Gräsel et al. 2006; Little, 1990; Meirink et al. 2010; Steinert et al. 2006). Some research suggests that it marks almost no difference between good and bad schools (cf. Fend, 2009). At the other side of the spectrum it was found that across school type and gender, the least used form of collaboration was the project-related form (PRC) which requires the most interaction among its members. These results might underscore the suggestion that schools in Germany do not provide teachers with the proper organizational structures to collaborate and/or commit to collaborate, and that teachers in Germany are actually working in cellular, "egg-crate" (Lortie, 1975) type of structures, isolated from one another, independently the type of school they work in, or their gender. In all the three investigated forms of collaboration teachers in *Gymnasium* (grammar schools) collaborate significantly less than teachers in other types of schools and that women collaborate more than men and that. This is congruent with the assumptions and previous research (cf. Kullmann, 2010; Richter & Pant, 2016; Schümer; 1992; Soltau, 2007, 2011). No interaction effects were found between the type of school and the gender of the teachers.

5.1.2. Collaboration and Student Achievement

From the articles included in this dissertation, there is an indication that the organizational form of collaboration (ORC) is the only one that has a positive influence on student achievement, while the other two forms (IRC and PRC) are not positively related to this construct as they revealed a negative and a zero standardized regression weight. This result from publication B, using grades in the subjects of mathematics, German language, biology, physics and chemistry as measures, could be partially confirmed by using the PISA data of 2015 in publication C, where achievement was measured through test scores. Although the results of this publication showed that the "exchange and coordination of

teaching" (EXCHT) form of collaboration was negatively related to student achievement, in the final analyses only one form could be retained. Nevertheless, these results seem to confirm to a certain extent that complex forms of collaboration and consequently of interaction among teachers are predictors of student achievement.

5.1.3. The Conflicting Relationship between Instructional Leadership and Collaboration

The results of the 2015 dataset (publication C) pointed out that instructional leadership has a positive and significant effect on teacher collaboration and that its indirect relationship with student achievement is negative when mediated through the *exchange and coordination* form of collaboration. Although it is consistent with what was discussed in the theoretical background and in the publication (C), it is worth looking more closely at what might be a contradictory "state of affairs" between these two constructs. Instructional leadership requires, to a certain degree, a classical "top-down" hierarchical structure (cf. Hallinger & Murphy, 1985) where the principal takes the decisions and the teachers follow, whereas teacher collaboration in order to be effective, requires teachers who are able to participate voluntarily (cf. Friend & Cook, 2009) and capable of make their own decisions. Hence, at the core of this assertion lies a conflicting relationship between the two constructs. First, it must be stated that in an era where principals tend to have more accountability than autonomy, solely mentioning the term "top-down" makes educators feel and want to make others feel "appalled at this afront to their autonomy" (DuFour, 2007). However, the school system is arguably generally structured as a hierarchical organization, where one person or group delegates duties from the upper to the lower levels. Following the Fayol principles, this structuration is the simplest type of work distribution. In an educational system, political and higher administrative leadership occupy the highest level, followed by school leadership, then teacher activity, and finally, the achievement of individual students (Marzano, 2013). In other words, the responsibilities and processes in the school are, to a certain extent, pre-determined. However, the decisions made inside a specific level in the hierarchy or across levels are not. In the optimal organization, different structural components are used depending on the decisions to be made. Thus, it is possible for hierarchical structures to exist in the organization alongside structures with flat hierarchies (Förster, 2015, p. 48). This might, in principle, foster collaboration practices among teachers, as they would still be able to make their own autonomous decisions under the coordination from a higher structure, with coordination providing for coherence (Chrispeels et al., 2008), ultimately established through shared

agreement about its purposes and the role of leadership in accomplishing them (Leithwood et al., 2004; McLaughlin & Talbert, 2003). Moreover, in project groups, individuals from different hierarchical levels can work together, with decisions being made jointly within the group, thus overriding the formal hierarchical levels in the group (Kirchler et al. 2018, as cited in Förster, 2015), while still having the advantages of having a structure that binds the group within the organization. It is necessary, however, for teachers taking up leadership roles within the group or the organization to have knowledge not only of the organizational structure but also of the micropolitical dynamics, as this knowledge might help them construct their roles (Chrispeels & Martin, 2002), and consequently be able to engage and maintain their collaboration. It would be then advisable for principals to use a mixture of different approaches, something that in collaborative work is known as mixed-focus collaboration (Dewan et al. 2010) which describes basically a switch between "individual" and "work" group. Therefore, mixing up different approaches, such as taking elements of a transformational leadership model where it is assumed that "that leaders and staff have shared values and common interests" (Bush, 2003, p. 76), or integrating elements of transactional and even participative leadership might be more effective because single perspectives on school leadership do not provide for a complete picture of a school organization, as "organizations are many things at once! [. . .] complex, multifaceted [and] paradoxical." (Morgan, 1997, p. 347).

5.1.4. Summary of Findings

Altogether, the findings of this dissertation demonstrate that student achievement may be positively influenced by teacher collaboration, noting that this influence depends on the form of collaboration used by the teachers. Moreover, the results contribute to gain a deeper and more detailed insight into the teacher collaboration processes in German schools. Considering these results, the present dissertation solidifies the notion that collaboration as a construct that takes many forms and shapes, will not necessarily result in improved student achievement. There are, on the one hand, many factors that must be considered to give the proper impulse to collaboration practices among the teaching staff, and, on the other hand, it must be acknowledged that teacher collaboration has different forms and each form can influence distinctive aspects of the school. Consequently, this dissertation could be seen an impulse to reflect about collaborative practices taking place in schools, empowering teachers and principals to support an effective collaboration form which eventually might help improving student achievement. Furthermore, the results regarding the impact principal

instructional leadership has on teacher collaboration which showed a positive association may be taken as a further indication that underscores the importance of leadership style.

5.2. Implications

From a theoretical point of view the results of this dissertation replicate and stay in line with findings from previous studies regarding the differences in frequency of teacher collaboration between type of school and gender, which have shown that teachers in Gymnasium collaborate less than teachers in other types of school in Germany (Kullmann, 2010; Richter & Pant, 2016; Soltau, 2007) and other that women tend to collaborate more than men (Richter & Pant, 2016; Schümer, 1992; Soltau, 2011; Ulich, 1996). Additionally, previous research indicates that student achievement can be positively influenced by teacher collaboration (cf. Dumay et al., 2013; Lara-Alecio et al., 2012; Louis et al., 2010). This dissertation extends previous research by differentiating between specific forms of collaboration and by including covariates like age and experience to gather a better understanding of the factors influencing the frequency of teacher collaboration. This dissertation also expands the applicability of collaboration by proposing a new definition of the construct that will help to operationalize it in a theoretical and in a practical form. From a practical point of view the results indicate a need of action directed towards specific forms of collaboration, depending on what the goal of the school is. In other words these results ultimately can help schools' leaders 1) to understand that collaboration needs to be deconstructed into smaller portions and that each portion has an effect on specific aspects, and 2) to decide accordingly which form is the one they want to support when deciding which factor of the school they want to boost. Concretely, this dissertation has shown signs that the organizational form of collaboration, implying an organizational focus on student learning, is the one that can most likely enhance student achievement. Regarding the implementation of these findings, the results of this dissertation could be integrated into programs of professional development of professional learning communities (PLCs) which, as experts such as Darling-Hammond et al. (2017) and/or DuFour et al. (2016) argue, are essential for the development of the school, as these communities have at their core a culture that is continuously focused not only on student learning but also on taking responsibility for the school improvement as a group, as well as committing to collaboration which is manifested by de-privatizing teaching practices and/or by engaging in reflective dialogue among others.

5.3. Limitations and Suggestions for Further Research

Some limitations of this dissertation warrant attention. First, generally speaking, given that we used PISA data, we could only conduct secondary analyses, meaning that we could not perform any changes on the development stages of the instrument even if it was deemed necessary. Furthermore, given that "in PISA the target population is not defined as a grade, but as students of a particular age" (OECD, 2009a, p. 145) and because this sample does not come from intact classrooms but rather from a random within-school sample, with differences of their classes, teachers and levels of instruction, we could only investigate classroom-level variables at the individual student level or at the school level. Second, concretely referring to the publications of this dissertation, the instruments used in both 2012 and 2015 proved to have some problems regarding its factorial validity, which meant some collected information could not be analyzed and had to be disregarded. Particularly problematic was the teacher data of 2015 where a form of teacher collaboration had to be excluded from the analysis.

Because of legal impediments concerning the data usage from PISA, no comparisons between *Länder* (federal states) could be conducted. While this dissertation revealed specific results regarding the German schools as a whole, it would be very interesting for future research to use or collect data that allow such comparisons in a country where the 16 *Länder* have their own education departments and policies. Furthermore, future research could shift the focus to either other countries or conduct international comparisons in order to establish how these findings apply in other cultural settings. This could serve as a basis to establish if the benefits, difficulties, and effects teacher collaboration may have on several school variables remains stable in different countries. This is of importance because what works in one context may not work in another. Additional variables that can serve as mediator or moderator variables could be taken into account for future studies, such as job satisfaction or teachers' self-efficacy.

Moreover, investigating the effects of teacher collaboration on student achievement could be also be furthered by using longitudinal data, which in contrast to the cross-sectional data that PISA uses, would allow to draw – to some extent – conclusions regarding causal relationships or to show how specific aspects related to teacher collaboration, as well as collaboration itself, evolve or devolve over time. For example, based on the literature and our results regarding the low level of collaboration among teachers in German schools as well as their preference to engage in the easiest form of it, suggesting they are actually working in isolated cellular structures fostered by "loose-coupled systems", future research could

investigate the effects that an intervention aimed at the creation of bottom-up strategies within the school has on the frequency, attitudes, motivation and/or engagement teachers have to collaborate, commit to collaborate and/or how this influences student achievement, teacher self-efficacy or teacher motivation. Specifically, such an intervention could consist of establishing professional learning communities (PLCs). Some researchers argue that both "loose-coupled systems" and PLCs have their roots on a constructivist epistemology making the latter work with, rather than against the system into which PLCs are established and teaching takes place (cf. Goldspink, 2007). Moreover, as already discussed, even before getting into the profession, pre-service teachers might have already an ingrained predisposition to work in isolation, making longitudinal designs suitable to investigate if, through specific interventions, such convictions can be changed across time. To our knowledge the only study which looked at this aspect was *Teamorientierung und Einstellungen zur kollegialen Kooperation im Lehramt* (TEKLA), a research project at the University Münster (cf. Rothland, 2016). However, more empirical evidence is needed.

Finally, given that in this dissertation student achievement was investigated using both reported grades (publication B) and standardized test scores (publication C), but with data coming from two different PISA studies, it would be very interesting for future research to test, within the same sample – at least of teachers – the extent to which the relationship between teacher collaboration and student achievement differs with regard to student grades and test scores. This would allow control the extent to which teacher collaboration influences achievement as well as the specific forms that might influence it. Future research should focus on this differentiation, since grades and test scores differ in several aspects, as Willingham et al. (2002) notes: "[there are] differential strengths of grades and tests: Grades can represent broader content and reflect unique accomplishments, but tests can more easily emphasize the most important content. Tests can more readily assess cognitive skills, but grades can more readily assess motivational components of achievement" (p. 30). Depending on what results can be drawn from this differentiation, specific collaboration practices can be applied by both the principals and the teachers.

To sum up, this could help advance the current collaborative practices of schools, as well as its study, which eventually might result in better schools.

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Dissertation Publications

Publication (A)

Mora-Ruano J. G., Gebhardt, M. & Wittmann, E. (2018). Teacher Collaboration in German Schools: Do Gender and School Type Influence the Frequency of Collaboration Among Teachers? *Frontiers in Education, 3*(55). doi:10.3389/feduc.2018.00055

Publication (B)

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Publication (C)

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