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The impact of collaboration on teachers' individual data use.

Research considers collaboration to be a significant factor in terms of how teachers use data to improve their practice. Nevertheless, the effects of teacher collaboration with regard to teachers' individual data use has remained largely underexplored. Moreover, little attention has been paid to the interplay between collaboration and the personal factors that influence teachers' data use. This paper addresses this research gap by defining factors that affect collaboration, and by investigating the impact of collaboration on teachers' individual data use. The resulting research questions were answered by drawing on questionnaire data from 1,472 primary and secondary school teachers in Flanders. The findings indicate that collaboration is the main explanatory factor for teachers' individual data use compared to teachers' self-efficacy and attitude. Therefore, this study demonstrates the value of collaboration for future research and for creating a supportive environment for teachers' individual data use.

Keywords: data use, collaboration, attitude, self-efficacy

Introduction

Over the years, there has been increased interest in teachers' data use because of its potential benefits for student achievement (Campbell & Levin, 2009; Carlson, Borman, & Robinson, 2011). Cognitive and non-cognitive learning outcome data are generally seen as informative for teachers in terms of developing and improving their practice. Therefore, the amount of literature on this topic has expanded recently (Jimerson, 2014). To date, international researchers have demonstrated a rather pessimistic state of the art regarding teachers' use of data in general, and of teachers' use of pupil learning outcome data in particular (Schildkamp, Visscher, & Luyten, 2009; Vanlommel, Vanhoof & Van Petegem, 2016; Verhaeghe, Vanhoof, Valcke, & Van Petegem, 2010).

Recently, a change of direction from descriptive to explanatory research with regard to teachers' data use has been introduced. In the literature, we find two main

pathways to explain teachers' (non-) use of data. First, the authors generally point to personal factors as influences for the (non-) use of data. For example, teachers' limited confidence in their capacity to use data appropriately (self-efficacy) can result in data remaining untouched (Pierce & Chick, 2011; Schildkamp, Ehren, & Lai, 2012). Second, school-wide collaboration on data use has often been considered to be influential for teachers' data use (Daly, 2012; Marsh, 2012; Young, 2006). Collaboration involves internal support among teachers, alignment in terms of norms and agendas, and a shared responsibility with regard to data use (Datnow, Park, & Kennedy-Lewis, 2013; Farley-Ripple & Buttram, 2014; Hubbard, Datnow, & Pruyne, 2014; Jimerson, 2014).

Therefore, collaboration is considered an important factor in terms of overcoming barriers deriving from personal factors that influence teachers' data use. Moreover, collaboration is assumed to shape fundamental conditions for teachers' data use, since collaboration on data use requires a high degree of teacher involvement and more perseverance in terms of implementing improvement actions (Blink, 2007; Jimerson, 2014; Verhaeghe, Vanhoof, Valcke, & Van Petegem, 2011; Wayman, Jimerson & Cho, 2012).

Although the aforementioned pathways are suggested in explanatory research, the interrelationship between each of them has not been sufficiently explored. Despite the attention attached to teachers' personal factors in terms of data use, little is known about the interplay of these factors with regard to collaboration. Yet literature has suggested that there are two specific personal factors that can be related to teacher collaboration in the context of data use. More than other personal factors, a positive attitude towards, and self-efficacy in terms of data use are identified as prerequisites for teacher collaboration in the context of data use (Datnow et al., 2013; Hubbard et al., 2014). Therefore, knowledge is needed on how teachers' attitude and self-efficacy and

their collaboration in terms of data use are interrelated, in order to provide a deeper understanding of the importance of collaboration in creating a supportive data use environment. Furthermore, despite the interest attached to collaboration in the data use literature, researchers have not specifically focused on the effect of collaboration on teachers' individual data use. Nevertheless, it is necessary to examine the assumption that collaboration creates a supportive and stimulating environment for teachers in their use of data (Daly, 2012; Marsh, 2012; Young, 2006). Therefore, insight into the impact of collaboration on teachers' individual data use is essential. Moreover, this knowledge would expand our understanding of the potential sustainability of interventions that are built on collaboration, in order to create a supportive data use environment in schools.

The present study addresses the aforementioned research gaps by investigating the extent to which teachers collaborate in the context of data use, the impact of teachers' collaboration on their individual data use and the explanatory value of self-efficacy and attitude for teachers' collaboration. Given the impact of attitude and self-efficacy on teachers' data use, we hypothesize that differences in teachers' collaboration with regard to data use can be the result of variety in these factors (Datnow et al., 2013; Datnow & Hubbard, 2016). That is why we will examine the impact of attitude and self-efficacy on (1) collaboration and (2) teachers' individual data use.

These main research objectives lead to the following research questions:

- (1) To which extent does collaboration take place among teachers in the context of data use?
- (2) To which extent does collaboration affect teachers' individual data use?
- (3) To which extent do teachers' self-efficacy and attitude affect (a) collaboration and (b) teachers' individual data use?

In the next sections, we will first clarify the central concepts and hypotheses associated with this study. Then, we will describe the research approach we adopted. Subsequently, we will provide insights into teachers' collaboration on data use and how it is affected by self-efficacy and attitude, and into the effects of teachers' collaboration on their individual use of data. Conclusions will be drawn from the research results. We will also consider the limitations of the research and implications for further research.

Theoretical framework

In this section we will provide an overview of the literature with regard to what is known about collaboration in the context of data use, and on how collaboration can affect teachers' individual data use. Finally, we will describe the concepts of self-efficacy and attitude in the context of data use, and formulate hypotheses on how these factors can affect collaboration and teachers' individual data use. Figure 1 visualises the theoretical approach of this study.

<<Insert Figure 1>>

Figure 1. Theoretical framework.

Teachers' individual data use

Data use has been described as a cyclical process, in which the phases of discussing, interpreting and diagnosing data and taking action follow on from each other (Verhaeghe et al., 2010b). Data use can involve the use of several types of data - both qualitative and quantitative - that are informative for schools and teachers (Hulpia, Valcke, & Verhaeghe, 2004; Schildkamp & Kuiper, 2010).

With regard to teachers' individual data use, this study focuses on a type of data that is generally seen as being highly informative to teachers: pupil learning outcome data. Given the potential of this type of data for improving teachers' practice and eventually pupils' achievement (Campbell & Levin, 2009; Carlson et al., 2011), several studies have investigated teachers' use of learning outcome data (Jimerson, 2014). Research often delimits this concept to cognitive output indicators, which is criticized because these indicators in themselves fail to provide a complete picture of a pupil's learning (Schildkamp et al., 2012; Schildkamp & Kuiper, 2010). Therefore, we include cognitive outcomes (i.e. linguistic and arithmetic skills) as well as non-cognitive learning outcomes (i.e. attitudes, art and physical education) in our conceptualization of teachers' individual data use. Additionally, learning outcomes are not narrowed down to quantitative data (e.g. class tests). In addition, qualitative data (e.g. observations) fit into our conceptualization.

Collaboration

Collaboration is a concept that is strongly dependent on the context in which it is embedded (Datnow et al., 2013; Kelchtermans, 2006; Little, 2012; Spillane, 2012; Stoll, Bolam, McMahon, Wallace & Thomas, 2006). Therefore, a universal definition of the concept is not readily available.

The idea of collaboration in the context of data use is that a group of individuals initiates and undertakes data use processes, with the specific aim of problem solving or sharing expertise (Hammick, Freeth, Copperman, & Goodsmith, 2009). In the context of data use, this means that the initiation of data use inherits a shared responsibility (Stoll et al., 2006). Among teachers, the shared responsibility for data use generally lies in student learning (Louis, Dretzke, & Wahlstrom, 2010; Wahlstrom & Louis, 2008).

Next, collectively undertaking processes involving data use (collaboration) implies that more dense connections are present among teachers. Teachers build constructive relationships through conversations with colleagues (Louis et al., 2010; Stoll et al., 2006). These relationships allow them to better apply one-another's strengths with regard to data use (Datnow et al., 2013; Jimerson, 2014; Young, 2006) and to engage in processes of knowledge creation and knowledge sharing (Datnow et al., 2013; Farley-Ripple & Buttram, 2014; Hubbard et al., 2014; Louis et al., 2010; Stoll et al., 2006). Furthermore, collaborative processes in the context of data use provide teachers with help or support. Colleagues work with one-another in processes of analysing and interpreting data or introducing improvement actions (Datnow et al., 2013; Farley-Ripple & Buttram, 2014; Hubbard et al., 2014; Jimerson, 2014).

Many forms of collaboration are possible in the context of data use (Wayman & Jimerson, 2014). Transcending the differences between several forms of collaboration, it can be seen as a way of structural support for data use. Collaboration allows teachers how to learn to engage in data use and use it as a source of support when needed (Farley-Ripple & Buttram, 2014; Jimerson, 2014; Young, 2006). Several studies have attributed teachers' individual data use to the existence of collaboration (Datnow et al., 2013; Hubbard et al., 2014; Jimerson, 2014). Engaging in collaboration in the context of data use motivates teachers to use data in order to improve their instruction (Young, 2006). That is why we assume that collaboration affects teachers' individual data use in a positive manner.

Attitude and self-efficacy

This study focuses on the interplay between collaboration and person-related factors in the context of data use. Although the data use literature suggests an extensive list of influential person-related factors with regard to individual data use (Datnow &

Hubbard, 2016; Vanlommel et al., 2016), few studies indicate a relationship between person-related factors and collaboration with regard to data use.

Two factors are explicitly mentioned as influencing collaboration in the context of data use: attitude and self-efficacy (Datnow et al., 2013; Hubbard et al., 2014; Kelchtermans, 2006). A positive attitude towards data use is seen as indispensable for teachers for them to engage in collaboration (Datnow et al., 2013; Young, 2006). Lack of knowledge and skills with regard to interpreting data can be moderated in collaborative settings through conversational routines. However, only teachers with a positive attitude towards data use will engage in such conversations, and will be willing to face interpersonal conflicts for school improvement (Datnow et al., 2013; Young, 2006). Also positive self-efficacy is crucial for collaboration in the context of data use. According to Datnow et al. (2013), believing that data can be used properly is particularly more important for persuading teachers to engage in collaboration than teachers' actual knowledge and skills in handling data. By means of discussion, disagreements can be overcome and teachers can achieve deeper insights, but a positive self-efficacy is needed to initiate these processes (Datnow et al., 2013).

Attitude

Attitude is generally seen as an important factor in terms of influencing teachers' data use (Datnow & Hubbard, 2016; Schildkamp & Kuiper, 2010; Verhaeghe et al., 2010). Attitude denotes the teacher's cognitive picture of data use, which can be described as his or her knowledge about this subject. It implies the beliefs, models, preferences and other aspects that determine what teachers think about data use, and to what extent they believe that using data to improve their practice is valuable (Vanhoof, Vanlommel, Thijs, & Vanderlocht, 2014).

A negative attitude towards data use is generally seen as one of the main barriers to teachers' data use (Datnow & Hubbard, 2016; Vanhoof et al., 2014; Verhaeghe et al., 2010). Empirical research suggests that data use is hindered when teachers, for example, do not believe in fair data for (some types of) students (e.g. learning outcome data of low SES students), do not believe that some aspects of schooling are measurable (e.g. learning progression of students) or are not convinced that data use can improve teaching and learning within the school. A negative attitude therefore causes such data to remain unused (Kowalski & Lasley, 2009; Schildkamp et al., 2012). The general assumption is that a positive attitude is an important precondition for teachers' data use (Datnow & Hubbard, 2016; Schildkamp & Kuiper, 2010; Verhaeghe et al., 2010). Little is known about how attitude impacts various data use processes differently (e.g. individual or collaborative data use). Therefore, following the assumption that a positive attitude is a necessary condition for teachers to engage in any type of data use, we hypothesize that a positive attitude on the part of teachers with regard to data use will affect various kinds of data use they engage in (i.e. both individual and collaborative data use).

Self-efficacy

Next to the attitude of teachers, self-efficacy impacts on teachers' use of data (Datnow & Hubbard, 2016). Self-efficacy denotes the way in which data users see themselves as capable of handling data (Bandura, 1997; Deci & Ryan, 2000; Woolfolk, 2008). When teachers' self-efficacy is high, they will be more confident in using data to successfully achieve their goals. As a result, they will set more ambitious goals with regard to data use, and demonstrate more perseverance in achieving them (Bandura, 1997; Woolfolk, 2008). From this point of view, we hypothesize that teachers' self-efficacy impacts on

their data use positively (Vanhoof et al., 2014). The positive impact of teachers' self-efficacy on data use has been found (or documented), both in studies on individual data use (Vanhoof et al., 2014) and on collaborative data use (Datnow et al., 2013).

Therefore, similarly to teachers' attitude, their self-efficacy can be seen as a precondition for different types of data use. Following the assumption that teachers' self-efficacy affects engagement in any type of data use, we hypothesize that self-efficacy both impacts individual and collaborative data use of teachers.

Method

Context of the study

This study took place in Flanders, which has, compared to the surrounding countries, a specific context in which to study data use. The Flemish government wields a rather school improvement oriented perspective with regard to data use. Whereas standards are defined at the end of secondary education, schools are autonomous as to how to achieve these standards (the curriculum) (Penninckx, Vanhoof, & Van Petegem, 2011). In addition, central exams do not exist. Therefore, no public databases or rankings of schools are available (Organisation for Economic Co-operation and Development (OECD), 2014). Schools themselves are responsible for obtaining insight as to whether or not they have achieved the Flemish standards at the end of secondary education. Thus, government expectations with regard to data use are rather implicit, and the responsibility for using data and the support for data use lies with individual schools and teachers.

Participants

In this study, we made use of a quantitative research approach, involving an online survey. Questions were included on teachers' individual data use, collaboration in the

context of data use, and teachers' attitude and self-efficacy with regard to data use.

The target population consisted of Flemish teachers in primary and secondary education. In order to generate a representative sample, we stratified for the school's network (i.e. schools providing a Catholic education, schools from Flemish cities and provinces, and GO! education of the Flemish community), school size and school type (i.e., schools offering academic or vocational education). A total of 1,472 teachers, from 63 primary schools and 54 secondary schools, participated in the study. A response rate of at least 50% was required for schools to be included in the analyses of this study. In the majority of the schools (68%), a participation ratio of at least 70% was achieved. Our sample consisted of 22.2% male and 77.8% female participants: 77% of the participants hold a bachelor's degree and 22% participants a master's degree, 26% are beginning teachers (less than 5 years of teaching experience) and 74% are experienced teachers (more than 5 years of teaching experience). Generally, a representative sample for Flanders was achieved despite a slight oversizing of the share of beginning teachers.

Instrument

Most of the scales in the questionnaire were derived using existing and validated survey instruments (Vanhoof et al., 2014; Vanhoof, Van Petegem, Verhoeven, & Buvens, 2009). Only the scale regarding teachers' individual data use was developed and validated during this study. For all scales a 5 point Likert scale was used (1- entirely disagree, 2 - disagree, 3 - partly disagree/partly agree, 4 - agree, 5 - entirely agree) with an additional category 'don't know/inapplicable'.

The construct validity of the instrument was tested through a confirmatory factor analysis. For all items, the cutoff factor loading on the latent concept was set at 0.50. Fit indices that were taken into account to evaluate the validity of the instrument were the Comparative Fit Index (CFI), the Tucker Lewis Index (TLI) and the Root Mean Square

Error of Approximation (RMSEA). χ^2 was not included given the potential bias due to the sample size (Barrett, 2007). For the CFI and TLI a cutoff of 0.95 was used (Schumacker & Lomax, 2004), which was exceeded for both indices (CFI: 0.98 and TLI: 0.97). For the RMSEA, a cutoff of 0.05 was taken into account (Chen, Curran, Bollen, Kirby, & Paxton, 2008). The RMSEA-value of 0.04 thus indicates a good fit. In sum, the confirmatory factor analysis confirmed the validity of the instrument.

Additionally, we calculated the Cronbach's alpha values in order to evaluate the reliability of the instrument (see Table 1). The Cronbach's alpha value of 0.65 indicates a reasonable reliability for the scale 'teachers' individual data use', given the small number of items (2) (Sijtsma, 2009; Tavakol & Dennick, 2011). The reliability of the other scales can be evaluated as good to very good, given the range of the Cronbach's alpha values, ranging from 0.89 to 0.93 (DeVellis, 2012). Table 1 provides an overview of the scales that were included in the questionnaire with an indication of their Cronbach's alpha values.

Table 1: Psychometric characteristics and descriptive statistics of the different scales

	items	n	Ave	SD	Cronbach's alpha
Individual data use					
<i>I use data about the cognitive results of pupils to shape my practice.</i>	2	1417	3.77	0,79	0.65
Collaboration					
<i>In our school, we make good use of the expertise of others to analyse data.</i>	6	1257	3.41	0.88	0.93
Self-efficacy					
<i>I see myself as able to handle data appropriately.</i>	5	1396	4.02	0.57	0.93
Attitude					
<i>I am convinced that the use of data in schools is valuable.</i>	3	1421	4.28	0.61	0.89
Relevance					
<i>The data that is available to me is relevant.</i>	6	1294	3.88	0.64	0.89

Analyses

In order to answer the first research question, we looked at the descriptive statistics of the different scales. The second and third research question were analysed using Structural Equation Modeling (SEM). Given the fact that we were analysing teachers within schools, the nested structure of the data was taken into account (TYPE = COMPLEX in Mplus). A path model was built, including the five relationships that resulted from the theoretical framework (Figure 1). In the analysis, the measurement model behind each variable (several manifest items measuring a latent variable) was modelled to become a veracious conceptual representation of reality, and to account for error in the different scales used. Taking into account the fit indices, the path model was found to fit well to the empirical data (RMSEA = 0.02; CFI = 0.97 and TLI = 0.97).

Results

We will begin by presenting the descriptive results for the different variables. The descriptive results on collaboration in the context of data use provide an answer to our first research question. We will then go on to the explanatory results, which will provide insight into the answers regarding the second and third research question.

Descriptive results

An overview of the descriptive results is provided in Table 1. With regard to teachers' individual data use, we find a moderately positive average scale score (ave = 3.77). Thus, teachers indicate that they use cognitive (i.e. linguistic and arithmetic skills) and non-cognitive learning outcome data (i.e. attitudes, art and physical education) to a certain extent. Taking into account the frequencies, close to 64% of the teachers surveyed largely/entirely agree with the statements included about their use of data to shape their practice. This result indicates that there is also a fairly large number of teachers who reacted neutrally or negatively to these items (36%). Hence, teachers use learning outcome data to shape their practice to some extent, but we cannot call it a standard practice.

Overall, teachers respond neutrally to moderately positively to the subject of collaboration in the context of data use. The average of 3.41 implies that teachers neither agree nor disagree that support is provided with regard to analysing and interpreting data, that data use is a responsibility of the whole school team, or that teachers collaborate intensively with regard to data use. The frequency measures underpin this result. Only 32.7% of the surveyed teachers largely/entirely agree with the items on collaboration with regard to data use. This means that the average score of

63.7% of the participants is neutral to negative for this variable. We thus find that collaboration among teachers is relatively uncommon.

Teachers respond positively to questions related to person-related factors that might influence data use. We find that teachers generally believe that data use is valuable and that they usually perceive themselves as capable of handling it, as indicated by the averages of the attitude scale (ave = 4.28) and the self-efficacy scale (ave = 4.02).

In sum, these results indicate that teachers take a fairly positive stance towards data use. However, this positive stance towards data use does not lead to data use being a common practice among teachers. Also, with regard to our first research question, teachers do not appear to collaborate extensively in the context of data use. Thus, in Flemish schools, a stimulating and supporting environment in the form of collaboration with regard to data use is not common among teachers.

Explanatory results

The path model is summarised in Figure 2. The direct effect of attitude on teachers' use of learning outcomes was excluded from the model because of the statistical insignificance of this effect ($p > 0.05$).

<<Insert Figure 2>>

Figure 2. Explanatory results.

The path model first confirms our assumption that collaboration in the context of data use affects teachers' individual data use. More specifically, we find that collaboration bears a statistically significant positive relationship to teachers' individual

data use. Teachers who collaborate to a greater extent in the context of data use also make more use of data to inform their individual practice. This relationship is characterized by a medium effect size. The regression coefficient of 0.34 indicates that close to 11% of the variance in teachers' individual data use can be explained by collaboration.

A second finding is that attitude does not affect teachers' individual data use directly. However, it does affect it indirectly. This effect runs through collaboration. The path model shows a statistically significant positive relationship between attitude and collaboration. In other words, the more teachers perceive data use to be valuable, the more collaboration on data use they report, and the more they say that they use data to inform their individual practice. The effect of attitude on collaboration on data use is small ($\beta = 0.22$). Only 5% of the differences in the extent of teacher collaboration can be explained by teachers' attitude towards data use. It is remarkable to find that the effect of attitude on teachers' individual data use is small in our sample, and that this effect only results from collaboration instead of affecting teachers' individual data use directly.

Thirdly, the results confirm both of our hypotheses regarding self-efficacy. We find that self-efficacy affects teachers' individual data use directly as well as indirectly. Both are statistically significant relationships. Teachers who are more confident about their capacities to use data, appear to use data more extensively (direct effect). Furthermore, an indirect impact of self-efficacy on teachers' individual data use runs through collaboration. Teachers who report a higher degree of self-efficacy tend to collaborate more, and subsequently appear to use data to a greater extent (indirect effect). Given the interest dedicated to self-efficacy in data use, it is notable that the effect sizes of both the direct and indirect effects of self-efficacy are relatively small.

The regression coefficient of 0.20 indicates approximately 4% of the explained variance in collaboration (indirect effect), whereas the regression coefficient of 0.22 corresponds to an amount of 5% of the explained variance in teachers' individual data use (direct effect).

The model as a whole provides a reasonable explanation for teachers' individual data use. The R^2 value denotes that 32% of variance in this variable can be explained by means of the model. Additionally, the model explains variation in collaboration in the context of data use to a smaller extent. The R^2 value shows a percentage of 15% of explained variance in teachers' collaboration in the context of data use.

Conclusion and discussion

Although researchers widely agree upon the important role of collaboration in teachers' data use, little was known as to whether or not collaboration moderates two main personal factors of influence on teachers' individual data use: attitude and self-efficacy. In order to contribute to this gap in the current knowledge base on data use, the following research questions were proposed:

- (1) To which extent does collaboration take place among teachers with regard to data use?
- (2) How does collaboration affect teachers' individual data use?
- (3) How do teachers' self-efficacy and attitude affect (a) collaboration and (b) teachers' individual data use?

To address the aforementioned research questions, we used questionnaire data of 1,472 teachers, from 63 primary schools and 54 secondary schools in Flanders. Descriptive statistics were calculated and Structural Equation Modelling (SEM) was conducted.

We first found that teachers' collaboration in the context of data use is rather limited in Flanders. According to teachers, they do not collaborate extensively to address team members' competences in order to analyse and interpret data, or to create alignment and a shared responsibility around data use within the school team. Thus, in the context of data use, collaboration among Flemish teachers is not standard practice. Internal support, constructive relationships and knowledge sharing are not readily available. An explanation for this finding can be that Flemish teachers sense a great deal of individual instead of collective responsibility for qualitative teaching and learning in school. Hence, data use might be perceived as an individual responsibility of teachers. Consequently, teachers may not tend to initiate collaborative activities with regard to data use. Yet, teachers' individual data use remains low as well.

The finding of limited collaboration among teachers is not uncommon given the educational context in which the study took place. International comparative research (OECD, 2014) has shown that Flemish teachers do not generally engage in collaborative activities, which can be explained by the limited resources available for professional development in Flanders. Resources for structured time for collaboration in teachers' lesson schedule may encourage Flemish teachers to engage in data use collaboration so that data use becomes a shared responsibility in schools. An additional explanation for the amount of collaboration found in this study, is that, overall, data use is limited in the Flemish educational context (Vanlommel et al., 2016; Verhaeghe et al., 2010). Thus, the result of limited collaboration in the context of data use is in line with what we would have expected on the basis of previous research on collaboration and on data use in Flanders.

Second, this study shows that collaboration is an important factor for teachers' individual data use. With a medium effect size, the path model indicates that teachers

who report a higher amount of collaboration, also report more personal data use. It is likely that the key features of collaboration (i.e. internal support, constructive relationships, collective responsibility, knowledge creation/sharing) provide valuable handles for teachers' individual data use. For teachers who, for example, struggle with the interpretation of their pupils' test results, collaboration provides a safe environment for learning how to do so, which eventually can lead to an increased individual data use.

The finding that collaboration has an impact on teachers' individual data use is consistent with what has been found in previous research. In the context of data use, involvement in collaborative activities is found to impact on teachers' individual data use (Datnow et al., 2013; Young, 2006). Collaboration has been emphasized as a way of providing structural support, since collaborating teachers are continuously provided with learning opportunities and mutual support (Farley-Ripple & Buttram, 2014; Jimerson, 2014; Young, 2006). In this way, teachers are motivated to persevere with regard to engaging in data use to inform their individual practice.

The last major finding is that collaboration is the main explanatory factor for teachers' individual data use, compared to teachers' attitude and self-efficacy. Taking into account teacher collaboration, no direct effect of attitude and only a small direct effect of self-efficacy on individual data use are found. Moreover, this study shows that attitude and self-efficacy (also) affect collaboration. The indirect effects of attitude and self-efficacy can be explained by how collaboration is shaped in schools. In the context of data use, it is likely that teachers will engage in collaboration with colleagues who are convinced that data are valuable (attitude) and who feel confident in using data (self-efficacy). Subsequently, collaboration is a way to achieve a data culture in schools with clear expectations with regard to data use. Therefore, the involvement of teachers in collaboration in the context of data use is reflected in their individual data use.

The findings of indirect effects of teachers' attitude and self-efficacy on their individual data use through collaboration are in line with prior knowledge. Consistent with previous research, the expectation grew that personal barriers such as a lack of self-efficacy and a negative attitude also explain why teachers do (not) collaborate in the context of data use (Datnow et al., 2013; Hubbard et al., 2014). This is confirmed by our study. Moreover, collaboration turns out to be a reinforcing factor in data use. Teachers with a greater self-efficacy or a more positive attitude towards data use are more likely to engage in collaboration, which eventually can lead to an increased degree of individual data use.

Despite the broad understandings this study provides regarding the role of collaboration in teachers' data use, some methodological limitations must be noted. First, given the context in which the study is conducted, the question arises whether (future) cross-contextual generalizations of the research findings are needed. In the context of data use, Flanders stand out from other educational systems given its limited amount of standardized data sources available. Schools and teachers primarily depend on their own data sources, such as self-composed tests and their own observations. Therefore, attempts to establish a data rich culture in Flanders and interventions to increase schools' and teachers' data use capabilities are still growing. Thus, on the one hand, choosing Flanders as a context in which to study data use has been an opportunity to address knowledge gaps on how teachers use data in rather school improvement oriented contexts. On the other hand, due to the specificity of this context, it remains unclear as to whether or not conclusions are applicable to other educational contexts. Replications of this study in other educational contexts or cross-contextual investigations are necessary to strengthen the findings of this study. Second, we conceptualized 'collaboration' in this study in a broad sense, including general

characteristics of collaboration found in data use literature. The strength of this approach is that, particularly in the context of Flanders, in which schools are not systematically supported in data use collaboration, different types of collaborations that are embedded in existing social structures are included in the concept. However, in this way, collaboration remains the container concept it is in a lot of studies and the granularity of the concept needs to be better addressed. Therefore, more in-depth methodological approaches are needed in order to explore the wide range of collaborative forms of data use that lie in between individual data use and more strict types of collaboration (e.g. a datateam or work group).

Altogether, this study confirms the importance of collaboration with regard to teachers' data use. Even when controlled for significant personal factors (self-efficacy, attitude), collaboration appears to be the main explanatory factor in teachers' individual data use. Therefore, the need arises to dig deeper into teachers' collaboration in the context of data use. First, an exploration of the concept 'collaboration' is essential in this context. Up to now, great variance exists in how the concept is approached in different studies, ranging from team work to professional learning communities (Datnow et al., 2013; Hubbard et al., 2014; Schildkamp, Poortman, & Handelzalts, 2016). Conceptual clarification is needed in order to enhance the comparability of (cross-contextual) research. Furthermore, more micro-level research on teacher collaboration in the context of data use is essential. This type of research would not only provide opportunities for further unravelling the interplay between collaboration and personal influences on data use, but would also have the potential to reveal how collaboration within these processes does or does not contribute to teachers' professional learning. Since research suggests that collaboration is a type of structural support with regard to individual data use (Farley-Ripple & Buttram, 2014; Jimerson,

2014), it is necessary to invest in research on the outcomes of collaboration in the context of data use for teachers' professional learning in general and for learning with regard to data use in particular.

The results of this study imply that collaboration in the context of data use should be a major focus among practitioners for the development of teachers' individual data use. Even more than investing in teachers' attitudes and feelings of self-efficacy with regard to data use, the need arises for collaboration to become the focus in schools. The initiation of collaboration activities in the context of data use is the basis for working on a stimulating environment in which individual data use can flourish. In such collaboration initiatives, the involvement of all teachers is a point of focus. Our results indicate that teachers with a greater self-efficacy and a more positive attitude towards data use are more likely to engage in collaboration. Thereby, collaboration reinforces the data use of teachers who already take a more positive stance towards data use. Thus, it will be challenging for practitioners to involve teachers with a lower self-efficacy and less positive attitudes towards data use in collaboration initiatives without imposing these initiatives. Nevertheless, this balancing act will have to be made in order to stimulate the individual data use of all teachers in schools.

Given the increasing emphasis on data use for instructional improvement, it is necessary to think about how policy and research will accompany teachers in data use processes. This study has shown that next to addressing individual barriers, attempts will have to be made to facilitate data use at the team level. Despite differences between teachers in their attitude and self-efficacy with regard to data use, collaboration can be a powerful key to further develop and improve data use in schools.

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