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Effects of a data use intervention on educators' use of knowledge and skills

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ABSTRACT

Data use is increasingly considered to be important for school improvement. One promising strategy for implementing data use in schools is the data team intervention. Data teams consist of teachers and members of the school leadership team, who collaboratively analyze and use data to solve an education-related problem at the school. This mixed-methods study aims at measuring the effects of working in a data team on the application of data use in ten secondary schools by using questionnaires and case study interviews. The results show that at the end of the intervention period, educators on the data teams did not apply data use more often for accountability actions, but seemed to be more aware of data use for school development and instruction. Furthermore, it seemed that the teachers made a start at applying data use for instructional actions.

1. Introduction and conceptual framework

Data use is identified as a common and core characteristic of high-performing schools (Schaffer, Reynolds, & Stringfield, 2012; Snipes, Doolittle, & Herlihy, 2002; Supovitz & Klein, 2003), and is widely believed to promote school improvement (Datnow & Hubbard, 2015). Data use has become a requirement for both school leaders and teachers in many parts of the world (Datnow, Park, & Kennedy-Lewis, 2013; Marsh, Bertrand, & Huguet, 2015; Schildkamp, Karbautzki, & Vanhoof, 2014a). The term 'data' is defined as *information that is systematically collected and organized to represent some aspect of schools* (Lai & Schildkamp, 2013). Assessment data make up the most prominent type of data used in the school context (e.g., Hamilton, Stecher, & Yuan, 2009b; Jimerson, 2014; Jennings, 2012; Supovitz, 2012). However, other qualitative and quantitative data, such as observation data from teacher instruction (process data), questionnaire data and interviews (perception data), student demographics (input data), and dropout data (output data) may also be used by schools (Marsh, 2012).

Recent research has found that data use in schools can lead to school improvement in terms of increased student achievement (e.g., Carlson, Borman, & Robinson, 2011; Lai, Wilson, McNaughton, & Hsiao, 2014; McNaughton, Lai, & Hsiao, 2012; Wohlstetter, Datnow, & Park, 2008). At the same time, research also shows that schools still struggle with implementing effective data use (Mandinach & Gummer, 2013; Marsh, 2012). Data literacy among educators is a crucial factor for successfully implementing effective data use in schools (Schildkamp & Poortman, 2015). In this study the term data literacy is defined as the knowledge and skills that educators need to effectively use data within the data use intervention. This entails, for example, knowledge and skills with regard to accessing, collecting, and analyzing data, transforming data into information, transforming information into decisions about improvement measures, and evaluating the outcomes of these improvement measures.

However, teacher training colleges only pay little attention to the knowledge and skills related to data use (Mandinach, Friedman, & Gummer, 2015), and researchers frequently mention that in-service teachers lack the skills and knowledge to use data effectively (e.g., Marsh, 2012). Educators need professional development in the use of data (Marsh, 2012). Therefore, we have developed and implemented a data use intervention that aims at professional development for educators regarding data use in secondary schools.

Little research is available on the long term effects of professional development related to data use and data use actions by educators in practice (Jimerson & Wayman, 2015). In a recently published article, Marsh et al. (2015) call for long term research that focuses on the influence of data on educators' practice.

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Accordingly, the current study addresses this need for research by examining the effect of working in a data team on educators' (perceptions of) data use actions in secondary schools.

1.1. Data use theory of action

Data use is a complex, non-linear, and iterative process that requires educators to access data, collect data, analyze data, and turn the data into meaningful and useful information. To become meaningful and useful, this information must further be combined with understanding and expertise (Coburn & Turner, 2011; Marsh, 2012). The data use theory of action framework presented in Fig. 1 describes the iterative process of data becoming valuable information for schools that leads to the desired outcomes or goals. The framework (Fig. 1) shows that data-based decision making is embedded in the organizational context in which data use takes place (e.g., the extent to which a school-wide vision for data use exists, the role of the school leader with regard to facilitating data use, and being a role model for data use), individual and team characteristics that may influence data use (e.g., knowledge and skills for data use, knowledge about the data management system, attitude about data use), and data characteristics (e.g., the availability of data in a data system, reliability and validity of data, and data available on a timely basis). The way in which the several factors within the different layers are fulfilled, highly influences the way in which data use is implemented in schools. For example, several studies show that organizational characteristics, individual and team characteristics, and data characteristics all influence the use of data (e.g., Schildkamp & Kuiper, 2010). Often, the presence of a factor acts as an enabler to data use (e.g., access to data), and the absence of a factor (e.g., lack of knowledge and skills) acts as a barrier (e.g., Datnow et al., 2013). Furthermore, the framework shows that data use involves several feedback loops with every step that is taken.

The starting point for using data effectively is a *purpose* in the form of a problem definition and a related goal. When *data* have been accessed and collected to investigate hypotheses related to the *purpose*, the data should be checked (validity and reliability), organized, and interpreted to verify or reject the hypotheses. Only then do the data turn into *information* that is valuable for the school. To turn into *knowledge*, the *information* should be combined with the understanding and expertise of data team members. Subsequently – and this is where this study is focused – this new *knowledge* can be applied and turned into *action*, e.g., in the form of an intervention related to classroom instruction. After this *action*, the team should evaluate whether the action has led to the desired *outcomes*. In the framework presented, the interaction between people and data, surrounded by the school context, ultimately results in decisions about interventions that can be implemented.

1.2. Data use actions

The actions (see Fig. 1) that educators can take based on data can be divided into three categories: actions with regard to *accountability*, *instruction*, and *school development* (Breiter & Light, 2006; Coburn & Talbert, 2006; Diamond & Spillane, 2004; Schildkamp, Lai, & Earl, 2013; Wayman & Stringfield, 2006; Wohlstetter et al., 2008; Young, 2006). *Data use for accountability* refers to schools using data (e.g., assessment data and results from internal evaluations) in external reports, for example, to present some aspect of the performance of the school for inspectors (Coburn & Talbert, 2006; Diamond & Spillane, 2004; Wohlstetter et al., 2008; Young, 2006). High policy pressure for data use, as in the 'No Child Left Behind' act, can lead to schools using data extensively for accountability actions (Wayman, Spikes, & Volonnino, 2013). However, using data for accountability actions does not automatically lead to school improvement.

Furthermore, data can be used to modify *instruction*. Effective instruction by educators in classrooms involves actions with a clear goal, that are aimed at explaining concepts and procedures, providing insight at the start of the learning process or sustaining

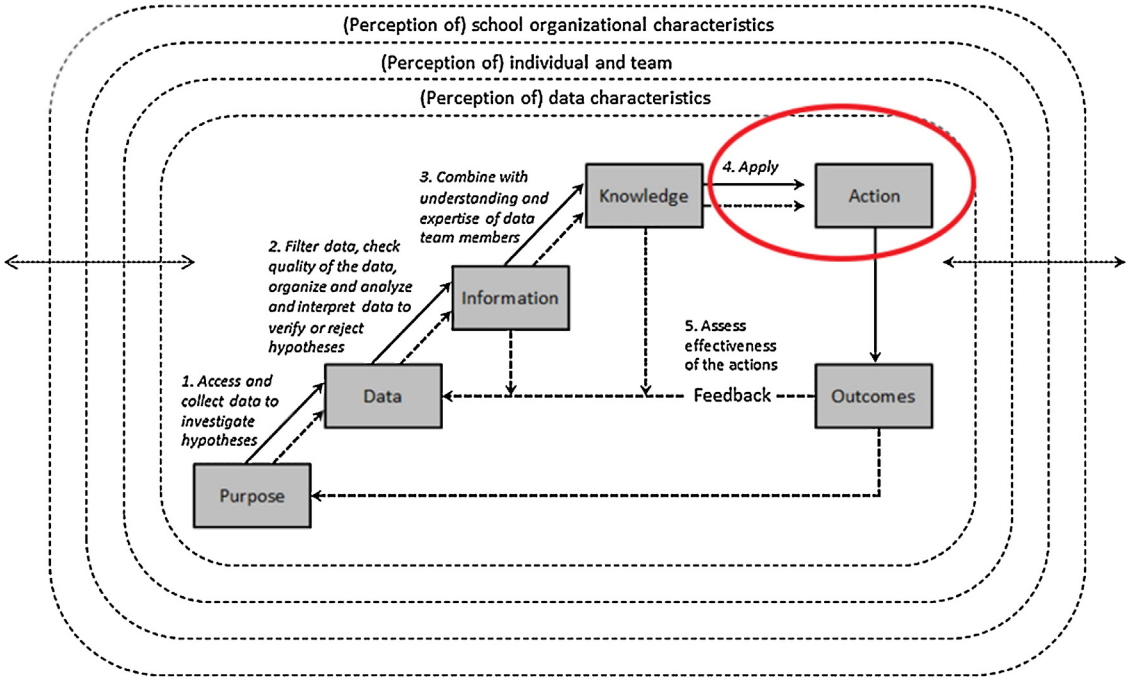

Fig. 1. Data use theory of action, and factors influencing data use (Schildkamp & Poortman, 2015; based on Coburn & Turner, 2011; Ikemoto & Marsh, 2007; Lai & Schildkamp, 2013; Mandinach, Honey, Light, & Brunner, 2008; Marsh, 2012, p. 4; Schildkamp, Handelzalts, & Poortman, 2012; Schildkamp & Kuiper, 2010; Schildkamp & Lai, 2013; Supovitz, 2010).

the learning process, and motivating students (Hattie, 2009; Hattie & Timperley, 2007). Recent research points out the potential of *data use for instruction* as a way to support higher student achievement (Campbell & Levin, 2009; Carlson et al., 2011; Lai, McNaughton, Amituanai-Toloa, Turner, & Hsiao, 2009; McNaughton et al., 2012). Educators can use data in several ways to improve their instruction (see, e.g., Breiter & Light, 2006; Coburn & Talbert, 2006; Kerr, Marsh, Ikemoto, Darilek, & Barney, 2006; Wayman & Stringfield, 2006; Wohlstetter et al., 2008; Young, 2006), for example, to differentiate in lessons (Kelly, Downey, & Rietdijk, 2010), to identify students' strengths or weaknesses (Brunner et al., 2005; Marsh, McCombs, & Martorell, 2010; Roehrig, Duggar, Moats, Glover, & Mincey, 2008), and to track student progress toward standards throughout the year (Hamilton et al., 2009a).

Schools can also use data for *school development*. *Data use for school development* refers to schools that use data, for example, to evaluate and alter the curriculum (Anderson, Leithwood, & Strauss, 2010; Brunner et al., 2005), to formulate yearly goals for school improvement, and to determine effective teaching methods (Breiter & Light, 2006; Coburn & Talbert, 2006; Wayman & Stringfield, 2006; Wohlstetter et al., 2008; Young, 2006).

Although the data use actions are presented as three distinct categories, in reality these are intertwined. For example, data which are being used for accountability purposes may also be used for school development purposes. Furthermore, we recognize that school improvement entails using data for instructional purposes as well as school development purposes. In some cases the distinction is merely the level of aggregation. For example, teachers can use individual student achievement data for goal setting in their classrooms, and school leaders may use school level student achievement data for goal setting at the school level. In this study, we used the distinction between these three actions with regard to data use, because it is the aim to investigate whether educators use data for the several actions which can be distinguished not only by their purpose, but also at the classroom and school level.

1.3. Professional development effects

Professional development of teachers is linked with efforts at school improvement (Borko, 2004). Therefore, the data team intervention had the goal of both professional development and school improvement. Regarding professional development, the intervention aimed at providing educators with the necessary skills and knowledge related to data use in schools, at educators applying the knowledge and skills in practice, and at educators having a positive attitude toward data use. Regarding school improvement, the intervention aimed at solving the educational problem the data team worked on.

As mentioned earlier, scholars in the field of data use have frequently found that in-service educators do not possess the knowledge and skills needed for effective data use in their schools (e.g. Marsh, 2012), and also that teacher training colleges pay little attention to these skills (Mandinach et al., 2015). Previous research related to this intervention has shown that educators can acquire the necessary knowledge and skills by participating in a data team (Ebbeler, Poortman, & Schildkamp, 2015). However, there is a difference between acquiring certain knowledge and skills, and actually going on to apply that knowledge and those skills. Ultimately, to accomplish improved student achievement, educators need to *apply* their knowledge and skills regarding data use (Desimone, 2009; Guskey, 1998, 2000; Kirkpatrick, 1996). Use of the acquired skills and knowledge is part of the professional development process (Koellner & Jacobs, 2015). Therefore, this paper focuses primarily on the use of the acquired knowledge and skills: taking actions to improve the educational situation that are based on data.

1.4. The data team intervention

Data use is best undertaken collaboratively, for example, in professional learning communities (PLCs). A PLC consists of a group of teachers that is focused on collaborative learning by sharing experiences and critical reflections. PLCs focused on data use may also be called data teams or inquiry teams (Marsh et al., 2015; Nelson, Slavit, Perkins, & Hathorn, 2008). During the last two decades, collaboration was identified as one of the key elements for the professional development of teachers (e.g., Avalos, 2011; Binkhorst, Handelzalts, Poortman, & van Joolingen, 2015; Borko, 2004; Van Veen, Zwart, & Meirink, 2012). Several studies show that collaboration in teams is essential for professional development with regard to data use (e.g., Datnow et al., 2013; Wayman, Midgley, & Stringfield, 2006). Wayman et al. (2006) reported that professional development in the form of data teams shows promise. Data teams in this study consisted of 4–6 teachers, 1–2 team leaders/school leaders, and in some cases an internal data expert, who collaborated on trying to solve an educational problem within the school. Each data team consisted of members all working in the same school.

The data team intervention used a structured approach, which consists of eight steps (Fig. 2) that lead to the implementation of improvement measures based on data analysis. The approach is iterative and cyclic (inspired by Earl & Katz, 2006), and team members go back and forth between the steps (Schildkamp & Ehren, 2013, pp. 56–57) (see Fig. 2). There is a general consensus about the steps that are important for effective data use by educators, albeit the steps vary across publications (see e.g., Boudett, City, & Murnane, 2005; Earl & Katz, 2006; Mandinach & Jackson, 2012; Marsh, 2012). The steps in the data team procedure were inspired by existing data use manuals developed by Earl and Katz (2006), and for example, the Data Wise project from Harvard (Boudett & Steele, 2007). Also, the main activities of the data use theory of action (Fig. 1) come back in the eight steps of the data team intervention (Fig. 2). The eight step approach starts with a

Fig. 2. The eight steps of the data team procedure (Schildkamp & Ehren, 2013, p. 56).

Table 1
Instruments and time frame of the study.

Group	Pre-measurements	Post-measurements
Experimental group: data team schools (10 schools)	• Data use questionnaire (January 2012)	• Data use questionnaire (June 2013) • Interviews (only in case study schools) (June 2013 and June 2014)
Comparison group: schools without a data team (42 schools)	• Data use questionnaire (January 2012)	• Data use questionnaire (June 2013)

purpose by defining a problem and goals the team wants to focus on (step 1). Next, hypotheses about the possible causes of the problem are formulated (step 2), and data have to be collected to test the hypotheses (step 3). Subsequently, data team members check the quality of the data (step 4), analyze the data (step 5), and draw conclusions based on their analysis (step 6) implying data are to be transformed into information. Combined with the team members' expertise and skills, the information is turned into knowledge. Next, team members take action to implement improvement measures (step7). Finally, these improvement measures are evaluated (step 8). The data team determines whether the improvement measures were effective and the goals are met based on the evaluation plan. New data must be collected for this evaluation. If the goals have been accomplished and priorities met, the team can move on to definition of a new problem. The teams were trained in the data team process by an external data coach from the university, over a period of one-and-a-half years. The external data coach visited each data team every 2–3 weeks in their school, for about 90 min. The role of the external data coach involved giving just-in-time support, for example, supporting teams with formulating a clear and concrete problem definition, formulating measurable hypotheses, preventing the team from jumping to conclusions, and supporting the analysis of the data. Furthermore, the intervention included a comprehensive set of guidelines and activities to support the teams. The external data coach was not part of the team of researchers studying the data teams, but monitored the progress and process of the data teams and gave just-in-time support. For more information see Schildkamp and Poortman (2015).

In addition to 'collaboration', the approach in this intervention is in agreement with other criteria for effective professional development: shared vision and goals; professional development related to daily practice within educators' contexts; active participation of all participants; leadership, structure and support (Borko, 2004; Garet, Porter, Desimone, Birman, & Yoon, 2001; Jimerson & Wayman, 2015; Stoll, Bolam, McMahom, Wallace, & Thomas, 2006; Vescio, Ross, & Adams, 2008; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Research has also found that long-term interventions are more effective compared to short-term interventions (Desimone, 2009; Van Veen, Zwart, Meirink, & Verloop, 2010).

In this paper we focus on the effects of the data team intervention on educators' (perceptions of) application of their new knowledge and skills in their own schools after the intervention has ended. This concerns the 'Action' part of the data use theory of action (Fig. 1). To evaluate these effects we formulated three sub-questions: To what extent do educators apply their knowledge and skills as developed in the data team intervention for:

a) Accountability actions?
b) Instructional actions?
c) School development actions?

2. Method

To study the application in practice of new knowledge and skills with regard to *data use for accountability*, *school development*, and *instruction*, we employed a mixed-methods approach[1]. The external data coach in the data teams was not one of the researchers. She helped the researchers with making audio observations of each data team meeting and distributing questionnaires in the data teams, the data team schools and the comparison group. In Table 1, we present an overview of the research instruments and the time frame of the study.

2.1. Context

This study took place in the context of Dutch secondary education. Dutch schools have a considerable amount of curricular autonomy. For example, they are free to choose their pedagogical principles. Dutch schools also have considerable freedom regarding the subject-matter taught, assessments, and instructional strategies (Ministry of Education, Culture and Science, 2000). At the end of their secondary education, all students take national final assessments. These final exams consist of unstandardized internal school-based assessments and standardized national assessments.

In the Netherlands, the inspectorate[2] is more and more holding schools accountable for making use of data in order to improve the quality of the education they provide (Verbeek & Odenthal, 2014). In 2010, only 20% of the Dutch secondary schools engaged in data use (Dutch Inspectorate, 2011). It is the aim of the Ministry of Education that by 2018 at least 90% of primary and secondary schools engage in data use. Dutch schools have several data sources available as a basis for improving the quality of education the education they provide, including school inspection and self-evaluation data, data on intake, transfer and school leavers, assessment and examination results, and student and parent questionnaire data (Schildkamp & Kuiper, 2010).

2.2. Participants

This article presents the results of a study on the implementation of data use in Dutch secondary education in one of the largest school boards[3] of The Netherlands. To be able to link results about educators' use of new knowledge and skills about data use to the data use intervention, we used a mixed-methods approach. Ten[4] out of 52 schools belonging to this school board voluntarily signed

[1] Financial support for the conduct of the research was provided by Stichting Carmelcollege. Stichting Carmelcollege had no influence on the study design, the collection, analyses, and interpretation of data, and the writing of the report.

[2] It is the goal of the Dutch inspectorate to assess and improve the quality of schools. All Dutch schools are visited at least every four years. Based on the results of the inspection schools receive a report about their strengths and weaknesses alongside with suggestions for improvement. All reports are publically available online. If a school receives the label 'weak school' it is visited more frequently by the inspectorate (Ehren & Visscher, 2008).

[3] The tasks of school boards in the Netherlands are comparable to the tasks of districts in the US. School boards in the Netherlands, for example, formulate visions and goals, have financial responsibility, and make final decisions regarding teaching methods.

[4] After six months, one of the data teams chose not to proceed with the project because the intervention did not connect to the team leaders' goals. Their data regarding the questionnaire were therefore not included and no other data were collected there.

Table 2
Group comparisons at pre-test for data use for accountability, data use for instruction, and data use for school development.

	Group						95% CI for Mean Difference		
	Data team schools			Comparison group					
	M	SD	*N*[a]	*M*	SD	*N*[a]		*t*	df
Accountability	2.9038	.1538	9	2.9875	.3665	35	−.0954, .2628	.943	42
School development	2.6894	.1975	9	2.6455	.2809	35	−.2454, .1574	−.441	42
Instruction	2.7168	.2419	9	2.9994	.4100	37	−.0058, .5710	1.975	44

Notes: The items in the scales data use for accountability and data use for school development were answered using a Likert-type agreement scale, with 1 = *completely disagree* to 4 = *completely agree*, with the alternative answer *I don't know*. Items in the scale data use for instruction were answered using a scale from 1 to 6: *never*, *yearly*, *a couple of times per year*, *monthly*, *weekly*, or *a couple of times per week*, with the alternative answer *not applicable*.
[a] The number of responding schools.

up for participation with a data team. Each of the participating schools designated a data team consisting of 5–8 members. The other 42 schools of this school board were the comparison group and did not implement data teams in their schools, but they operated under the same school board (with the same vision and general policy regarding data use) as those schools that implemented the intervention. Therefore, they were a more appropriate comparison group than schools from other school boards. The data team schools and comparison group schools did not differ significantly on their pre-test scores for *data use for accountability* ($t(42) = .94$, $p > .05$), *school development* ($t(42) = -.44$, $p > .05$), and *instruction* ($t(44) = 1.98$, $p > .05$) (see also Table 2, for more information about the instrument see Table 6).

Furthermore, the two groups were comparable regarding participants' gender distribution, the distribution of teaching lower (12–14 year old students) and higher (14–18 year old students) secondary school, and participants' distribution regarding the teaching of languages, science and mathematics, or other subjects (e.g., creative subjects such as arts and drama) (see Table 3).

The data teams were supported by an external data coach for one-and-a-half years. Typical problems data teams worked on included, for example, the declining number of students passing the final year of secondary education, and disappointing final examination results in a specific subject area (see also Table 4).

The experimental group and the comparison group were studied over the period of one-and-a-half school years using a pretest–posttest questionnaire about data use in schools. Additionally, three data teams were selected for a longitudinal qualitative case study using interviews over two-and-a-half school years. The longitudinal approach has been chosen for being able to repeat observations regarding the application of data use over a longer period of time. Also, this approach is suitable because it cannot be expected that respondents fully implement data use in their own practice when the support from the external data coach just ended. The interviews were held at the end of the intervention period and one year after the intervention had ended.

Table 3
Comparability of data team schools and comparison schools.

	Gender (%)		Lower/higher secondary school (%)		Subjects taught (%)	
Data team schools	Male	50.2	Lower	39.7	Languages	27.4
	Female	49.8	Higher	60.3	Science/math	31.0
					Other	41.5
Comparison schools	Male	54.0	Lower	47.4	Languages	22.9
	Female	46.0	Higher	52.6	Science/math	33.2
					Other	43.9

To select the three case study schools from among the participating data team schools, first, a cluster analysis was carried out based on the pre-test results of a questionnaire about data use that was distributed among the participating Dutch secondary schools. To identify relatively homogeneous groups of cases, we used an agglomerative hierarchical cluster analysis. All responding schools were clustered into groups based on their amount of reported data use at the start of the project. The three data team case study schools represented three different data use clusters, ranging from low to high average data use scores per school. Second, the three teams were selected based on the presence of at least one school leader, one internal data expert, and at least three teachers during the data team meetings. Table 4 provides further information about the composition of the case study data teams, and the number of participants who were interviewed. Details about the case study data teams' work, that is, the problem statement, hypotheses that were tested and the outcomes, are given in Table 5.

2.3. Instruments

2.3.1. Data use questionnaire for teachers

We administered a 'data use questionnaire' as a pre-test and post-test, for teachers at data team schools (pre-test: $N = 277$, 38.8% response rate; post-test: $N = 243$, 38.51% response rate) and teacher at comparison group schools (pre-test: $N = 485$, 20.7% response rate; post-test: $N = 788$, 35.53% response rate). This questionnaire consisted of 23 items addressing *data use for accountability*, *instruction*, and *school development*. Detailed information on the scales, including example items, can be found in Table 6.

The items making up the scales for *data use for accountability* and *data use for school development* were set on a four-point Likert scale ranging from 'completely disagree' (1) to 'completely agree' (4). Due to the early stage of data use in The Netherlands, the alternative answer 'I don't know' was also included.

For validity reasons, different response categories were used regarding the items in the scale for *data use for instruction*. Respondents were asked to indicate how often they used data for specific instructional actions, on a scale from 1 to 6: 'never', 'yearly', 'a couple of times per year', 'monthly', 'weekly', or 'a couple of times per week'. Again, due to the early stage of data use in The Netherlands, 'not applicable' was included as possible answer in this scale. The reliability analysis showed that the reliability of all scales was sufficient to good (Schildkamp, Poortman, Ebbeler, & Luyten, 2014b).

2.3.2. Semi-structured interviews with selected members within the case study data teams

At the end of the intervention period, semi-structured interviews were conducted. During the interviews data regarding respondents' application of newly acquired knowledge and skills

Table 4
Description of case study data team composition and interview participation.

School	# Meetings	# Teachers	# Team leaders/ school leaders	# Internal data experts
A (scored highest for data use in cluster analysis)	18	6	2	1
B (scored lowest for data use in cluster analysis)	15	4	2	1
C (scored middle for data use in cluster analysis)	16	6	1	1[a]

[a] The internal data expert of this school stopped joining the data team meetings after 6 months.

regarding data use were collected from selected respondents within the three case study schools (interview round 1: $N = 11$). These interviews were repeated one year after the intervention period had ended (interview round 2: $N = 8$) (see Table 7).

Three to four members per case study data team were selected for the individual interviews: one team leader/school leader, two teachers, and the internal data expert (if available) were individually interviewed (see Table 5). The interviewees were selected with the help of the external data coach for the data team. The external data coach was asked to indicate which two teachers in the data team were best able to articulate how they apply data use in their own practice. The same applied to the selection of the

Table 5
Description of case study data teams' work.

School	Problem statement	Hypotheses and qualitative research questions tested by the team	Outcomes
A (scored highest for data use in cluster analysis)	Decrease in number of students passing the final year of pre-university education	#1: The number of boys switching from pre-university education to a lower track (providing access to polytechnics) in their final year is significantly higher than the number of girls in the same group of students	Rejected
		#2: Students switching from pre-university education to a lower track (providing access to polytechnics) have an 'Economics & Society' specialization in their subjects significantly more often	Rejected
		#3 (qualitative): What are causes for not passing their second to last year of the pre-university track?	Learning capacity and motivation of students were found to be most relevant in a questionnaire. The data team chose to further investigate the motivation of students in grade 11 of pre-university education
B (scored lowest for data use in cluster analysis)	Disappointing final examination results of geography students	#1: Students coming from other middle schools than our own middle school track and who transfer into our high school track have a negative impact on the average mark for the final examination, and also a negative impact on the difference between the average mark for the final examination and the average for the internal school examination	Rejected
		#2: Final examination tasks related to questions where students have to explain phenomena have the biggest negative impact on the final examination mark in the pre-university education track and the track providing access to polytechnics	Accepted: Improvement measures for practicing these examination tasks have been set up for the next exam candidates. Also, improvement measures for ensuring curriculum coherence over the years have been set up to ensure that students learn how to respond to these tasks accurately
		#3: Geography classes containing a high number of students with a 'Science' specialization in their subjects score significantly higher on the final examination in the pre-university track and the track providing access to polytechnics	Rejected
		#4: The track providing access to polytechnics has a low correlation between scores on the internal school examination and the final examination	Accepted, with limits of the dataset
C (scored middle for data use in cluster analysis)	Decrease in number of students passing senior secondary education (providing access to polytechnics)	#1: The trend of declining number of students passing the higher grades of the track providing access to polytechnics is caused by the high percentage of students (usually more than 20% of the students) who fail to pass the 10th grade in the track providing access to polytechnics	Rejected
		#2: Students in the 9th grade of the track providing access to pre-university education with a grade point average score lower than average after primary education have a significantly higher likelihood of repeating a class.	Rejected

Table 6
Reliability and example items for the scales in the data use questionnaire (Schildkamp et al., 2014b, p. 6).

Name of scale	Number of items	Cronbach's alpha	Example items
Data use for accountability	3	.75	• The data we use for accountability actions (e.g., to show parents and the school inspection how we are performing) represent the reality • Results of our internal evaluations are documented in external reports (e.g., a report for the school inspection)
Data use for school development	9	.87	• Student achievement results are used to identify gaps in our curriculum • In my school we use student results to determine yearly goals for school improvement
Data use for instruction	11	.91	To what extent do you use data to: • Set learning goals/targets for individual students • Determine which topics and skills students do and do not possess • Determine progress of students

Notes: The items in the scales data use for accountability and data use for school development were answered using a Likert-type agreement scale, with 1 = *completely disagree* to 4 = *completely agree*, with the alternative answer *I don't know*. Items in the scale data use for instruction were answered using a scale from 1 to 6: *never*, *yearly*, *a couple of times per year*, *monthly*, *weekly*, or *a couple of times per week*, with the alternative answer *not applicable*.

team leaders/school leaders who were interviewed, where there were two team leaders/school leaders in the data team.

The questions in the interview schedule were based on the theoretical framework. Therefore, the interview schedule included questions about the application of knowledge and skills in practice, for example, 'How do you apply data use in your own classroom, in team meetings, or at the school level? ', and 'Which changes did you observe with regard to data use within your school? '. The interview schedule was validated by an expert panel consisting of three researchers with teaching experience.

2.4. Analysis

2.4.1. Independent samples t-test with the data use questionnaire for all participants

To investigate whether data team schools began applying the data use knowledge gained as a result of the data team intervention, we compared the results of the data use questionnaire between the group of schools with data teams and the comparison group schools, in terms of their gain scores from pre-test to post-test. In order to compare the gain scores at the end of the intervention period for *data use for accountability*, *data use for school development*, and *data use for instruction* between respondents from the data team schools and the comparison group, an independent samples *t*-test was conducted.

Due to privacy reasons and high overturn rates in schools, it was not possible to match pre-test and post-test responses to the data use questionnaire at the individual level. Therefore, the independent samples *t*-test was conducted with mean scores for the scales at the school level.

Table 7
List of participating interviewees.

School	Position in school	June 2013 (interview round 1)	June 2014 (interview round 2)
A	Internal data expert	√	√
	Teacher 1	√	√
	Teacher 2	√	√
	Team leader/school leader	√	√
B	Internal data expert	√	√
	Teacher 1	√	*No participation*[a]
	Teacher 2	√	√
	Team leader/school leader	√	√
C	Teacher 1	√	*No participation*[a]
	Teacher 2	√	*No participation*[b]
	Team leader/school leader	√	√

[a] No participation due to competing demands at the time of the interviews.
[b] No participation, because the interviewee was no longer working in the school.

2.4.2. Poisson analysis with the data use questionnaire for all respondents

Because of the early stage of data use in The Netherlands, the alternative answers 'I don't know' and 'not applicable' were also included in the data use questionnaire. We expected the number of times respondents within schools that participated in the intervention answered 'I don't know' or 'not applicable' on the data use scales to be lower at the end of the intervention compared to the number of times respondents within comparison schools chose these answers. We, therefore, analyzed if there was a decrease in the number of times respondents from data team schools and comparison group schools answered 'I don't know' and 'not applicable', with regard to the post-test compared to the pre-test, by conducting a Poisson regression analysis. A Poisson regression analysis is the most advised analysis to model count data, because the Poisson distribution is suitable for modeling count data that only take on nonnegative integer values of zero or greater (Coxe, West, & Aiken, 2009).

2.4.3. Semi-structured interviews with selected members within the case study data teams

Semi-structured interviews were held for obtaining in-depth insight into how respondents use data in their own practice, e.g., by asking respondents for examples with regard to their data use actions. Furthermore, semi-structured interviews allowed the respondents to bring up examples of data use practices that were possibly not covered by the data use questionnaire, as the questionnaire contained more general questions on data use. The interviews with a selection of data team members within the case study data teams were audio-recorded and transcribed verbatim. A member check was conducted by sending interview summaries to the individual participants. The participants agreed with the content of the summaries. The transcriptions were analyzed by applying an *a priori* coding scheme (Strauss & Corbin, 1998; Weber, 1990) based on the theoretical framework, using ATLAS.ti. Codes were applied per utterance.

After coding the interviews, those fragments concerning the application of knowledge and skills were further categorized into *data use for accountability*, *data use for school development*, or *data use for instruction*. The example fragment from the interviews that is presented in Table 8, for example, was categorized into the category *data use for instruction*. Two researchers independently coded 10% of the interview fragments and found an almost perfect Cohen's Kappa of .83.

3. Results

In the results section, we will present the results of this study by type of data use action (*data use for accountability*, *instruction*, and

Table 8
Code and corresponding interview fragment.

Code	Example fragment from the interviews
Implementation of knowledge and skills	'[I am using data] not as much as I would like to, because it takes a lot of time. When I am analyzing exams . . . and I see results I did not expect, then I take a look at the tasks pupils score very low and very high on. Then I am trying to support individual pupils at these specific tasks. . . .'

school development). In each section we will first present the quantitative results from the independent samples *t*-test (also given in Table 9). Then, the qualitative results from the interviews with case study data team members will be presented, followed by the results of the Poisson analysis (also given in Table 10). In this study we use the term 'educators' instead of 'teachers' in the cases where the results apply to teachers, school leaders, and internal data experts together.

3.1. Data use for accountability

Inspection of the gain scores from pre-test to post-test indicate that at the end of the intervention period, mean scores for the application of *data use for accountability* increased more for teachers in data team schools ($M = .1012$, SE = .0513) than for teachers in the comparison group schools ($M = .0193$, SE = .0681). However, the results of the independent samples *t*-test show that these differences were statistically non-significant $t(36) = -.648$, $p > .05$ (see Table 9).

The interview results also showed that the data team intervention schools were not using data for accountability to a high extent. The educators could not mention any examples with regard to data use for accountability. The descriptive statistics of the Poisson analysis (see Table 10) show that the mean of the numbers of times teachers in schools with a data team chose 'I don't know' decreased for data use for accountability during the intervention period. The descriptive statistics also show that the mean of the numbers of times teachers in comparison schools chose 'I don't know' for data use for accountability increased. However, we do not know if these differences are significant, because the data for data use for accountability were over-dispersed, and therefore did not allow further analysis by means of a Poisson regression analysis.

3.2. Data use for instruction

Inspection of the gain scores indicates that at the end of the intervention period mean scores for the application of data use for instructional actions increased less for teachers in data team schools ($M = .0972$, SE = .1116) than for teachers in the comparison schools ($M = .3996$, SE = .1397). However, according to the results of the independent samples *t*-test, these differences were statistically non-significant $t(40) = 1.097$, $p > .05$ (see Table 9).

The interview results show that data team case study schools were starting to apply data use for instructional actions to some extent. One participant in school A reported, for example, that she observed a tendency for teachers to discuss more data during team meetings. She refers to other teachers' conversation:

> I heard that they use more data in their team, to compare the data, just to talk about the data – not to judge someone, but just to have a look –, for example, to see if they detected any differences within the data. (participant at school A, interview round 1).

The internal data expert at school A also reported being asked by individual teachers who participated in the data team for help producing charts for their examination results at the classroom level:

> The nice thing is that teachers asked me how they can produce scatterplots based on their own classroom data . . . in my opinion, that is the result of the data analysis course [held at the university for data team members], because in that course scatterplots were discussed. And I told them that they could easily produce scatterplots with their own data. They were kind of surprised and asked how. I explained it and they did it. (participant at school A, interview round 1).

One interviewee at school A said in the first interview round that due to the data team she applied her knowledge about statistics for the first time at the school level. She had learned about statistics during her teacher education coursework, but until her participation in the data team she had not applied this knowledge at school. However, in the interview she also stated that she did not apply data use in her own classroom. According to her, data were useful for specifying problems. However, in the classroom the teacher is busy with teaching and it is not possible to use data on a daily basis. She would use data only when having meetings with the school leadership team, for example, to talk about student results and adjust her planning for the next year.

At school B, the interview rounds also gave some insight into how the two interviewed teachers from school B actively tried to apply their knowledge from the data team for improving their instruction. Two participants at school B also reported that the chemistry teacher who joined the data team meetings in the second year of the intervention had replicated the data analysis of the data team for the subject of chemistry.

Table 9
Results of independent samples *t*-tests and descriptive statistics for data use for accountability, data use for instruction, and data use for school development.

Outcome	Group						95% CI for mean difference		
	Data team schools			Comparison group					
	M[a]	SD	N	M[a]	SD	N		t	df
Accountability	.1012	.1538	9	.0193	.3665	29	−.3382, .1745	−.648	36
Instruction	.0972	.3347	9	.3996	.8022	33	−.2547, .8595	1.097	40
School development	.0646	.2128	9	−.0060	.4195	29	−.3672, .2260	−.483	36

Notes: The items in the scales data use for accountability and data use for school development were answered using a Likert-type agreement scale, with 1 = *completely disagree* to 4 = *completely agree*, with the alternative answer *I don't know*. Items in the scale data use for instruction were answered using a scale from 1 to 6: *never*, *yearly*, *a couple of times per year*, *monthly*, *weekly*, or *a couple of times per week*, with the alternative answer *not applicable.*

[a] Mean of the gain score.

Table 10
Descriptive statistics of the Poisson analysis for the number of times a respondent chose 'I don't know' and 'not applicable'.

		Data use for accountability (mean (SD)–*N*)	Data use for instruction (mean (SD)–*N*)	Data use for school development (mean (SD)–*N*)
Data team schools	Pre-test	1.43 (1.13)–277	1.02 (2.34)–266	2.27 (2.53)–277
	Post-test	1.20 (1.13)–241	.72 (1.63)–235	1.98 (2.25)–241
Comparison group	Pre-test	1.38 (1.09)–564	1.01 (2.07)–557	2.41 (2.54)–566
	Post-test	1.45 (1.12)–788	1.00 (2.30)–773	2.48 (2.51)–788

Notes: The items in the scales data use for accountability and data use for school development were answered using a Likert-type agreement scale, with 1 = *completely disagree* to 4 = *completely agree*, with the alternative answer *I don't know*. Items in the scale data use for instruction were answered using a scale from 1 to 6: *never*, *yearly*, *a couple of times per year*, *monthly*, *weekly*, or *a couple of times per week*, with the alternative answer *not applicable*.

> Some time ago we did a correlation analysis with the marks [for geography] of previous school years and the final examination mark [for geography]. We talked about the results of the analysis [in the data team]. The very same week [the chemistry teacher] did the same analysis for his subject. (participant at school B, interview round 1).

Another interviewee at school B also reported how he analyzed the data and applied his knowledge:

> I analyzed the results from the final exam from 2013 of the students from the pre-university track. In the analysis I saw that [certain groups of] students scored low on final exam questions regarding physical geography, for example, earthquakes, climate, and so on. So I thought, that for the class that is taking the exam next year, I have to put more emphasis on this particular issue during class. We are working on that topic right at the moment. And so I decided to adjust my planning for the year and give students more time to work on the topic and to dive deeper into the topic. (participant at school B, interview round 1).

In the second interview round, one participant at school B reported that when looking at the data and seeing something unusual, for example, a student scoring very low on a certain topic or kind of exercise, he sat down with the student and talked with the student about the issue. Together, then, they would think of another way the student could learn to avoid making those mistakes again. However, he also described that he used data less than he would have liked, because of a lack of time. Also, the participant said that he still lacked a routine for using data effectively.

In school C, one teacher reported that she implemented a kind of data team consisting of teachers in her own department and tried to use data in her own practice:

> Well, in our faculty we look at the performance of parallel classes, and we analyze [the results], for example, of three different teachers in upper pre-university education. After each exam we compare the results with each other, and we analyze which questions were difficult, where the most mistakes were made. Once, for example, we decided to let every student re-sit the exam with a better version of the exam ... That way everyone should try to have a look at the results of the exam and see if something has to be changed. (participant at school C, interview round 1).

The results of the Poisson analysis of the questionnaire data also indicate that the awareness of the importance of using data for instruction grew in data team schools. The descriptive statistics of the Poisson analysis show that the mean number of times participants in schools with a data team chose 'not applicable' decreased for *data use for instruction*. However, this number stayed nearly the same for the comparison schools in the post-test results. Results of the Poisson regression analysis also show that the number of times respondents answered 'not applicable' on the *data use for instruction* scale was significantly lower for respondents from data team schools at the post-test compared to the pre-test than for schools from the comparison group ($b = -.337$, $p < .000$).

3.3. Data use for school development

Inspection of the gain scores indicates that at the end of the intervention period, teachers in data team schools slightly increased the degree to which they responded that they applied *data use for school development* ($M = .0646$, SE = .0709), while the mean score for teachers at comparison schools slightly decreased ($M = -.0060$, SE = .0779). However, according to the results of the independent samples *t*-test, these differences were statistically non-significant $t(36) = -.483$, $p > .05$ (see Table 9).

During the interviews, not all case study data teams could give examples of how they applied *data use for school development* as result of their data team participation. One example was given for school B. In that school, the school leadership team asked teachers from all subjects to report about curriculum coherence over the years as a result of the data team analyses that were carried out:

> Possibly he [one of the team leaders/school leaders in the team] always had the idea that the school has to do something about curriculum coherence. And the data team came to the conclusion that we really have to design the subject based on what students are required to be able to do in the final examination. So, take these requirements and write down what to teach in which grade. A few months ago we got the task from the principals to write down the curriculum ... And now the whole school does it. Due to the data team, he [one of the team leaders/school leaders in the team] was reassured that we are on a good path and that it should be done for every subject like we do it in the data team. So, indirectly the data team is visible in the whole school. (participant at school B, interview round 2).

In addition, similar to what was seen for *data use for instruction* the results of the Poisson analysis also show that at least the awareness of the importance of using data for school development is growing. The descriptive statistics of the Poisson analysis (see Table 10) show that the mean number of times teachers in schools with a data team chose 'I don't know' decreased for *data use for school development*. In contrast, the mean number of times teachers at comparison schools answered 'I don't know' for items on the scale for *data use for school development* increased. The Poisson regression analysis indicates that the number of times a teacher answered 'I don't know' on the *data use for school improvement* scale on the post-test compared to the pre-test was significantly lower for the data team schools than for the comparison group ($b = -.199$, $p < .000$).

4. Conclusions and discussion

This study aimed at examining the effects of working in a data team on educators' application of data use in schools. Based on the theoretical framework, we distinguished three different types of data use actions that data users could take: *data use for accountability*, *instruction*, and *school development*.

With respect to the effects of working in a data team on *data use for accountability*, we can conclude that the quantitative results did not show any effects. At the end of the intervention period, data team schools did not increase their use of data for accountability actions significantly more than did schools in the comparison group. Also, interviewees could not report any examples related to *data use for accountability*. This might be explained by the fact that the data team method is aimed more specifically at improving education within schools, rather than external accountability.

However, teachers in schools that had participated in the intervention significantly less often answered 'I don't know' in the post-test scale for *data use for accountability* than did their colleagues in the comparison schools. This might indicate that at the end of the intervention period data team schools were more aware of the importance of actions with regard to *data use for accountability* than teachers in comparison schools.

Furthermore, as the quantitative results for the effects on *data use for instruction* show, data team schools did not significantly increase their use of data for instruction compared to their colleagues in comparison schools. However, teachers at data team schools significantly less often chose to answer 'not applicable' on the data use questionnaire at post-test. Again, this might indicate that teachers at these schools became more aware of the importance of data, and their instructional data use actions. In the case study interviews with data team members, several examples were given of how teachers began to use data in order to adjust the instruction in their classrooms. For example, data were used to adapt teaching by adjusting the amount of time dedicated to specific topics within the subject for students who had to take an exam, based on the results of the students that took the exam the year before.

The questionnaire results for *data use for school development* did not show large effects. However, here as well, interviewees reported about first steps of using data within the school for school development by discussing data in teams of teachers. One school, for example, used the results of the data team work to think about curriculum coherence over the years for all of the subjects taught in school.

Though the results of the data use questionnaire were not significant, the results of the Poisson analysis which was conducted with all data team school respondents and the comparison schools, and the qualitative results show that data team schools seem to be at the start of making a change toward the application of data use. The results of the study show that some of the respondents were trying to apply their newly learned data use knowledge and skills. However, the step from problem identification via formulating questions and interpreting results to developing solutions is difficult. Scholars have found that many educators are much more focused on interpreting data than on catalyzing further learning based on the results of the data analysis (Jimerson & Wayman, 2015). Therefore, it is not surprising that the crucial step from interpretation to developing and implementing improvement measures occurs only in a minority of settings (e.g., Anderson et al., 2010). For changes in practice – as opposed to knowledge – to be lasting, it must be integrated in a teacher's existing routines, and this takes time (Wiliam & Leahy, 2015, p. 18).

By implementing the data team intervention, we wanted to help schools overcome this issue. However, when the support from the external data coach ended after one-and-a-half years, only one of the case study teams was at the point of actively thinking about and implementing improvement measures. In most of the other data teams, support by the external data coach had ended while no improvement measures had yet been taken. The fact that data teams were not yet at the point of thinking about improvement measures, and that improvement measures were difficult to implement after the intervention had ended, confirms the crucial role of coaches in helping educators to think about and implement improvement measures based on the results of the data analyses (see e.g., Marsh, 2012), and also that professional development initiatives are more effective when they take place over a longer period of time (i.e., two years; Houtveen & Van de Grift, 2007, 2012; Houtveen, Van de Grift, & Creemers, 2004).

4.1. Limitations of the study

Some limitations of the study should be discussed. We did not find statistically significant results using the data use questionnaire. This may have been caused by several methodological issues. First, the questionnaire results are based on self-perceptions. Teachers may have assumed at the pre-test that they applied data use more than they actually did, and may have become more aware of their actual data use at the end of the support period. Also, the results of the Poisson regression analysis indicate that data team school became more aware of their data use actions.

Second, the analysis of the data use questionnaire was conducted at the school level. We would have preferred to split the respondents into three groups: participants of the data team, colleagues of the data team in the same school, and colleagues in comparison schools. However, this was not possible due to privacy reasons and high turnover rates in the schools. Due to the fact that the level of analysis is the school level, it may have been more difficult to observe change based on the data use questionnaire as this concerns data use by all the educators in the school and not just the relative small group of people involved in the actual data team.

Third, one might argue that the items of the data use questionnaire were not nuanced enough. We distinguished in this study between data use for school accountability, data use for school development and data use for instruction. Although the factor analysis clearly indicated that the questionnaire has these three scales, there might be overlap between the scales, and in reality the three purposes are likely to be intertwined. Moreover, the items in the questionnaire concern general data use actions, which are not specifically tailored to the work of data teams, and therefore might not capture certain nuances in the use of data.

4.2. Implications for practice

This study shows that data use in schools can be improved and that educators need (long-term) professional development regarding data use. Schools should invest not only in developing the knowledge and skills of educators, but also in assistance for educators for catalyzing change in schools based on the results of data analyses, e.g., instructional coaches who help to modify instruction in the classroom. These coaches can support teachers in actually developing and implementing actions based on data to improve student learning. For example, educators still struggled with the integration of data use in their daily classroom activities at the end of the support provided by the external data coach. Therefore, schools should provide support, for example from instructional coaches, for teachers to learn how to integrate data use in their daily practice.

4.3. Implications for further research

In this research we aimed at measuring the effects of participating in a data team intervention on the application of data use knowledge and skills in the long-term, using a questionnaire and interviews. To be able to capture data use in practice, future studies should also take into account the possibility of using classroom observations to study the use of data for instruction. Moreover, the use of data for school development and accountability might be captured in greater depth by studying team and school leader meetings.

Though the quantitative results of this study are not statistically significant, it does not mean that the results are insignificant. First, what we can learn from these results it that knowledge on how to use data does not automatically transfer from the data team members to the colleagues in the school. More attention needs to be paid to knowledge dissemination from the team to the colleagues in the schools. Second, although the qualitative results show that data team members started to use data in their school, the results also show that even after the intervention participants still had difficulties in using data. Also, based on these results of the study, we were able to improve the material provided to participants in data teams. For example, more specific guidelines were set up on how to implement an improvement measure in schools and set up a plan on how to test if this improvement measure worked.

Furthermore, future research should take into account that possibly more than one year is needed between the end of an intervention and answering the question whether and how educators apply their knowledge and skills as learned during an intervention. Future research should also take note that organizational factors (e.g., providing time for data use; vision of data use) may play a vital role in teachers' application of knowledge and skills regarding data use in practice (e.g., Marsh, 2012; Schildkamp & Kuiper, 2010). Therefore, future research should also try to capture the effects on the organization when participating in such an intervention.

Along with the limitations, we also want to highlight a more innovative aspect of this study, which is the use of Poisson analyses. In survey data, the 'I don't know'-category is often treated as missing data. However, as the results of this study show, 'I don't know' data can give valuable insights into the phenomenon that is being studied. One way to use this type of data is by conducting Poisson regression analyses, as we did in this study. Poisson regression is a tool that can model count data, such as the number of times participants in a certain condition choose a certain answer. Though over-dispersion may be a problem in some instances, such analysis may also provide scholars with further insight into how the response patterns on questionnaires have changed.

In this study, we focused on the application phase of data use. However, further research is needed to focus on whether schools that participate in data use interventions actually solve their problem, and thus, if an improvement in student achievement can be observed. Only then will the ultimate goal of professional development have been reached (Guskey, 2000; Kirkpatrick, 1996). In this study, for example, some of the schools indicated that their data team found the causes of their problem and implemented improvement measures to improve their student achievement. Further research is needed in order to assess whether these improvement measures have had an impact on student achievement.

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