Factors Influencing the Functioning of Data Teams

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Abstract
Professional development in the use of data is urgently needed. However, we need a more fundamental understanding of how we can increase the effectiveness of data-use-related professional development. This study therefore focusses on the factors influencing a professional development intervention for data-based decision making: the data team procedure. Data teams are teams of teachers and school leaders who collaboratively learn how to use data, following a structured approach. In this study we focused on observing in depth the factors that influence the work of four data teams. These teams were followed over a period of two years. The results show how several data characteristics (e.g. access to data), school organizational characteristics (e.g. shared goal), and individual and team characteristics (e.g. pedagogical content knowledge) influence the use of data in data teams. We discuss how these factors influence the use of data and how these factors are interrelated.

Introduction and Theoretical Framework
In a context where schools are held more and more accountable for the education they provide, data-based decision making has become increasingly important. Our definition of “data” in the context of schools is information that is systematically collected and organized to represent some aspect of schooling. This definition of data is deliberately broad to include any relevant information derived from qualitative and quantitative methods of analysis (Lai & Schildkamp, 2012; Wayman, Jimerson, & Cho, 2012). Examples include assessment data, structured classroom observation data, and student survey results. Data-based decision making (in short, data use) refers to making decisions based on these data (Lai & Schildkamp, 2012; Mandinach & Honey, 2008).

In the school effectiveness literature, data use is identified as a common core characteristic of high-performing schools (Ragland, Clubine, Constable, & Smith, 2002; Snipes, Doolittle, & Herlihy, 2002; Schaffer, Reynolds, & Stringfield, 2012; Supovitz & Klein, 2003). Studies show that data-based decision making can lead to increased student achievement (Campbell & Levin, 2009; Lai, McNaughton, Timperley, & Hsiao, 2009). However, most teachers do not use data to its best effect, or do not use data at all (Schildkamp & Teddlie, 2008; Schildkamp & Kuiper, 2010). Decisions by teachers are generally taken based on intuition and limited observations (Ingram, Louis, & Schroeder, 2004), and these decisions do not always contribute to student learning. Also, in most cases, little attention is paid in teacher training colleges to data use (Herman & Gribbons, 2001; Mandinach & Gummer, 2013). Therefore, professional development (PD) in data-based decision making is urgently needed, and is essential for improving the quality of schools (Desimone, 2009). This PD should include training with regard to how to use data, and, perhaps even more importantly, how to connect data to the daily practice of school leaders and teachers (Black & William, 1998; Datnow, Park, & Wohlstetter, 2007; Supovitz & Klein, 2003).

However, PD is often ineffective in terms of improving the knowledge, skills, and attitude of the receiver. We therefore need a more fundamental understanding of data-use-related PD (Desimone, 2009). How teachers collaborate around the use of data has not been explored extensively (Datnow, Park, & Kennedy-Lewis, 2013). Moreover, a great deal still remains
unknown with regard to the conditions influencing data use (interventions) (Coburn & Turner, 2012; Marsh, 2012). This study therefore focusses on the factors influencing a professional development intervention for collaborative data-based decision making: the data team procedure.

Data teams are teams of 4–6 teachers and 1–2 (assistant) school leaders, who collaboratively use data to solve a certain educational problem within the school, using a structured approach. The data team procedure includes a comprehensive set of guidelines and activities and support from a facilitator of the university. This external facilitator visits the data team’s school every 2–3 weeks for a meeting to work on the steps, for a period of 2 years. Collaboration around the use of data brings focus to the conversations, a sense of purpose, helps teachers to learn from each other how to use data, and allows for a fertile exchange of ideas and strategies (Datnow et al., 2013; Wayman, Midgely, & Stringfield, 2006; Wohlstetter, Datnow, & Park, 2008). Also, collaborative data use is more likely to contribute to teacher and student learning than individual data use (Chen, Heritage, & Lee, 2005; Means, Padialla, & Gallagher, 2010; Means, Chen, DeBarger, & Padilla, 2011; Wayman et al., 2006; Wayman & Stringfield, 2006).

Data teams can be seen as a form of professional development with the ultimate goal of school improvement. Although presented as a rather linear process, the data team procedure is an iterative and cyclic procedure (developed based on Earl & Katz, 2006), consisting of eight steps. The data team members go back and forward between the steps (see also Figure 1) (Schildkamp, Handelzalts, & Poortman, 2012; Schildkamp & Ehren, 2012, p. 56–57):

1. **Problem definition**: The team decides on which educational problem and goals they want to focus their efforts. For example, if the data team decides to focus on grade retention, in this step, the first thing the team has to do is to collect data on grade retention (e.g., how many grade repeaters does the school have in each grade?).
2. **Formulating hypotheses**: The team develops hypotheses (e.g., on what causes grade retention).
3. **Data collection**: The team collects data to test the hypotheses. Several types of data can be collected (e.g., assessment data, inspection reports, and examination results), both quantitative as well as qualitative data.
4. **Data quality check**: Are the collected data reliable and valid?
5. **Data analysis** (e.g., summarizing, calculating, comparing): This can involve simple data analyses (e.g., descriptive analyses, summarizing interview data) as well as more sophisticated analyses (e.g., correlational and regression analyses).
6. **Interpretation and conclusions**: If hypotheses turn out to be false, new hypotheses need to be tested. The data team needs to collect additional data (back to step 2). If the hypotheses are correct, the team draws conclusions based on the collected data.
7. **Implementing improvement measures**: The team describes the measures that are needed to solve the problem, and the goals that go with these measures. The team makes team members responsible for implementing the actions, and determines which resources are available for implementing the actions. The data team also thinks of ways to monitor the implementation of the actions, sets deadlines, and determines which data are needed to establish the effectiveness of the implemented actions.
8. **Evaluation**: Are the actions effective? Are the goals met? Are the problems solved, and is the team satisfied? To evaluate the actions, new data need to be collected. This process continues until the priorities are met and the goals have been accomplished. In that case the team can continue with a new problem and therefore start with a new ‘step 1’.
A Data Use Framework
Our theory of action, illustrated in Figure 2, is based on the analyses of several data use models and frameworks (Coburn & Turner, 2011; Lai & Schildkamp, 2012; Mandinach, Honey, Light, & Brunner, 2008; Marsh, 2012; Schildkamp & Kuiper, 2010; Schildkamp & Lai, 2012). Our framework dynamically links a broad view on data and data use to enablers and barriers that influence the use of data. The framework takes into account the process of data use (based on Mandinach & Honey, 2008; Marsh, 2012), the organizational context in which data use is taking place, and the characteristics of the data and data systems available, but also that individual data users in the data team influence the process at a micro level. Although the core section of the framework implies that data use occurs as a linear, rational process, we acknowledge that data use involves a number of complex processes, conditions, and contexts that interact in complex ways. This is illustrated in Figure 2 by showing that school organizational characteristics interact with individual and team characteristics, data characteristics, and data use. The interaction between data and people, in a certain context, results in decisions with regards to what action to take. Data use involves an interpretative process, in which data have to be accessed, collected, and analyzed to be turned into information, and combined with understanding and expertise to become meaningful and useful for actions (Coburn & Turner, 2011; Mandinach et al., 2008; Marsh, 2012).

The Process of Data Use
Firstly, when describing the use of data by data teams, we can look at the activities these teams undertake (see Figure 2). These activities follow along the line of the steps of the data use process described by Marsh (2012), with the exception that data teams start with a purpose in
the form of a problem definition and a related goal instead of with data. Often teachers and/or school leaders have the conception that something is wrong (which may be supported by, for example, inspection data), but they do not know what exactly the problem is and how big this problem is. So they start with their conception that something is wrong, for example in the area of mathematics, and start with the purpose of defining and solving this problem. After coming up with a problem definition based on data, hypotheses concerning the problem are formulated and data to investigate these hypotheses are accessed and collected. Data as such have no meaning. These data have to be filtered (e.g., are the data valid and reliable; if not, additional data need to be collected and a new feedback loop is created), organized to investigate the hypothesis, and analyzed and interpreted to become information. This is all done in step 4, 5 and 6 of the data team procedure. Combined with stakeholder understanding and expertise, this becomes actionable knowledge. In the data team procedure, this relates to two possible actions: either the hypothesis is incorrect and the action is to go back to formulating new hypotheses (a feedback loop is created) or the hypothesis is correct and the data team takes action based on the data. If the data team takes action based on the data, they also need to evaluate (collect new data) if their actions have led to the desired outcomes and goal; in this way another feedback loop is created (Mandinach et al., 2008; Marsh, Pane, & Hamilton, 2006; Marsh, 2012).

SECONDLY, THE TERM **DEPTH OF INQUIRY** IS RELEVANT IN STUDYING THE PROCESS OF DATA USE IN DATA TEAMS. HENRY (2012) DEFINES DEPTH OF INQUIRY AS THE DEGREE TO WHICH TEAM CONVERSATIONS EXPRESS HIGHER LEVEL THINKING SKILLS, SUCH AS ANALYSIS, SYNTHESIS, CRITIQUE, GOAL SETTING, REFLECTION, AND MONITORING. CONVERSATIONS THAT LACK DEPTH FOCUS ON TELLING INFORMATION, RETELLING, DESCRIBING, AND STORYTELLING.
High depth concerns data team members going through the whole data use cycle and developing new knowledge based on data, focused on taking action in their school or classroom.

Data Use in Data Teams: Influencing Factors
Our literature review shows that the process of data use is influenced by several factors that can either enable data use or form a barrier toward effective data use. These are summarized in Table 1. Firstly, data characteristics can become an affordance or constraint for the use of data. Schools that have access to high quality data are more likely to show an increased level of data use (Breiter & Light, 2006; Coburn & Turner, 2011; Park & Datnow, 2009; Schildkamp & Kuiper, 2010; Wayman & Stringfield, 2006; Wohlstetter et al., 2008). The following data characteristics were identified in the literature:

- Access to high quality data (Coburn & Turner, 2011; Kerr et al., 2006; Mandinach & Honey, 2008; Marsh et al., 2006; Means, et al., 2010; Schildkamp & Kuiper, 2010; Sharkey & Murnane, 2006; Wayman et al., 2006; Wayman & Stringfield 2006; Wayman, et al., 2007; Wayman et al., 2012).
- Availability of multiple sources of data, not just standardized assessment data, that fit with the needs of the user (Coburn & Turner, 2011; Mandinach & Honey, 2008; Means, et al., 2010; Schildkamp & Kuiper, 2010; Wayman et al., 2006; Wayman, et al., 2007; Wayman et al., 2012).
- Availability of tools and information management systems for data storage, retrieval, and analysis (Breiter & Light, 2006; Coburn & Turner, 2011; Datnow, et al., 2007; Datnow et al., 2013; Kerr et al., 2006; Mandinach & Honey, 2008; Means, et al., 2010; Schildkamp & Kuiper, 2010; Sharkey & Murnane, 2006; Wayman & Stringfield, 2006; Wayman et al., 2006; Wayman, et al., 2007; Wayman et al., 2012; Wohlstetter et al., 2008).

Moreover, data use can be enabled or constrained by certain school organizational characteristics. Our literature review pointed to the following influencing factors:

- Leadership: The school leader plays an essential role in the use of data. The school leader needs to encourage, motivate, and facilitate teachers (e.g., provide them with time to use data) (Coburn & Turner, 2011; Datnow et al., 2007; Datnow et al., 2013; Kerr, Marsh, Ikemoto, Darilek, & Barney, 2006; Leithwood, Jantzi, & McElheron-Hopkins, 2006; Levin & Datnow, 2012; Marsh et al., 2006; Marsh, 2012; Means, et al., 2010; Park & Datnow, 2009; Schildkamp & Kuiper, 2010; Supovitz & Klein, 2003; Wayman & Stringfield, 2006; Wohlstetter et al., 2008; Young, 2006).
- Shared goals: The school needs to have shared and measurable goals. Without clear and agreed-upon goals, the effective use of data is difficult (Datnow et al., 2007; Datnow et al., 2013; Earl & Katz, 2006; Honig & Venkateswaran, 2012; Kerr et al., 2006; Levin & Datnow, 2012; Park & Datnow, 2009; Schildkamp & Kuiper, 2010; Sharkey & Murnane, 2006; Spillane, 2012; Supovitz & Klein, 2003; Wayman & Stringfield, 2006; Wayman, Cho, & Johnston, 2007; Wohlstetter et al., 2008; Young, 2006).
- Training and support: Training and support for data use either internally (by a data expert, somebody from within the school who has access to data and can help with analysis and interpretation) or externally (through workshops, onsite support from somebody outside the school) can enable data use (Breiter & Light, 2006; Coburn & Turner, 2011; Honig & Venkateswaran, 2012; Kerr et al., 2006; Mandinach & Honey, 2008; Marsh et al., 2006; Marsh, 2012; Means, et al., 2010; Nelson & Slavit, 2007;
Schildkamp & Kuiper, 2010; Supovitz & Klein, 2003; Wayman & Stringfield, 2006; Wohlstetter et al., 2008; Young, 2006).

Finally, individual and team characteristics can influence the use of data. Data teams consist of individual teachers who work together in a team. As stated by Daly (2012, p. 2): “the interpretation and use of data for improvement take place within the individual and between educational actors, who, through social interaction co-construct and make sense of data and their use.” The following influencing factors were identified in our literature review:

- Knowledge and skills (e.g. to use data effectively, pedagogical content knowledge) (Coburn & Turner, 2011; Datnow et al., 2007; Earl & Katz, 2006; Kerr et al., 2006; Levin & Datnow, 2012; Mandinach & Honey, 2008; Marsh et al., 2006; Marsh, 2012; Schildkamp & Kuiper, 2010; Sharkey & Murnane, 2006; Spillane, 2012; Vanhoof, Van Petegem, & De Mayer, 2009; Wohlstetter et al., 2008; Young, 2006).
- Attitude and beliefs (Coburn & Turner, 2011; Datnow et al., 2007; Kerr et al., 2006; Marsh et al., 2006; Marsh, 2012; Schildkamp & Kuiper, 2010; Spillane, 2012; Vanhoof, et al., 2009; Wohlstetter et al., 2008; Marsh et al., 2006).
- Collaboration of teachers regarding the use of data (Coborn & Turner, 2011; Datnow et al., 2013; Huffman and Kalnin, 2003; Marsh, 2012; Nelson & Slavit, 2007; Park & Datnow, 2009; Schildkamp & Kuiper, 2010; Wayman, et al., 2006; Wohlstetter et al., 2008; Young, 2006).

Table 1  Factors influencing data use in data teams

<table>
<thead>
<tr>
<th>Main factors</th>
<th>Sub-factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data characteristics</td>
<td>• Availability of tools and information management system</td>
</tr>
<tr>
<td></td>
<td>• Access to high quality data</td>
</tr>
<tr>
<td></td>
<td>• Availability of multiple sources of data</td>
</tr>
<tr>
<td>School organizational characteristics</td>
<td>• Leadership</td>
</tr>
<tr>
<td></td>
<td>• Shared goals</td>
</tr>
<tr>
<td></td>
<td>• Training and support</td>
</tr>
<tr>
<td>Individual and team characteristics</td>
<td>• Knowledge and skills</td>
</tr>
<tr>
<td></td>
<td>• Attitude and beliefs</td>
</tr>
<tr>
<td></td>
<td>• Collaboration</td>
</tr>
</tbody>
</table>

The factors that influence the use of data have been studied extensively. However, the majority of these studies concern the use of data in general and not the use of data in data teams nor do these studies concern the factors influencing a professional development data use intervention. Therefore, the following research question guided the study that took place in secondary education in the Netherlands: Which factors influence data use in the data teams?

1. How do data characteristics influence the work of data teams?
2. How do school organizational characteristics influence the work of data teams?
3. How do individual and team characteristics influence the work of data teams?
Method
To capture the detail, nuance, and patterns of interaction in data teams, we employed a micro-process perspective (see Little, 2012). Little (2002) describes a micro-process as “zooming-in” to the interactions that occur between actors. In this case we “zoomed in” on the interaction between data team members, and the factors that enabled or hindered the work of the data teams. Following Little (2012, p. 144), this article argues for a more conceptually robust, methodologically sophisticated, and extensive program of micro-process research on data use that also anticipates the ways in which local practice both instantiates and constructs institutional and organizational structures, processes, and logics. We therefore employed a case study method (Yin, 2003), focusing on observing in depth the factors that influence the work of the data teams, and interviewing the data team members about these factors. A case study methodology was used as we focused on data teams in their natural contexts, using a variety of measures to answer the research questions. Moreover, the purpose of this study was to generalize to theoretical propositions, not to populations (Yin, 2003). Applying a case study design allowed for a deep examination and rich description of the enabling and hindering factors of the data teams in their specific contexts. The observation results, together with our field notes and interview results formed a comprehensive view of the use of data in the data teams, and the factors influencing the use of data.

The Dutch context
This study took place in the Netherlands. Dutch schools are rather autonomous. This implies freedom in choosing the religious, ideological, and pedagogical principles on which their education is based and in organizing their teaching activities. Dutch schools have considerable freedom regarding the subject matter taught, the textbooks, assessments, and the instructional strategies used (Ministry of Education, Culture & Science, 2000). The Netherlands do have an inspectorate, which holds schools accountable for their education.

This study focusses on secondary education. At the end of secondary education students have to take a national test. This is the only standardized assessment that is used by all secondary schools in the Netherlands. This final exam consists of an internal school-based assessment, and an external national assessment. National examinations are school-independent and equal for each Dutch student within a track. School-internal examinations are developed by schools themselves and differ per school. Both parts of the final examination, the external and internal part, are considered to be equally relevant: for each subject, the average school-internal examination grade makes up 50% of the final examination grade, the average central examination grade makes up the other 50%. To obtain a leaving certificate, an examinee must have scored passing marks in a specified number of subjects, such as Dutch, English and mathematics (Schildkamp, Rekers-Mombarg & Harms, 2012, p. 230). Other important data sources available to Dutch schools include: school inspection data; school self-evaluation data; data on intake, transfer, and school leavers; student work; curriculum assessments; and student and parent questionnaire data.

Respondents
Four data teams of six schools for upper secondary education (one team consisted of members of three different schools) were followed over a period of two years (see also Schildkamp et al., 2012) by observing all their meetings, collecting their documents, and interviewing their members (see Table 1). These schools voluntarily approached the university to participate, because they had heard about the university’s intention to pilot this new form of professional development. Our initial meeting was with the school leader and one or two teachers, and we
talked about the topic that they would like to investigate. The problems formulated by the school leader, partly based on data (for example from school inspection reports) were not very concrete and specific yet (see Table 1). For example, one school leader knew that they had several students repeating grades in the higher levels of senior secondary education, he was told by the Dutch inspectorate that he should work on reducing grade repetition, but he did not know exactly how many grade repeaters they had in the different classes. The school leaders in the four schools decided on the general topics (e.g. grade repetition, mathematic improvement), but left it up to the data teams to specify the problem and come up with a clear and measurable problem definition.

Table 1  

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Function</th>
<th>Years of experience</th>
<th>Subjects'</th>
<th>Data team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team W topic: High percentage of grade repeaters in higher levels of secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Teacher and mentor</td>
<td>19</td>
<td>History</td>
<td>W.</td>
</tr>
<tr>
<td>2</td>
<td>Teacher and mentor</td>
<td>19</td>
<td>Arts and Music</td>
<td>W.</td>
</tr>
<tr>
<td>3</td>
<td>Teacher and school leader of the havo department</td>
<td>15</td>
<td>German</td>
<td>W.</td>
</tr>
<tr>
<td>4</td>
<td>Teacher and havo coordinator</td>
<td>27</td>
<td>Dutch</td>
<td>W.</td>
</tr>
<tr>
<td>5</td>
<td>Teacher</td>
<td>36</td>
<td>English</td>
<td>W.</td>
</tr>
<tr>
<td>6</td>
<td>Teacher and mentor</td>
<td>25</td>
<td>English</td>
<td>W.</td>
</tr>
<tr>
<td>7</td>
<td>Data expert</td>
<td>3</td>
<td>N.A.</td>
<td>W.</td>
</tr>
<tr>
<td>Team B topic: low mathematics achievement in lower levels of secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Mentor, mathematics teacher and department head</td>
<td>32</td>
<td>Mathematics</td>
<td>B.</td>
</tr>
<tr>
<td>9</td>
<td>Mentor and mathematics and science teacher</td>
<td>8</td>
<td>Mathematics and technique</td>
<td>B.</td>
</tr>
<tr>
<td>10</td>
<td>School leader havo and vwo</td>
<td>11</td>
<td>History (not teaching)</td>
<td>B.</td>
</tr>
<tr>
<td>11</td>
<td>Mathematics, ICT teacher, ICT coordinator</td>
<td>2</td>
<td>Mathematics and informatics</td>
<td>B.</td>
</tr>
<tr>
<td>12</td>
<td>Teacher</td>
<td>NI*</td>
<td>Mathematics</td>
<td>B.</td>
</tr>
<tr>
<td>13</td>
<td>Data expert</td>
<td>3</td>
<td>N.A.</td>
<td>B.</td>
</tr>
<tr>
<td>Team Ca topic: low mathematics achievement in lower levels of secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>School leader havo/vwo</td>
<td>32</td>
<td>Physical eds. (not teaching)</td>
<td>C.</td>
</tr>
<tr>
<td>14</td>
<td>Teacher and mentor location 1</td>
<td>25</td>
<td>Mathematics</td>
<td>C.</td>
</tr>
<tr>
<td>15</td>
<td>Teacher and mentor location 1</td>
<td>4</td>
<td>Mathematics</td>
<td>C.</td>
</tr>
<tr>
<td>16</td>
<td>Teacher and mentor location 3</td>
<td>32</td>
<td>Mathematics and English</td>
<td>C.</td>
</tr>
<tr>
<td>17</td>
<td>Teacher location 2</td>
<td>7</td>
<td>Mathematics</td>
<td>C.</td>
</tr>
<tr>
<td>18</td>
<td>Teacher location 3</td>
<td>30</td>
<td>Mathematics</td>
<td>C.</td>
</tr>
<tr>
<td>19</td>
<td>Data expert</td>
<td>NI</td>
<td>N.A.</td>
<td>C.</td>
</tr>
<tr>
<td>Team G topic: Low(er) performance of pre-vocational education students entering senior secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Teacher</td>
<td>34</td>
<td>Biology</td>
<td>G.</td>
</tr>
<tr>
<td>21</td>
<td>School leader havo and vwo</td>
<td>11</td>
<td>Music (not teaching)</td>
<td>G.</td>
</tr>
<tr>
<td>22</td>
<td>Teacher</td>
<td>31</td>
<td>Physics and Mathematics</td>
<td>G.</td>
</tr>
<tr>
<td>23</td>
<td>Teacher and teacher trainer</td>
<td>20</td>
<td>Religious Studies and Social Studies</td>
<td>G.</td>
</tr>
<tr>
<td>24</td>
<td>Teacher</td>
<td>25</td>
<td>History and Geography</td>
<td>G.</td>
</tr>
<tr>
<td>25</td>
<td>Data expert</td>
<td>11</td>
<td>N.A.</td>
<td>G.</td>
</tr>
</tbody>
</table>

NI: not available for interviews

Data collection and Instruments
We collected observation data by audio recording all data team meetings and making field notes during the participant observation of these meetings by the researcher. One of the researchers
was the facilitator of the data team. Recording the meetings facilitated the micro-process approach. A total of 34 meetings, lasting between 1 and 1.5 hours, were recorded. Also, all data team participants were interviewed using an interview schedule based on the theoretical framework. The interviews concerned the way participants experienced the data teams and what factors they thought influenced their work. With regard to the influencing factors we asked respondents to describe whether they had experienced any hindering or enabling factors in their work with the data team. Next, we asked questions about the variables described in our framework, for example with regard to school organizational characteristics we asked: “Can you describe the role of the school leader with regard to the data team?” With regard to data characteristics we asked: “Can you describe how you have been collecting and using data with your data team?” With regard to individual and team characteristics we asked, for example: “Can you describe the process of collaboration in your data team?”. These one-hour interviews, twenty-three in total, took place approximately six months after the start of the data team.

Data Analysis
The researcher that did not facilitate the data team conducted all the data analyses. We transcribed both the observation data and the interview data verbatim. We used the program ATLAS.ti for coding the transcripts, relating the coded fragments to each other, and comparing the codes of different schools and respondents, within and across cases (cf. Boeije, 2002). We went through an initial round of coding using a coding scheme based on our theoretical framework, which arose from our literature review. With regard to the use of data, we checked how many steps of the data team cycle the data teams completed, if they went through multiple feedback loops, if the team created actionable knowledge based on the data (e.g. did they talk about possible measures that they could take based on the data), and the depth of inquiry that was reached (“no depth,” which concerns only storytelling, retelling [known] information and personal anecdotes, “average depth,” which concerns fragments that show data team members’ basic data use and basic understanding and explanations based on data, such as “the percentage of students that pass is too low,” and “high depth” concerns data team members developing new knowledge based on data, focused on taking action in their classroom) (Schildkamp, et al., 2012). With regard to the influencing factors, we employed codes for each of the influencing factors. With regard to school organizational characteristics, for example we used codes such as school leader support. For data characteristics we used, for example, access to data, and for individual and team characteristics we used, for example, attitude and beliefs. This first round of coding was followed by more rounds of coding using an iterative approach. For each of the schools, a within case analysis was conducted, followed by a cross-case analysis comparing data teams to each other. These extensive rounds of analyses of all the data collected led to an in-depth picture of the factors influencing the work of the four data teams.

Reliability and Validity
We used a systematized approach for data collection, consistent with the research questions (Poortman & Schildkamp, 2011), as described in the ‘instruments and analysis’ section. This means that all respondents were approached in the same way in relation to the research questions. In addition, we triangulated the observational data with the field notes and interview data. Reliability was further enhanced by audio taping all the data team meetings and the interviews, which allowed for thorough analyses of the data by another researcher than the facilitator. Also, the instruments were based on our theoretical framework. To promote internal validity, we observed the teams for an extended period (two years) and applied thick description (both the context and the behavior) of the results (Poortman & Schildkamp, 2011).
results, we describe extensively how the factors identified played a role in the teams’ data use, including examples and respondent quotes (Poortman & Schildkamp, 2011). External validity was enhanced by providing case-specific and cross-case thick descriptions (also including citations of respondents), and describing the congruence with the theoretical framework (Poortman & Schildkamp, 2011). Finally, two researchers coded approximately 10% of the same transcripts. We calculated the inter-rater agreement and found a satisfactory Cohen’s Kappa of 0.76.

Results: Within Case Analyses

As it is not within the scope of this article to discuss all the cases in depth, we will present the detailed results of one case here to demonstrate how we analyzed and interpreted the data, and the summaries of the other three cases. We choose this case, as this data team went through all the data use steps described in our theoretical framework, and was able to solve their problem. This is case is thus an exemplary case.

First we will describe the process of data use. Next, in line with Table 1, we will describe the influencing factors ‘Data characteristics’, ‘school organizational characteristics’, and ‘individual and team characteristics’.

Results Team W

The Process of Data use in Data Team W

Team W focused on the large number of grade repeaters in the higher levels of senior secondary education. Their initial thought was that they had a problem in the third grade (age 14/15), but in step 1 data showed that they had the most grade repetition in the fourth year (age 15/16) (on average over 30% per year). The team went through several feedback loops during 12 official data team meetings (the team sometimes also gathered in subgroups between meetings without the presence of the facilitator or data team expert). This team started with a low depth of inquiry and mainly pursued more external hypotheses in step 2 of the data team cycle rather than hypotheses about their own functioning during the first meetings: e.g., “our problem is caused by our schools’ retention policy” and “our problem is caused by a lack of motivation of our students.” The team collected several forms of data to investigate different hypotheses (step 3). For example, they collected data from their school registration system, and they checked the quality of these data in step 4, which were, in this case, considered sufficiently reliable and valid. A motivation survey used in step 3 to collect data about a motivation hypothesis showed that failing students were not less motivated than students who passed, and that students in both groups needed help in planning, more feedback, and more consequent checking of homework (e.g. step 6: interpretation and conclusion). In addition, the absenteeism data showed that a considerable part of the problem (approximately 16%) could be explained by student absenteeism. Furthermore, a curriculum coherence survey used to investigate another hypothesis, in a next feedback loop, showed that there were problems with the coherence of their curriculum. For example, the curriculum of the third grade level was not aligned in terms of content taught and assessments used with the curriculum of the fourth grade level. The team was starting to develop new actionable knowledge based on the collected data, implying a higher level of depth of inquiry. The team came up with several measures (step 7 of the data team cycle) addressing these issues: a new policy for student absenteeism; more regular checking of homework and more feedback to students; and setting up working groups to create
a more coherent curriculum. The next year, evaluation results (step 8) showed that the number of students repeating a class was significantly reduced to 23%.

Influencing Factors W: Data Characteristics

Availability of tools and information management system
Team W’s school had an information management system from which data regarding, for example, the number of failing and passing students could be extracted. In meeting 1, the data team referred to this system and the possibilities to collect the required data for defining the problem. The quality care manager mentioned that it was “a lot of work” to extract the numbers of failing and passing students per grade for all years, though. However, the necessary data were collected.

Access to high quality data
In general, the team had access to high quality data. They team collected data from their information management system in which data are systematically registered. However, further along the process the team found out that some particular data, regarding student absenteeism, were not registered sufficiently reliably: there were a lot of unknowns (e.g., they still needed to check whether it was an authorized or unauthorized absenteeism).

Availability of multiple sources of data
The data team was also able to collect multiple sources of data. All the data the team collected were related to their hypothesis about what caused grade repetition. In meeting 4, results of a student survey administered a couple of years ago were brought to the table, and the team decided they wanted to administer this survey on student learning (e.g., motivation) again to investigate their motivation hypothesis. In the fifth meeting, the team had the results of the third-year students’ survey. The team also administered a teacher survey, obtained from The Dutch Institute for Curriculum Development, on curriculum coherence to investigate another hypothesis. The team also collected student absenteeism data to investigate another hypothesis.

Influencing Factors W: School Organizational Characteristics

Shared goal
During the meetings, the goal of the data team was often discussed (e.g., decreasing grade repetition), but the team members did not express by how much. Also, during the interviews, all respondents mentioned the goal of decreasing grade repetition, but none of the respondents mentioned by how much.

Leadership
The school leader took up different roles in the data team. Sometimes she acted as an equal part of the team. She, for example, proposed several hypotheses that the teachers did not think of beforehand, for example with regard to teachers’ own role in the classroom. To some team members, leadership was perceived as equally distributed among team members; however, according to others, it was the school leader who made the decisions. The school leader started to take on more of a steering role as of meeting 6. She started to summarize and conclude more actively toward possible solutions at the level of the teachers’ own functioning: “what students are missing. Direction, motivation by the teacher, directing their planning and not expecting
them to do it perfectly within two weeks, but maintaining it. Our attitude in that is very important (. . .). We should agree about this together. (. . .) We should address each other about it too.” After the meeting, she explicitly explained to the facilitator that she was actually very impatient about the issue of the teachers relating their own functioning to the problem: “You should look at yourself more, really.” The teachers made only slow progress toward this idea.

Furthermore, the school leader supported the implementation of measures, as became clear in meeting 7. One of the teachers expressed his concern that the solutions that the team comes up with will not be implemented because, for example, it will be too expensive. Another teacher agreed: “Will the results really be used?“ The school leader assured them that if the team has proven that the solution is good and directed to the interest of the students, it will be implemented.

When it came to taking measures based on data, the school leader also took on an explicit role in planning and organizing, for example, with regard to the assignment regarding curriculum coherence for all the subject matter department; however, the teachers also had an active role in discussing this. They thoroughly discussed the issue of having enough time for the teachers to work on the assignment, and agreed on how this could be achieved.

Finally, the school leader had a supporting and motivating role, as expressed by three teachers during the interviews, and was also a role model, because, according to one of the teachers, she showed that she also made decisions based on data herself. As another teacher stated: “Sometimes our schedule is cleared (e.g., cancellation of lessons) so that we can participate in the data use meeting. This is special. Our school really tries not to cancel any lessons. If lessons are cancelled for this, this means that it is very important.”

Training and support: Facilitation by the Researcher (External)
The observation results show that, overall, the facilitator from the university was more guiding than substantially directive, and that all the members actively participated in the whole process. Throughout the whole process, the facilitator advised the team and supported decision making, for example, with regard to:

- Giving advice to focus on a specific grade level instead of focusing on all grade levels
- Giving advice with regard to hypotheses: e.g., focusing on hypotheses with regard to causes that can be dealt with by the team instead of focusing on uncontrollable factors
- Directing the team toward formulating new hypotheses when previous ones have proven to be wrong
- Advising what data to collect
- Giving advice on how to draw conclusions from the data and how to proceed in general; for example, by stating that the next step for the team should be to synthesize all their knowledge developed about the problem of failing students and draw conclusions
- Summarizing team discussions and progress made
- Pointing the team to relevant literature. In one of the meetings, she brought a research report about failing students to the meeting to list possible causes that might also apply to this school

Furthermore, the facilitator had an essential role in analyzing the data, as none of the data team members had the skills to do this. She involved the team in this process; by, for example, helping
decide what data were required for the next step and explaining how she would analyze the data. During the interviews, all the respondents also indicated that the support of the facilitator was needed in analyzing the results and to redirect the process when the team members lose their focus (e.g., start making claims without data backing up these claims). After a while, the facilitator did not have to correct the teachers anymore. In the rare case that a teacher proposed an action not based on data, he or she was corrected by colleagues instead of by the facilitator. Finally, all the data team members in the interviews indicated that the facilitator brought a more objective perspective to the team, as she was not working at the school.

**Training and support: Designated Data Expert (Internal)**

The data expert played an important role in this data team both in terms of participating in the discussions as well as with regard to collecting data from the information management system and preparing the student and teacher surveys for administering. During the interviews, the data team members expressed that the data expert provided the data team with a lot of the data they needed, and also was supportive of analyzing and interpreting the results.

**Collaboration with and Involvement of Relevant Stakeholders**

Although it was not included in our theoretical framework, we found that collaboration between data team members and colleagues from outside the data team can be essential. At meeting 7, the team reported their experience at a meeting with their colleagues in which they reported the activities and outcomes of the data team. However, their colleagues were very defensive and skeptical about the data team outcomes so far. In meeting 7, the data team discussed the fact that the lack of support of colleagues outside the team was a major challenge. However, they acknowledged that they might not have involved their colleagues enough so far. In meeting 8, the team also briefly discussed how to communicate the data team’s plans with regard to the hypothesis about the curriculum coherence. The team concluded that one of the teachers would explain this to all the colleagues during a meeting. During the interviews, three team members also worried that they did not communicate sufficiently about their work with their colleagues outside the data team. As one teacher stated: “We can find out in our data team that a certain hypothesis or myth is incorrect, but in the teacher lounge these myths can still survive.”

**Influencing Factors W: Individual and Team Characteristics**

**Knowledge and skills**

The observation results show that teachers lacked data literacy. In meeting 6, for example, the school was only able to provide raw data and the facilitator was needed to help with preparing these data for (more advanced) analyses. The observation results also point to the importance of pedagogical content knowledge (PCK) and knowledge on the organization of the school. The teachers related much of their knowledge about failing students to the discussion of the problem: regarding the trajectory from the lower to higher levels of secondary education; connections between lesson materials in this respect; students’ attitudes; their instruction; and the number of students that fail in their own group or in the departments as a whole.

**Attitude and beliefs**

Although one teacher expressed that he does not “care so much about grades,” the team generally demonstrated an interest in data. During meeting 2, for example, the team appeared to actively try to make sense of the data. They also showed to be curious about the answers further data collection may yield. At meeting 3, the data team members were still very positive...
about the data team approach. At the end of the meeting, some team members expressed that they had the feeling they were “getting somewhere.” The data team members stayed consistently positive about the data team approach, as was again demonstrated at meetings 10 and 11. The enthusiasm for the data team procedure was still high and they discussed how to continue with their work next school year.

In the interviews, all data team members also expressed a positive attitude toward data use in general, and toward the data team approach specifically. The team members all indicated that they appreciated the structured method. As one of the teachers stated: “It is very good to work analytically, and not just say this is the problem and this is what we are going to do. We need to look at the causes by generating hypotheses and collecting data to prove or disprove the hypotheses. I think this is very good and different from the typical intuitive educational world.” And another teacher stated: “Data are important; I am a person with a lot of hypotheses, a lot of gut feelings; I take things for granted. Some of my hypotheses might be true, but it is stronger if I can prove this with data.” One of the teachers even finds the work of the data team so important that he participated in the meetings on his days off. He stated that the school leader had made it clear that their work was very important; also, he was very interested in the whole data team procedure and really wanted to learn how to apply this.

Collaboration
The teachers in the data team had worked together in the past, and all expressed how satisfied they were with the collaboration in this team. As one of the teachers stated: “People work together, appointments are kept, everyone is actively involved, people listen to each other and are not afraid to speak up. We all work together at an equal level.” One teacher expressed that he was a bit worried that in one phase of the process the team did not collaborate sufficiently, and this is in step 6 (the interpretation and conclusions phase). He felt that the department head did a lot of interpretation on her own in advance; this should be a more shared activity.

Ownership
Another factor not included in our theoretical framework but found in the data concerns ownership. During the first meeting, the entire team agreed that the number of failing students in their school was problematic. All the respondents indicated in the interviews that they felt ownership over the problem of grade repetition. Only one teacher indicated that she did not think grade repetition was necessarily a problem, however, she did acknowledge the importance of the problem for the school: “Students all develop at a different pace. Also, at this stage other things are more important, such as social emotional development. I don’t worry about students repeating a grade; however, I do see it as a problem for the school, because the school is judged on this topic and it also generates negative publicity.”

Participation
Another factor not included in our theoretical framework, which may influence the work of data teams is whether participation was voluntary. In the interviews, when asked how they came to join the team, all the participants indicated that they participated voluntarily in the data team.
Results Team C

The Process of Data Use in Data Team C
Team Ca focused on the problem of low mathematic achievement in the first two grades of secondary education (age 12–14), which they all considered to be a problem. The team had 12 meetings during which they went through several feedback loops. They engaged in an iterative process of generating hypotheses (step 2 of the data team procedure) about what caused this problem, collecting and analyzing data, and rejecting and accepting hypotheses. Several hypotheses of the team were rejected based on the data. For example, a previously administered motivation questionnaire showed that no relationship could be found between motivation and mathematic achievement. The level of depth of inquiry increased from meeting 6, when the team really started using data to draw conclusions about their problem, hypotheses, and possible solutions (step 6). They were able to accept two important hypotheses. The first hypothesis related to the entry level of students. Assessment data from the primary schools showed that several students had very low mathematic skills. Another hypothesis confirmed, based on two assessments administrated at the beginning of the school year and again after a couple of months, that students were able to complete the assessment successfully right after they had been taught how to solve percentage and fracture assignments, but they lost these skills within a couple of months. Based on these hypotheses, the team came up with two measures in step 7 to solve this problem: (1) repetition on percentages and fracture assignments by means of short pop-quizzes every lesson. (2) For the low entry level students, the team found several online programs students could use to practice. After four months, the teachers administered the assessment again (step 8: evaluation), and discovered that student achievement did not decrease significantly anymore between tests. The year after that, they administered the same assessment again to the same group of students and the results remained stable.

Influencing Factors C: Data Characteristics
This team had access to multiple sources of data: primary school data, motivation questionnaire data, and assessment scores. Regarding assessment scores, however, they did not have all scores from former years. From another program within the school, scores for arithmetic were also available—initially, not all team members knew this, however. The data resulting from the tests initially constructed by the team members for further determining the problem regarding fractions and percentages were not sufficiently reliable, because the team members had administered different tests, which were too short, at different moments in their student groups (e.g. problems with the quality of the data). Therefore, a new test was developed. The team needed to go through different channels to get the information they needed, indicating a problem with access to high quality data.

Influencing Factors C: School Organizational Characteristics
The team worked on a shared goal of improving the mathematics lessons. The extent of the problem was not explicitly discussed in the meetings, however.

In terms of school leadership, the school leader was often not present during data team meetings. This did not hinder the use of data in the data team, however. This is probably a consequence of the fact that the teachers felt supported by the school leader, in terms of time, but also by her enthusiasm for the data team and the fact that she constantly indicated how important their work was.
In terms of training and support, the facilitator played a substantial role in explaining the data team procedure and helping the team make decisions about which hypotheses to study, what data to use, and what next steps to take. Regarding decisions about what data to use and regarding the (more advanced) data analysis, the role of the facilitator was larger; the team members gave much input regarding hypotheses and solutions. The team valued the support from the facilitator and indicated that it was necessary, for example, in withholding the group from jumping to conclusions. The data expert was only present at the first meeting, and only appeared to play a role regarding delivering the required data. The team could turn to him for support of their work with regard to data collection and data analyses.

The team members were from different school locations. They sometimes mentioned how colleagues in other subjects (such as economics) handled percentage sums; however, they did not explicitly discuss communicating data team findings with colleagues outside the data team. They did not collaborate with and involve relevant stakeholders. In meeting 12, they did report that colleagues had also implemented the repetition of fracture and percentage sums for a specific level of students.

Influencing Factors C: Individual and Team Characteristics

With regard to individual characteristics, all team members possessed a certain amount of knowledge and skills with regard to data use (e.g. data literacy). They understood the concepts of reliability and validity; however, they sometimes needed help with analyzing the data and taking action based on the data. The team members stated that data team members that are working on improving their subject also need PCK, as one teacher illustrated: “You need to be able to grasp a certain level of mathematics. You also need to have classroom experience.”

The team members all had a positive attitude regarding the use of data. Three of the teachers and the school leader felt that they were not only participating in the data team to solve this problem, but also to learn how to use the data team procedure: “We need to learn the data team procedure. It is a learning process; we do not yet have the skills necessary to do this on our own, but I am confident that we will in the future.” Another teacher stated: “I have seen many interventions come and go, and I have been disappointed a couple of times. I don’t think we will find a solution that will be perfect, but the fact that participating gets me thinking is a very important effect. I already pay more attention to certain things in my classroom as a result.”

The data team members also felt ownership of the problem and felt that they worked together effectively. To the question, what makes their collaboration so valuable, all the teachers indicated that this had to do with the fact that they all teach the same subject, but also that the collaboration involved teachers from different locations. They liked hearing from each other what is going on in these locations and what problems these teachers are facing. Finally, the team participated voluntarily.

Results Team B

The Process of Data Use in Data Team B

Data team B focused on low mathematic achievement in the third grade (age 14/15). In the first meeting it became clear that the school leader considered this to be a problem, but that the teachers wanted to use the data team to show the school leader that it is not a problem. It was
not until meeting 5 that the entire team finally agreed that the mathematics results were too low (passing rates varied between classes from 46% to 75%, but several classes did not meet the threshold of 30% passing). The team finally decided to focus on what caused low mathematics achievement. Discussions in this team were confined to a low level of depth, because they were mainly about personal experiences and opinions, and the question whether there actually was a problem at all. The teachers of team B did sometimes discuss causes of their problem at the level of their own functioning, in addition to more external causes such as “mathematics is difficult.” The team generated several hypotheses, but never got to actually collecting data to investigate the hypotheses, so they never completed a feedback loop. The procedure was terminated after six meetings for several reasons: school leader changes, the difficulty to find time to get together, and teachers not seeing it as a priority.

Influencing Factors B: Data Characteristics
With regard to data characteristics, although data about mathematics grades were available, availability of multiple sources of data and access to high quality data for further study was problematic. Primary school assessment data, for example, turned out to be confidential and not available to the team for analysis. A hypothesis about the absence of both teachers and students could not be checked, because it was not possible to identify absence specifically for mathematics.

Influencing Factors B: School Organizational Characteristics
Several school organizational characteristics seemed to hinder effective data use in this school. Firstly, for a long time, the teachers and school leaders were unable to come to a shared goal. According to the teachers, they did not have a problem, and therefore setting an improvement goal was not necessary. According to the department head: “Math is a very difficult subject, so I do not see it as a problem that several students are failing.”

Also, school leadership was problematic. The relationship between the teachers and the school leaders formed a barrier to data use. Some members felt that the data team was started by school management to blame teachers for unsatisfactory grades; this seemed partly right. In the interview, the school leader stated that he wanted to participate to address the functioning of a specific teacher: “She does not see that she has a problem. That is understandable because she has been a teacher for so many years and nobody ever told her that she had a problem. I hope that the data will show that she has a problem that she needs to address.” Also, the school leader was not very active in the data team. In the interviews, he explained that this was deliberate: “I think it is their responsibility. [...] I try to make them look at their own functioning by making statements such as: ‘I would be so ashamed if I would have so many insufficient marks.’” Another issue for some of the teachers was that their work in the data team was not formally facilitated.

In terms of training and support, the data team facilitator tried to guide the team through the data team process even though the atmosphere was sometimes rather tense. She generally summarized the team’s ideas and conclusions. She helped the team focus on the current step in the approach. All the team members indicated that they appreciated and needed the support from the facilitator as an “objective person from outside the school.” Also, they received support from a data expert, who had a substantial role in collecting the data and presenting overviews of the results, mostly based on descriptive analyses regarding the problem statement. The
progress of the data team was further hindered by a lack of collaboration with colleagues outside the data team.

**Influencing Factors B: Individual and Team Characteristics**

Knowledge and skills for data use, an important individual characteristic, seemed to be present in this team. The team members, mostly math teachers, did not appear to have problems with understanding the analyses so far. However, the team did not reach the level of more advanced analyses.

The negative attitude toward the use of data hindered progress in this data team. Also, the atmosphere during the first couple of meetings was not very positive and collaboration seemed to be an issue. Often, the data team members did not let each other speak freely, and interrupted each other.

Another hindering factor was that collective agreement about the problem was rather questionable initially. There appeared to be no ownership of the problem. Clearly, starting the data team was by the initiative of school management. Several team members were obliged to participate. Teacher members questioned whether they had time, whether they all needed to be present, and whether mathematics achievement was, in fact, a problem. Furthermore, the math department head did not believe that they were ever going to find the causes of their problem: “This process will take too long to investigate and the problem is too complex.”

**Results Team G**

*The Process of Data Use in Data Team G*

During six meetings, team G focused on students with a pre-vocational education background entering the senior general secondary education track (age 16/17). The team expected that the students coming from the pre-vocational education track (outside the school), would be doing worse than the “regular” students. The team generated several hypotheses with regard to the achievement of regular students compared to students from a pre-vocational education track (e.g., performance in different subjects, performance in later years, graduation rates). The team sometimes also mentioned causes regarding their own functioning during the meetings. For example, the role of their extra lessons and the role of their own advice regarding sector-profile combinations were mentioned. Apart from the fact that not enough data were available on the students from pre-vocational education (in several years, this group was too small), the team could not find many significant differences between these students and regular students. In other words, the original problem statement could not be supported by the data. The data team then continued with the problem of underperformance of students in the fourth grade.

**Influencing Factors G: Data Characteristics**

The data expert indicated that particular data characteristics hindered the use of data in this team. Access to high quality data was problematic: data were not always available or it was difficult to find the required data. The information management system available did not make things easier: “Sometimes the system defines things in three different ways, and then I have to collect all these data from three different access points manually . . . .”. The team used multiple sources of data about (transfer and subject) grades in several (upper level) school years, and data about prior education of students. It was challenging for them to determine the data
related to their hypotheses; in addition, there were too few cases for conclusions to be drawn about most of the hypotheses.

Influencing Factors G: School Organizational Characteristics
The goal of the data team was not entirely clear to all participants. For some participants, the goal was improving the transition from the vocational education track to the general senior education track, for others, it was a more general goal: “to improve the quality of education.”

According to the team members, leadership in the form of participation of the school leader was crucial. She added additional knowledge about the problem and supported the data team. According to one of the teachers: “It is not right to leave this all up to the teachers. The school leader needs to take decisions and make policy.” Only one of the teachers was facilitated for participation in the data team. Some other teachers stressed that facilitation should be provided.

Collaboration was also an issue for the team, mainly related to time pressure. The team was not able to plan sufficient meetings, which interrupted the flow of the process and decreased the feeling of involvement. The involvement of everyone in the team was a point of concern.

With regard to training and support, the facilitator played a substantial role in helping the team focus on the current step (e.g., the current hypothesis rather than new ones), understanding the (advanced) analysis, and drawing conclusions. She also summarized the in-between results of the data team. Accordingly, the team members indicated that a good researcher is essential. Two data experts were available to the team, and provided support mainly in the data collection.

Influencing Factors G: Individual and Team Characteristics
The team appeared to have little prior knowledge about using data. For example, in one of the first meetings a team member reacted in relation to determining a criterion for the problem statement: “Can’t we just look at the data and determine it then?” Although they all laughed about this, it remained challenging to decide. In addition, the facilitator needed to explain the results regarding significant differences extensively. Also, the importance of PCK and organizational knowledge was stressed, as indicated by several members: “A data team member should have sufficient knowledge on the school organization. A new teacher does not belong in a data team. . . . You need knowledge on the topic.”

The attitude of the team towards the use of data was positive. The team appeared committed to the idea of using data to accept or reject hypotheses. Although some of the hypotheses and related analyses were rather complicated, they appeared to actively try to carry out the steps of the procedure. In addition, they were looking forward to collecting more data. They also decided to continue the project after the pilot, guided by the new problem statement.

The team appeared to feel ownership of the problem, although the decision-making process was perceived differently by the different data team members. Two teachers and the data expert indicated that it was shared to some extent, but that ultimately most decisions were taken by one teacher and the facilitator. The school leader and two other teachers felt that it was a shared decision-making process. All teachers indicated that they decided to participate in the data team voluntarily.
Cross-case analyses
The results of the within cases analyses were compared and contrasted to each other. In the first section, we will describe the use of data in the four teams. Next, we will focus on how data characteristics influenced the process of data use in the data teams. Thereafter, we will describe how organizational characteristics influenced the use of data in the data teams, followed by the individual and team characteristics.

Cross-Case Analyses: The Process of Data Use

Table 3  The process of data use in the data teams

<table>
<thead>
<tr>
<th></th>
<th>Team W</th>
<th>Team C</th>
<th>Team G</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of meetings</strong></td>
<td>12</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Feedback loops</strong></td>
<td>Multiple</td>
<td>Multiple</td>
<td>Multiple</td>
<td>None</td>
</tr>
<tr>
<td><strong>Actionable knowledge</strong></td>
<td>Several factors do not cause grade repetition; Measures to reduce grade repetition</td>
<td>Several factors do not cause low mathematics achievement; Measures to increase achievement</td>
<td>The problem does not exist; a new problem statement is formulated</td>
<td>None</td>
</tr>
<tr>
<td><strong>Depth of inquiry</strong></td>
<td>High</td>
<td>High</td>
<td>Average to high</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 3 shows that the use of data in the teams varied. Teams W and C were the only teams that were able to complete all the eight steps of the data team procedure, both in twelve meetings. They went through several feedback loops and created actionable knowledge based on data. For example, team W took several measures to reduce grade repetition and team C took several measures to improve mathematic achievement. Both teams were able to reach high levels of depth of inquiry.

Team G was not able to complete all the eight steps in the six meetings they managed to plan, but went through several feedback loops with regard to defining their problem statement. They were able to create actionable knowledge: the data showed that their problem actually was not a problem (students that entered their school from a pre-vocational track did not do worse than their own students). The team reached average to high levels of depth.

The least successful team was team B. This team did not reach high levels of depth of inquiry and did not complete a single feedback loop. Furthermore, no actionable knowledge was created in this team. The team also quit after six meetings.

Cross-Case Analyses: Data Characteristics
All the data teams were facilitated with a data expert to provide support in the data collection (see Table 4). Team W and G both used the same information management system to collect the necessary data. However, according to their data experts, a lot of work was required to generate the data the teams needed. Three teams (B, C, and G) also had problems accessing some of the data needed and had to deal with incomplete data sets.
Teams W and C seem to have been the most successful in the use of data, as these two teams were able to complete all eight steps and reached a high level of depth of inquiry. However, in terms of data characteristics, there do not seem to be large noticeable differences between the teams. All the teams encountered some problems with regard to access and availability of data, but with the support of their data experts, they were able to overcome these problems.

Table 4  Data characteristics influencing data use in data teams

<table>
<thead>
<tr>
<th></th>
<th>Team W</th>
<th>Team C</th>
<th>Team G</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access and availability of multiple sources of data</td>
<td>Information management system (“a lot of work”)</td>
<td>Availability of most data; sometimes lack of awareness of availability. Sometimes difficult to access</td>
<td>Information management system (“a lot of work”)</td>
<td>Is a problem sometimes; primary school assessment data are confidential; student absenteeism is not registered properly</td>
</tr>
<tr>
<td>High-quality data</td>
<td>High-quality data; however, some data not up to date or complete</td>
<td>Problems with reliability of assessment data</td>
<td>Problems with accuracy</td>
<td></td>
</tr>
</tbody>
</table>

Cross-Case Analyses: School Organizational Characteristics

Table 5  School organizational characteristics influencing data use in data teams

<table>
<thead>
<tr>
<th></th>
<th>Team W</th>
<th>Team C</th>
<th>Team G</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared goal</td>
<td>Shared goal, but not specific</td>
<td>Shared goal, but not specific</td>
<td>Goal not clear</td>
<td>No shared goal for a long time</td>
</tr>
<tr>
<td>Leadership</td>
<td>School leader active and equal part of team; role model; steering teachers to take responsibility for student learning; support implementation of measures; planning and organizing of measures; facilitation in time; motivating and supportive</td>
<td>School leader is not always present but is seen as an equal part of the team; facilitated in time; communicates the importance of the work of the data team; motivating and supportive</td>
<td>School leader adds knowledge on the problem to the team; can help in implementing measures; lack of facilitation</td>
<td>School leader relationship with teachers is problematic; fear of using data to blame teachers; school leader not active; no facilitation</td>
</tr>
<tr>
<td>Training and support: facilitation by the researcher and a designated data expert</td>
<td>Researcher: data use support and coaching</td>
<td>Researcher: data use support and coaching</td>
<td>Researcher: data use support and coaching</td>
<td>Researcher: data use support and coaching</td>
</tr>
<tr>
<td></td>
<td>Data expert: discussion and data collection and analyses</td>
<td>Data expert: available if needed; no active participation</td>
<td>Data expert: discussion and data collection and analyses</td>
<td>Data expert: discussion and data collection and analyses</td>
</tr>
<tr>
<td>Involvement of relevant stakeholders</td>
<td>Collaboration with colleagues outside the team</td>
<td>Some collaboration with teachers outside the team</td>
<td>No collaboration with teachers outside the team</td>
<td>No collaboration with teachers outside the team</td>
</tr>
</tbody>
</table>

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With regard to school organizational characteristics (see Table 5), all the data teams mentioned goals related to solving their specific problem. In team G, there was some confusion about what the goal was (improving the transition from pre-vocational education to senior general education or to improve the quality of education in general). Only in team B did fewer consensuses exist regarding what the goal of the data team was. This had to do with their problem definition, as some of the teachers did not feel that they had a problem. What can also be noticed is that most of the goals formulated by the data teams were not very measurable (e.g., improve education), although this did not seem to stop them in the whole data use process.

In terms of leadership, three different types can be distinguished with regard to the data teams. Firstly, there is the encouraging, supporting, and actively participating leader, as found in the W and G data teams. Secondly, team C had a leader who supported and encouraged the data team members, but did not actively participate herself. Finally, the teachers of B, experienced problems with the school leader in the data team. Teachers complained that the school leader did not facilitate them, nor was he very active in the team, and he used data to “blame and shame” teachers. Though most of the teachers were facilitated in time by their school leader to work in the data team, the teams still struggled with finding the time to meet, especially in teams B and G. Team B even gave having no time as one of the reasons for disbanding the data team. Most of the other teachers stated that they thought it was a priority for which to make time.

In terms of training and support, all the teams were facilitated by the researcher. All the teachers indicated that this was needed, for several reasons: to guide the process, which consists of the eight-step data team procedure; to re-direct the teachers when necessary (e.g., you are talking about a solution, but we are still at the hypotheses step), to conduct data analyses; to teach teachers how to use data to improve education; because you need an objective person from outside the school, to bring a research background and a theoretical and scientific background. Some teachers felt that after two years of support, they could function without a researcher. Others felt that they might always need a researcher because of the research skills needed to do this or because the team needs an objective person from outside the school to do this effectively.

Also, the data teams were facilitated by a data expert. The C data team never needed this person, but he was available. All the other teams needed the data expert to collect data, either to locate existing data, or to provide support in collecting new data (e.g., provide support in the development of a survey).

All the teams also came to realize that it is important to involve and collaborate with relevant stakeholders at an early stage of the data use process. Team W, for example, did not involve their fellow teachers until they had their first results, which were received skeptically by their colleagues. If they had involved their colleagues early on, for example in developing a problem statement, this might have been prevented.

When comparing more-effective data teams (W and C) to less-effective data teams (G and B), two factors seem to account for the difference: having a shared goal (not present in team B, not clear in team G) and the role of the school leader. The role of the school leader was especially
problematic in school B, where the school leader was trying to use the data team to blame teachers for low-achieving students.

Cross-Case Analyses: Individual and Team Characteristics

Table 5  Individual and team characteristics influencing the use of data in data teams

<table>
<thead>
<tr>
<th></th>
<th>Team W</th>
<th>Team C</th>
<th>Team G</th>
<th>Team B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data literacy</td>
<td>Lack of data literacy</td>
<td>Data literacy to some extent</td>
<td>Lack of data literacy</td>
<td>Data literacy to some extent</td>
</tr>
<tr>
<td>Pedagogical content knowledge (PCK)</td>
<td>PCK</td>
<td>PCK</td>
<td>PCK</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Knowledge on your organization (KO)</td>
<td>Available</td>
<td>Not mentioned</td>
<td>Available</td>
<td>Not mentioned</td>
</tr>
<tr>
<td>Attitude</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Positive</td>
<td>Positive</td>
<td>Lack of involvement</td>
<td>Lack of involvement</td>
</tr>
<tr>
<td>Ownership participation</td>
<td>Ownership</td>
<td>Ownership</td>
<td>Ownership</td>
<td>No ownership</td>
</tr>
<tr>
<td></td>
<td>Voluntarily</td>
<td>Voluntarily</td>
<td>Voluntarily</td>
<td>Obliged</td>
</tr>
</tbody>
</table>

Concerning individual and team characteristics (see Table 5), in all the data teams it became apparent that members needed a certain amount of data literacy (e.g., what does a problem definition look like, how do you formulate a hypothesis, how do you analyze data). All the teams were guided by a researcher, but to be able to function without the researcher, they need to learn these skills. Next to data literacy, several data team members expressed that you need to know your school (e.g., organizational knowledge) and you need knowledge on the subject you teach and how to teach this (PCK).

In general, all data team members of the different schools were rather positive about the use of data in education, and the data team procedure. The only really negative teachers can be found in team B. One of the teachers was very negative, and another teacher that was not interviewed also expressed a very negative attitude during the meetings. These teachers did not perceive that they had a problem, and therefore the use of data was insignificant and meaningless to them.

Team members of team B also expressed that they felt that the team was not collaborating effectively. One person was doing all the work, and another person was trying to slow the whole process down. Also, during the meetings, people were not allowed to speak freely, and people constantly interrupted each other.

Furthermore, team B was also the exception when it came to ownership. In all the other data teams, most of the members felt ownership of the problem. According to the respondents of team B, only the school leader perceived low mathematic achievement as a problem that needed to be solved.

The least-effective data team (B) seems to differ on several individual and team characteristics from the other teams. The attitude of the individual data team members was rather negative, in
that some of the members did not believe in the use of data. Also, collaboration within the team was problematic. Data team members seemed not to be willing or able to speak freely and they constantly interrupted each other. There seemed to be no ownership of the problem. Finally, the defensive attitude of the data team members was probably caused by the fact that they were obliged by the school leader to participate, and they feared that they would be “blamed and shamed” based on the data.

Conclusions and discussion

Data use and influencing factors
Although this pilot study does not permit generalization beyond theoretical propositions, they provide more in-depth insight into the factors that enable and hinder interventions, focusing on supporting collaborative data use in schools. Regarding our data use theory of action, the data team intervention addresses not one single but all the leverage points as discussed by Marsh (2012, p. 4) that are important for supporting schools in the use of data: accessing and collecting data (step 3 from the data team procedure), filtering, organizing, and analyzing data (steps 4 and 5), combining information with expertise and understanding to build knowledge (step 6), knowing how to respond and taking action or adjusting one’s practice (step 7), and assessing the effectiveness of these actions or outcomes that result (step 8). In addition, it also supports schools in identifying problems, setting improvement goals, and formulating hypotheses regarding the problem (steps 1 and 2).

The four data teams in our study were not equally effective in the use of data. Team W and C were the only teams that made it through the eight steps in two years’ time and also were able to reach high(er) depths of inquiry. Furthermore, these teams went through several feedback loops, enhancing their learning, and they were able to construct actionable knowledge.

We found that several factors influenced the use of data in the data teams. With regard to the data characteristics, in general, access to high quality data, availability of multiple sources of data and availability of an information management system appeared to support Team W and Team C, the more successful teams, to eliminate particular hypothesized causes and find causes for their problem and ultimately, to design and implement measures accordingly. The less successful teams, B and G, however sometimes experienced problems with accessing the data they needed.

Several school organizational characteristics also influenced data use in the data teams. Firstly, school leadership is essential. School leader participation was important for several reasons: for support and facilitation (e.g., facilitation in time by clearing schedules for the teachers of team W and C); for bringing in a new perspective on the problem and data use (e.g. the school leader of team W put forward new hypotheses); for modeling effective data use (e.g. according to the teachers of team W the school leader showed how she took measures based on data); for ensuring the implementation of measures (e.g. the school leader reassured teachers of team W that measures based on data would be implemented); and for empowering teachers to use data to make decisions (e.g. the school leader of teams W and C stressed the importance of taking decisions based on data again and again). This also implies that school leaders themselves take data-informed action, that they use data to prompt questions and deliberation, and that they provide direction and support conditions that encourage teachers to ask questions, make
inquiry into practice, turn to data, and take actions based on these data. This type of leadership can be called data-informed leadership (Knapp, Swinnerton, Copland, & Monpas-Huber, 2006; Knapp, Copland, & Swinnerton, 2007).

However, the school leader can also have a negative effect on the data team, as happened in team B, where the school leader tried to use data to “shame and blame” teachers. The school leader in this school needs to build a safe culture of inquiry that supports data-based decision making where there is trust and teachers can ask questions and use data about practice and performance without the fear of repercussions. It is crucial that teachers feel empowered by data instead of threatened (Copland, 2003; Earl & Katz, 2006; Horn & Little, 2010; Knapp et al., 2006; Means et al., 2010; Wayman & Stringfield, 2006; Young, 2006).

Also, having a shared goal is essential. The goal for team B was not shared, as the team did not really agree on the problem. This team did not consider it to be a problem that nearly half of their students failed mathematics. Other research also stresses the importance of having a measurable and shared goal for data use (Datnow et al., 2007; Earl & Katz, 2006; Kerr et al., 2006; King, 2002; Sharkey & Murnane, 2006; Wayman & Stringfield, 2006; Wayman et al., 2007; Wohlstetter et al., 2008; Young, 2006). The results of this study show that perhaps having a shared goal is more important than having a measurable goal. The fact that most teams defined their goal as higher achievement or less grade repetition without specifying by how much did not seem to hinder their progress.

Also, support from an external researcher who taught the data team members how to use the data was essential. The importance of the role of the data expert and external facilitator can be explained, as suggested by Marsh (2012) from learning theory, which suggests that role modeling, providing learners with opportunities to discuss and reflect with each other, to practice the application of new knowledge, and to receive feedback from an expert are crucial for learning (Collins, Brown, & Holum, 1991; Lave & Wenger, 1991; Poortman, Illeris, & Nieuwenhuis, 2011).

Moreover, the results show, as also concluded by Marsh, Sloan McCombs, and Martorell (2010), that the external facilitator needed to assist in all steps of the data team procedure, not only in collecting and analyzing data, but also in identifying appropriate measures based on the data. This last task might be even more difficult than learning how to analyze data as the data will never exactly tell teachers what to do; this also requires expertise and creativity (Marsh et al., 2010). The question is whether or not data teams can take over the role of the external facilitator with this regard, or that data teams always need an external facilitator at this point in the process. However, the role of the facilitator evolved over time. In the beginning the role of the facilitator was much larger, but after a couple of meetings the data team participants started taking over some of the behavior of the facilitator. For example, after a couple of meetings, the researcher could intervene to a far lesser extent, as teachers corrected themselves and each other when they wanted to rush through the steps and take action based on intuition and prior experience instead of based on data.

Regarding individual and team characteristics, data literacy knowledge and skills were lacking in almost all team members. Although complex analyses were not required, most teachers and school leaders were not able to analyze the collected data. This had to be done by the data expert and researcher. Furthermore, PCK was also mentioned by several respondents as important. Shulman (1986) states that PCK includes subject matter content knowledge, but also goes
beyond it, to knowledge on how to teach subject matter knowledge. Data can help teachers to identify the conceptions and misconceptions of students, but teachers still need their PCK to determine how to alter their instruction accordingly. Mandinach (2012) refers to this as pedagogical data literacy: the ability to analyze data and, based on the data, combined with PCK, take meaningful action. Based on the results of our study, we would like to add to this that data team members not only need to be data literate and have PCK, they also need a substantial amount of knowledge on their school organization, for example, the rules, norms, and structures in their organization, especially if they are working on a school-level problem. An important question that deserves further research is whether or not beginning teachers are able to use data effectively, as they are still developing PCK and the necessary knowledge on their school organization.

Poor collaboration between team members may have hindered the work of data team B as well. For example, the team experienced problems with coming to consensus on what caused their problem. Furthermore, the teachers from team B were obliged to participate, which caused a lot of resistance. Finally, the teacher of team B did not feel ownership over the problem that they had to investigate, which negatively influenced their willingness to work on this problem. Collaboration, trust, and the willingness and capability to address conflict are necessary ingredients for the use of data (Copland, 2003; Datnow et al., 2013; Horn & Little, 2010; Means et al., 2010; Nelson & Slavit, 2007; Park & Datnow, 2009). As stated by Herman and Gribbons (2001, p. 18): “Combating a siege mentality and getting beyond blame and defensiveness to actions are problems that go far beyond technical and mundane aspects of data use.”

Next to participation on a voluntarily basis and ownership over the problem that is being investigated, there is one more factor that we need to add to our theory of action based on the results of this study: collaboration with and involvement of relevant stakeholders outside the data teams at an early stage of the data team cycle. Teachers may need to rely on others outside their team to collect certain kinds of data. They might also be dependent on their colleagues for implementing certain measures; for example, in the case of team W, curriculum coherence was a problem that needed to be addressed by all grade level and subject level teams. Furthermore, cross-school collaboration can also be beneficial for teacher learning. Teachers from team C came from three different locations and really appreciated this cross-site collaboration opportunity, as they valued the collective examination of data, each other’s (different) perspectives, and the focused conversations with regard to how to improve mathematics instruction. Similar findings were reported by Nelson and Slavit (2007) and Huffman and Kalnin (2003).

**Implications for practice and further research**

Summarizing, although based on a small pilot, our study shows how several data characteristics (access and availability of high-quality data), school organizational characteristics (a shared goal, leadership, training and support, involvement of relevant stakeholders), and individual and team characteristics (data literacy, PCK, organizational knowledge, attitude, and collaboration) influence the use of data in data teams. The results also show how these influencing factors seem to be interrelated. For example, the school leader can influence the data use attitude of participants, collaboration around the use of data can increase data literacy as well as PCK, and a data expert can facilitate access to the data needed. This provides important insights into how data use can be promoted in schools, regarding for example leadership, training and support, knowledge and skills required for data use and making data available for teachers.
As several studies (Copland, 2003; Datnow et al., 2013; Horn & Little, 2010; Means et al., 2010; Nelson & Slavit, 2007; Park & Datnow, 2009) show that collaboration is crucial for effective data use, we need to uncover these relationships and determine how they can impede or enable data use in teams. The results of team B showed that the negative interaction between members within a data team can really impede the use of data. As argued by Daly (2012), there is still too little knowledge on how relationships can support and constrain the use of data. An aspect that needs further exploring, therefore, is the social interaction through which data team members co-construct and make sense of data and use data.

The results of this data team pilot are promising in the sense that in three out of four teams the teachers really engaged in using data to improve education, and two of the teams actually succeeded in addressing their educational problem. We cannot conclude that school improvement was only caused by the work of the data team; however, it is likely that this contributed to the process. In addition, these three teams continued their work and some of the data team members also started new data teams in their school. An important question for further research is whether or not this form of professional development is also sustainable. After two years of participation, have the participants gained sufficient knowledge and skills to apply data-based decision making not only in a data team, but also in their daily practice (e.g., is transfer of these knowledge and skills taking place)? Has this process, this cycle of inquiry, become part of “how things are done in this school,” and has it become an organizational routine (Spillane, 2012)? A related question is whether or not former data team participants are able to start and guide new data teams within their school (e.g., a train-the-trainer model), to promote data use not only by the original data team members, but throughout schools as a whole.

Notes
1. Havo: general secondary education (after completing this track students can continue to a university for applied sciences)
2. Vwo: pre-university education (after completing this track students can continue to study at a university)

Acknowledgements
The authors would like to thank the Stichting Carmelcollege for making this project possible.

References


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