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Data-based decision making for teacher and student learning: a psychological perspective on the role of the teacher

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ABSTRACT
Data-based decision-making has the potential to increase student achievement results. Data-based decision-making can be defined as teachers’ systematic analysis of data sources in order to study and adapt their educational practices for the purpose of maximizing learning results. Teachers must apply the findings from their data use to their personal teaching activities. Therefore, data-based decision-making may be influenced by individual teachers’ psychological characteristics. The present study aimed to explore which psychological factors contribute to teachers’ data use in a Dutch primary school context. A questionnaire-based quantitative methodology was employed. We included the following psychological constructs: affective and instrumental attitudes, perceived control, social norms, self-efficacy, collective efficacy, and intentions regarding data use. Results of the path analysis showed that perceived control, instrumental attitude, and intention regarding data use all significantly influenced data use. Additionally, intention was found to be a mediator of the relation between affective attitude and data use. Interventions aimed at data-based decision-making should take these psychological factors into account to increase teachers’ implementation of data-based decision-making for instruction and, consequently, educational quality.

There is broad support for the potential of data-based decision-making, data use for short, as a means of maintaining and improving the quality of education (Schildkamp, Lai, & Earl, 2013). Data (in a school’s context) are defined as ‘information that is systematically collected and organised to represent some aspect of schooling’, for example assessment data, structured observation data, and student survey results (Lai & Schildkamp, 2013, p. 10). The definition includes any relevant information derived from qualitative and quantitative methods of analysis (Schildkamp et al., 2013; Wayman, Jimerson, & Cho, 2012).

Research stresses the importance of using these data for making instructional improvements. This is presumed to lead to improvements in educational processes and increased student achievement (e.g. Earl & Katz, 2006; Schildkamp & Kuiper, 2010; Vanhoof & Schildkamp, 2014; Young, 2006). However, teachers find data use difficult, do not make
effective use of data, or do not use data at all (e.g., Schildkamp & Kuiper, 2010). Teachers’ decisions related to the design or adaptation of their instruction are often based not on data, but on gut feelings (Ingram, Louis, & Schroeder, 2004), leading to ineffective modifications and persistent problems.

The fact that a number of teachers seem to be unable to use data for improvement of their instruction raises questions concerning the conditions that could influence data use (Honig & Coburn, 2008). Multiple studies have already focused on factors influencing data use (e.g., Farrell & Marsh, 2016; Little, 2012; Schildkamp, Karbautzki, & Vanhoof, 2014; Schildkamp et al., 2013; Wohlstetter, Datnow, & Park, 2008; Young, 2006). However, most of these studies do not consider individual psychological teacher characteristics, or focus on only a limited number of psychological factors. It is crucial to take these characteristics into account, as data use can be viewed as a highly personal activity. Teachers are asked to apply their data-based findings to their personal teaching activities. Evans (2009) stated that reform strategies, such as strategies to enhance data use, are only as effective as the individuals who deliver or implement them. ‘Much more attention needs to be paid to the psychological states of teachers and leaders, as what they do most likely is derived from what they think about what they do and who they serve.’ (Evans, 2009, p. 87). Therefore, in order to understand the effectiveness of reforms aimed at increasing data use by teachers, it may be important to look at factors at the individual user level (Coburn & Talbert, 2006; Earl & Katz, 2006; Little, 2012; Wohlstetter et al., 2008; Young, 2006), such as teachers’ individual psychological characteristics.

With the exception of attitude, few attempts have been made to examine the impact of psychological factors on data use among teachers. In addition, most research addressing psychological factors has used qualitative methods, which does not provide us with information on the relative size of impact of these factors. Understanding the relevant factors contributing to data use can contribute to the effectiveness of interventions that aim to enhance data use among teachers.

To study how these psychological factors influence data use, we first review the theoretical literature on psychological constructs related to data use, which focuses on the ways in which psychological constructs shape data use behaviour. Prior research, mostly on psychological factors found to be associated with data use, provided the framework for our current study.

**Theoretical framework**

**Data-based decision-making**

Data use can be defined as the systematic analysis of data (from internal or external sources of the school) (Schildkamp et al., 2013) in order to study teachers’ educational practices and adapt them for the purpose of maximising learning results. Data can contribute to teacher’s instruction and can indicate where instruction needs to be improved to enhance student learning (Gelderblom, Schildkamp, Pieters, & Ehren, 2016). However, teachers use tests mostly to monitor their students’ progress and knowledge and skills, and less often to make decisions about their own instruction (e.g., Schildkamp et al., 2014; Slavin, 2003).

Use of information about student learning and progress to inform school and classroom practices is widely recognised to be important for supporting improvement. Multiple studies have shown that effective data use improves student results (Campbell & Levin, 2009; Carlson, Borman, & Robinson, 2011; McNaughton, Lai, & Hsiao, 2012; Van Geel, Keuning, Visscher, &
Fox, 2016; Van Kuijk, Deunk, Bosker, & Ritzema, 2016). Application of data-based findings by teachers to their instruction is crucial in order to identify effects of instruction on student achievement results (Kirkpatrick, 1996). Based on data, teachers can improve their instruction (e.g. adapt it to the needs of students) which can lead to increased achievement. Therefore, the focus of this study is on data-based decision-making in relation to instruction. Instruction is defined as the goal-oriented actions of the teacher in a classroom that focus on explaining a concept or procedure, or on providing students with insights that will initiate or sustain their learning process (Gelderblom et al., 2016; Hattie, 2009; Marzano, 2000). Instruction focuses on predetermined goals and results, which can be determined by means of data from tests and exams. A wide range of instructional aspects has been revealed by research into instruction, which support its contribution to learning results (e.g. Scheerens, 2007). In general, aspects of instruction can be divided into four categories: feedback, purposeful teaching, adaptive instruction and learning time (Gelderblom et al., 2016). Data can be used to improve instructional feedback by providing information on the gap between the students' learning results and the teacher's objectives and standards. With regard to purposeful teaching, data can inform the teacher's actions that focus on student learning, which are characterised by consciously working towards clearly determined high and realistic goals. Additionally, data-based findings may also relate to learning time; analyses and interpretation of data can inform a teacher about the aspects of the curriculum that require additional time. Lastly, with regard to adaptive instruction, data can be used to inform the teacher’s actions that focus on purposeful adaptation of instruction to take into account differences between students.

Psychological factors

Data-based decision-making to improve instruction may be influenced by psychological factors. Psychological (also referred to as motivational) characteristics determine a person’s intention to engage in behaviour, and therefore, in this case, to use data. Motivation is usually defined as a set of beliefs that influence people’s pursuit of valued goals (Pintrich & Schunk, 2002), and is inferred based on choice, effort, and persistence behaviours. Psychological characteristics are known to be amenable to change and have been addressed in many behavioural interventions to change (health) behaviour. Important theories of behaviour change include the Theory of Planned Behaviour (Ajzen, 1991) and Social Cognitive Theory (Bandura, 1986). Important psychological factors derived from these theories are: attitudes, subjective norms, perceived control, self-efficacy, collective efficacy, and behavioural intentions. We conducted a literature review to identify psychological factors that may be related to data-based decision-making. These concepts are described below.

Attitude

Attitude is defined as one's personal orientation or beliefs related to performing the desired behaviour (Ajzen, 1991), which in our study is data use. Perception of data use and its influencing factors has major importance for successful implementation (Jimerson, 2014). Beliefs are known to influence how teachers interpret student achievement results and impact teachers' causal explanations for the outcomes observed in data (Bertrand & Marsh, 2015). Attitude can be divided into two components: affective and instrumental attitudes (Ajzen, 1991).
Affective attitude incorporates feelings or emotions arising from the prospect of data use. For example, to successfully implement data-based decision-making, teachers should not be afraid of making changes in their instruction based on data (Schildkamp & Teddlie, 2008; Schildkamp & Visscher, 2009, 2010). The perceived ease of instructional data use also falls into this category, as well as the expected enjoyment of engaging in data use.

Instrumental attitude includes beliefs about the likely consequences or other attributes of data use. The literature shows that if teachers do not believe that data use can lead to improvement and instead rely on their experiences and intuition, and do not believe that data can actually reflect on their teaching, this can hinder the implementation of data use in schools (Datnow, Park, & Kennedy-Lewis, 2012; Hubbard, Datnow, & Pruy, 2014; Schildkamp & Kuiper, 2010; Schildkamp, Rekers-Mombarg, & Harms, 2012; Schildkamp & Visscher, 2010; Wayman, Cho, Jimerson, & Spikes, 2012). However, if teachers believe in the utility of data use and the resulting improvement in the quality of their practice, this may enhance data use (Jimerson, 2014; Kerr, Marsh, Ikemoto, Darilek, & Barney, 2006; Schildkamp et al., 2012, 2014; Schildkamp & Visscher, 2009, 2010; van der Kleij & Eggen, 2013; Vanhoof, Verhaeghe, Van Petegem, & Valcke, 2012; Wayman et al., 2012; Yan & Cheng, 2015).

Subjective norms refer to beliefs about the normative expectations of other people, which result in perceived social pressure (Ajzen, 1991, 2002). Yan and Cheng (2015) found that teachers with positive subjective norms were more likely to express the intention to use data. On the other hand, social pressure can also hinder data use. In several studies, results showed that teachers felt forced to use data due to the accountability system, but not because they themselves thought data use to be important. In these cases, data use was linked to accountability and high stakes testing, and not to improvement (Hubbard et al., 2014; Schildkamp & Teddlie, 2008; Schildkamp & Visscher, 2010; Sutherland, 2004). This may hinder data use, as it is seen as something that is done to the school instead of by and for the school (Sutherland, 2004). Additionally, Young (2006) concluded that social pressure can hinder data use. Teachers need to view data use as related to their classroom activities and their instruction, instead of as a compliance activity independent of their classroom actions. On the other hand, studies found that social pressure by means of encouragement by the principal positively influenced data use (Schildkamp & Kuiper, 2010; Schildkamp & Teddlie, 2008; Schildkamp & Visscher, 2010; Schildkamp et al., 2012).

Perceived control refers to teachers’ control beliefs concerning the intended behaviour and includes beliefs about the presence of factors that may further or hinder performance of this behaviour (Ajzen, 2002). Several studies point to the importance of perceived control for data use. The degree to which teachers feel that they have autonomy to make decisions is related to actual data use. Therefore, teachers need to feel that they have enough autonomy to make changes in instruction and the curriculum based on data (Kerr et al., 2006; Schildkamp & Kuiper, 2010; Schildkamp & Teddlie, 2008; Schildkamp & Visscher, 2009; Schildkamp et al., 2012). Kerr et al. (2006), for example, found that perceived pressure to stay on pace can hinder data use, because it had the consequence that teachers followed the curriculum instead of the data. Additionally, in multiple studies teachers have expressed low perceived control with regard to effects of their teaching efforts (Schildkamp & Visscher, 2010; Yan & Cheng, 2015).
Schildkamp et al., 2012, 2014). Teachers did not feel that students’ results were influenced by their teaching, and argued that assessment results differ every year, depending on whether you have good or bad students. This could hinder their data use.

**Self-efficacy**
According to Social Cognitive Theory (Bandura, 1986) self-efficacy can also influence behaviour. Self-efficacy refers to one’s confidence for performing a desired behaviour across a range of situations. It acts as a capability factor (Bandura, 1986). In this study, self-efficacy refers to the conviction that one can successfully use data. Yan and Cheng (2015) found that self-efficacy is positively related to the intention to use data. Additionally, Schildkamp and Kuiper (2010) found that teachers perceived the analysis and interpretation of data as difficult, and were therefore not confident about using data. This may hinder data use.

**Collective efficacy**
Collective efficacy, which expresses the shared perceptions of a group’s ability to achieve collective goals (e.g. Bandura, 1993; Goddard, Hoy, & Hoy, 2004; Moolenaar, Sleeegers, & Daly, 2012), in this case, successful data use, can also influence behaviour according to Social Cognitive Theory (Bandura, 1986). Collective teacher efficacy differs from teachers’ individual sense of efficacy, in that collective teacher efficacy is a property of the school (Tschannen-Moran & Barr, 2004) (or team), and is a group attribute rather than the aggregate of individual teachers’ self-efficacy beliefs (Bandura, 1986).

Teacher’s practices regarding data use often occur in teams of teachers and may therefore require a collective feeling of efficacy in order to achieve data use. Research on collective efficacy in relation to data use is still scarce. However, multiple studies have reported the role of collective efficacy for other behaviours, such as for supporting student achievement (e.g. Bandura, 1993; Goddard & Goddard, 2001; Goddard et al., 2004; Moolenaar et al., 2012). Moolenaar et al. (2012), for example, found that teacher teams who felt that they were able to motivate and challenge their students were teaching in schools that achieved higher student performance for language. As data use and interpretation is often a collaborative activity in schools (e.g. in data teams, departments), we hypothesise that perceptions of collective efficacy could be an important psychological factor related to data use as performed by the individual teacher.

**Behavioural intention**
Behavioural intention represents a person’s motivation (a conscious plan, decision or self-instruction) to put effort into performing the target behaviour (Ajzen, 1991). In the case of data use, intention refers to the teachers’ preparedness and intention to use data at some future time point. In basic social psychology, intentions are thought to mediate the relation between attitude, perceived behavioural control, subjective norms and behaviour (Ajzen, 1991). Positive stances on psychological characteristics such as attitude, subjective norms and self-efficacy are assumed to increase the intention to use data. In turn, a positive intention to use data increases the actual behaviour of data use.

Few studies were found on the intention to use data. These studies showed that intention to use data is important for actual data use. Feldman and Capobianco (2008), for example, found that data use in the classroom requires a willingness to learn and a willingness to change one’s teaching. They concluded that teachers should be internally motivated to use
data to improve their instruction and student learning. Yan and Cheng (2015) also found that intention is an important precondition for actual data use.

**Purpose of the study**

The present study aims to build a structural understanding of the relations between the variables discussed in the theoretical framework, by exploring which psychological factors contribute to teachers’ actual data use in a Dutch primary school context. The main research question of this study is:

- To what extent can data use by primary school teachers be explained by psychological factors?

Figure 1 shows the proposed model of psychological factors influencing data use based on our literature review. We identified constructs that are derived from the Theory of Planned Behaviour and the Social Cognitive Theory and will examine the direct as well as the indirect relations via intention between the psychological factors and data use for instruction. As the Theory of Planned Behaviour assumes that behavioural intention is formulated based on attitude, subjective norm and perceived behavioural control, the model for this study will first test intention as a mediator between the psychological factors and data use (Ajzen, 1991). The Theory of Planned Behaviour also states that given a sufficient degree of actual control over the behaviour, in this case data use, people are expected to carry out their intentions when the opportunity arises. However, many behaviours come with difficulties of execution that may limit volitional control (Ajzen, 2002). Therefore, perceived control is expected to moderate the relation between intention to use data and actual data use. Finally, according to Social Cognitive Theory (Bandura, 1986) self-efficacy and collective efficacy

![Figure 1. Proposed framework for psychological factors and instructional data use.](image)
may also influence a person’s behaviour, and were therefore added to the framework as our literature review indicated these factors may have important links to data use as well. As our literature review did not evidently show the mediating role of intention, we will additionally test for direct effects between the psychological factors and data use.

**Method**

**Participants**

Participants were 131 primary school teachers (87.8% female), from 25 different primary schools in the Netherlands. The average amount of teaching experience was 17.44 years (SD = 10.9). Of the participants, 3.8% reported not teaching. Another 16% solely taught classes 1 and 2 (children 4–6 years old), and did not make use of curriculum assessments in their practice. The data from these respondents were omitted from further analysis, as the respondents did not meet the inclusion criteria for the sample. In the end, data from 105 primary school teachers were included for analyses.

**The Dutch context**

The present study is about psychological constructs, which refer in this case to perceptions and beliefs about data use. As context is known to (partially) shape these perceptions and beliefs (Ajzen, 1991; Bandura, 1986), some notes about the Dutch context should be mentioned here. Dutch schools are rather autonomous. Nearly all decisions are made at school level (OECD, 2010). This implies freedom in choosing the religious, ideological, and pedagogical principles on which their education is based and in organising their teaching activities. Schools can decide which textbooks they want to use, they can select the programmes that they want to offer, and they can decide on the range of subjects taught and the course content of these subjects, as well as the assessments used (within a framework at the central level) (Ministry of Education, 2000; OECD, 2008). Moreover, a standard curriculum is not required in the Netherlands. They do have an inspectorate, which holds the schools accountable for their education (OECD, 2010).

Schools are free to choose which assessments they want to use. However, they do have to use a pupil monitoring system, and at the end of primary school they have to administer a standardised assessment. There are a couple of approved standardised assessments schools can choose from, but the majority of schools used the assessment developed by the national assessment institute. Teachers make most use of curriculum assessments in their daily classroom practice (Gelderblom et al., 2016). These consist of assessments incorporated in the curriculum method they use (developed by publishers) and assessments developed by teachers themselves.

**Procedure**

A total of 300 primary school teachers from 14 schools from our network were invited to participate in completing the questionnaire (response rate 38.3%). Additionally, an email service targeting about 1000 primary education stakeholders (mostly school leaders) was used to inform them about the study. They were asked to tell their teachers about the study and to encourage their teachers to fill out the internet questionnaire (response rate 1.6%).
Inclusion criteria were that respondents had to be primary school teachers, teaching grades 3–8 (children’s ages 6–12), as they use curriculum assessments in their teaching practices.

**Measures**

A quantitative methodology was employed to study the psychological factors enabling and hindering instructional data use (Table 1). The questionnaire used for this study consisted of one scale for instructional data use and seven scales assessing the psychological characteristics. The scale for instructional data use as the outcome measure of this study was obtained from earlier research (Gelderblom et al., 2016).

**Instructional data use**

Instruction refers to the goal-oriented actions of the teacher in a classroom that focus on explaining a concept or a procedure, or on providing students with insights that will initiate or sustain their learning process. As classroom curriculum assessments have been found to be the most frequently used data source among teachers (Gelderblom et al., 2016), this scale addressed the use of this type of data. The scale included items based on four categories: feedback, adaptive instruction, learning time and purposeful teaching, which were combined in one dependent variable. Five items on the scale referred to data use as informing instruction for feedback (e.g. ‘I use curriculum assessment results to provide feedback on students’ motivation’). Fourteen items were related to adaptive instruction, which examined teachers’ actions that focus on purposefully adapting their instruction to the differences between students (e.g. ‘I use curriculum assessment results for providing extra instruction to weak students’). Five items referred to purposeful teaching (e.g. ‘I use curriculum assessment results to set educational goals’) and five items referred to the use of data in relation to learning time (e.g. ‘I use curriculum assessment results to determine additional homework’).

**Psychological characteristics**

The measures for the psychological variables were either adapted from existing measures or based on the literature. All scales showed good psychometric properties. Scale development for six of the psychological characteristics (affective and instrumental attitude, Table 1. Reliability of scales for instructional data use and the psychological characteristics.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Number of items</th>
<th>Cronbach’s alpha</th>
<th>Example items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional data use</td>
<td>29</td>
<td>0.94</td>
<td>‘I use curriculum assessments to set up learning goals for weak students’</td>
</tr>
<tr>
<td>Collective efficacy</td>
<td>6</td>
<td>0.79</td>
<td>‘Our team is motivated to learn how to make data-based decisions’</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>6</td>
<td>0.78</td>
<td>‘I can set up data-based measures for practice’</td>
</tr>
<tr>
<td>Perceived control</td>
<td>3</td>
<td>0.69</td>
<td>‘I can decide on my own if I will make my decisions based on data’</td>
</tr>
<tr>
<td>Subjective norms</td>
<td>4</td>
<td>0.91</td>
<td>I make data-based decisions, because my school leader thinks it is important’</td>
</tr>
<tr>
<td>Attitude (affective)</td>
<td>6</td>
<td>0.88</td>
<td>‘Data-based decision-making is interesting to me’</td>
</tr>
<tr>
<td>Attitude (instrumental)</td>
<td>9</td>
<td>0.85</td>
<td>‘Data-based decision-making may stimulate involvement’</td>
</tr>
<tr>
<td>Intention</td>
<td>5</td>
<td>0.88</td>
<td>‘I am planning to make decision based on data’</td>
</tr>
</tbody>
</table>

Note: $n = 105$. 

subjective norm, perceived control, self-efficacy and intention) was based on the Teacher’s Conceptions and Practices of Formative Assessment Questionnaire by Yan and Cheng (2015). The collective efficacy scale was based on the work of Goddard & colleagues (Goddard, 2002; Goddard, Hoy, & Hoy, 2000). We selected the relevant items for the present study, and reformulated them to match the subject of this study. For example, the original item ‘Formative Assessment makes my teaching easier’ (Yan & Cheng, 2015) was reformulated into ‘Data-based decision-making makes my teaching easier’ and ‘I can decide whether or not to implement Formative Assessment’ (Yan & Cheng, 2015) was reformulated into ‘I can decide whether or not to implement data-based decision making’. For the collective efficacy scale ‘If a child doesn’t want to learn teachers here give up’ (Goddard et al., 2000) was reformulated into ‘If one team member does not want to implement data-based decision-making, the others give up’. An item like ‘Drug and alcohol abuse in the community make learning difficult for students here’ (Goddard et al., 2000) was not included in the current questionnaire because of relevance. The questionnaire consisted of the psychological scales outlined in Table 1 and is available upon request.

At the beginning of the questionnaire, an accompanying text was provided explaining the importance and meaning of data-based decision-making. Participants were asked to rate each of the item of the psychological scales on a five-point Likert scale, ranging from ‘strongly disagree (1) – strongly agree (5)’. For the response scale for ‘Instructional data use’ the response category of ‘neutral’ was removed. These items ask if people do or do not use curriculum assessment results for different goals; the term ‘neutral’ is meaningless here. This resulted in a four-point scale ranging from ‘strongly disagree (1) – strongly agree (4)’.

**Factor and reliability analysis**

We first tested the psychometric properties of the scales by conducting an exploratory factor analysis to assess construct validity. A principal axis factoring analysis was conducted on the intended scales for the different psychological characteristics and the data use outcome, with varimax rotation. The Kaiser-Meyer-Okin measure verified sampling adequacy for the analysis ($KMO = 0.78$). An initial analysis was run to obtain eigenvalues for each factor in the data. Six factors had eigenvalues over Kaiser’s criterion of 1 and in combination explained 47.5% of the variance. The factor structure was consistent with the theoretical framework. The items that cluster on the same factors suggest that the factors represent: attitude, subjective norms, perceived control, self-efficacy, collective efficacy and intention. For attitude, we divided the scale into affective and instrumental attitude, based on theoretical considerations. Following the factor analysis, eight items were deleted from the original questionnaire; seven of these items loaded under 0.4. Three other items from two scales also loaded slightly below 0.4; however, we decided to maintain these items, because they loaded only slightly below 0.4, and based on theoretical considerations. First, the item ‘I am able to establish problems based on data’ was maintained for the self-efficacy scale, as this item reflects the overall definition of self-efficacy regarding data-based decision-making. Second, the item ‘I have sufficient autonomy to adjust my teaching practice based on data’ was maintained for the scale perceived control, as this item specifically refers to perceived control regarding the teachers’ instruction in the classroom. Lastly, the item ‘Data of my students reflect the quality of my instruction’ was maintained, as this item directly refers to the teachers’ attitude towards the consequences of data use. When the teacher believes, the data are not representative for his or her instruction, the teacher is not likely to apply the data-based
findings on the instruction in the classroom. One item was removed after reliability analyses. Reliability of the resulting scales was sufficient to good (Table 1). All measures yielded Cronbach's alphas of .69 or higher, which indicates high reliability (Clark & Watson, 1995). To optimise face and content validity of the questionnaire, the instrument was piloted on a small scale. The questionnaire was discussed with relevant researchers (3), experts (1) and teachers (2). They checked the questionnaire and commented on complexly phrased questions, or those which were not clear or ambiguous. Based on their comments, adjustments to the questionnaire were made to optimise face and content validity.

Data analyses

Descriptive statistics
We conducted descriptive analyses presenting means, standard deviations, minimum, and maximum of the psychological scales for affective and instrumental attitude, subjective norms, control beliefs, self-efficacy, collective efficacy, and intention to use data. Descriptive statistics were also calculated for instructional data use.

Path analyses
The data have a nested structure (teachers are nested within schools), which suggests multilevel analyses are needed (e.g. Dorman, 2008; Hox, 2002). However, the intraclass correlation coefficient (ICC) showed that the variance at school level was redundant (ICC < 0.05). Therefore, multivariate regression analyses were applied. Raw data scores were restructured to standardised z scores for interpretation purposes.

Several assumptions must be met to be able to conduct regression analysis (Field, 2013): The predictors should have some variation in value; no perfect linear relationship between two or more of the predictors should exist; the predictors should not be correlated with external variables; the variance of the residual terms is supposed to be constant; the residual terms for any two observations should be uncorrelated; the residuals in the model should be normally distributed errors; independency is required for all values of the outcome variable; and the mean values of the outcome variable for each increment of the predictors are expected to form a straight line. All of these assumptions were checked and met.

Multiple regression analyses by means of path analysis were performed to examine the extent to which the psychological factors (independent variables; affective attitude, instrumental attitude, subjective norms, perceived control, self-efficacy, and collective efficacy) explain instructional data use (dependent variable). The path analyses controlled for correlations between the psychological factors, which were additionally calculated.

To determine the model’s goodness of fit, we used four model fit indices: the comparative fit index (CFI), Tucker-Lewis index (TLI), chi-square ($\chi^2$), and the root mean square error of approximation (RMSE). For the chi-square value, the $p$ value has to be higher than .05 for the model to be considered a good fit (Barrett, 2007). Values higher than .90 indicate a good fit for CFI and TLI, and a value lower than .05 indicates a good fit for RMSE (e.g. Byrne, 2010). Additionally, bootstrap analysis was run to estimate mediation effects in our model. Bootstrapping ($n = 1000$) was performed at 95% confidence intervals (CI). The indirect effect can be considered significant if zero is not included in the 95% CI (Preacher & Hayes, 2004). The analyses were performed using IBM SPSS Statistics 22 and IBM SPSS AMOS 23.
Results

Table 2 shows the means and standard deviations for instructional data use among primary school teachers (response scale 1–4). Results showed that the mean score for instructional data use was 3.05 among participants, which falls between ‘agree’ and ‘totally agree’ on a four-point response scale. This means that, on average, teachers agreed moderately with statements such as: ‘I use curriculum assessments to adapt instruction to students’ needs’.

Additionally, the means and standard deviations for the different psychological characteristics are shown in Table 2. A five-point Likert scale was used for these variables. Means for attitude, self- and collective efficacy, and intention were around 4.00, which means that teachers responded, on average, positively to the statements on these scales. However, for perceived control teachers responded, on average, between ‘disagree’ and ‘neutral’ on statements such as ‘I can decide on my own about the way I work according to data-based principles’. For subjective norms, respondents also answered, on average, between ‘disagree’ and ‘neutral’ on statements such as ‘I make data-based decisions because my colleagues think it is important’.

Path analyses

The fit of the hypothesised model (Figure 1) was tested, with the following results: \( \chi^2 (5) = 10.66 \) (\( p = .06 \)), CFI = .97, TLI = .81, RMSEA = .09, 90% CI [.00, .17]. TLI and RMSE results were not in the satisfactory boundaries. This means that the model, in which the psychological factors influence intention, and intention influences data use, did not fit the data appropriately. The next step was to test for direct effects between the psychological factors and data use for instruction, as direct relations have been found in the literature review. Results indicated direct effects for the instrumental and affective attitude and instructional data use. Then, indirect effects were estimated to test the hypothesised and additional mediation effects in our model. The correlations between the psychological factors, which were controlled for in the analyses, are shown in Table 3.

Figure 2 represents the adjusted model, after taking the exogenous variables into account. Results demonstrated a good model fit: \( \chi^2 (4) = 3.97 \) (\( p = .41 \)), CFI = 1.00, TLI = 1.00, RMSEA = .00, 90% CI [.00, .15]. This model explained 23.9% of the variance in primary school teachers’ instructional data use. For teachers’ intention the explained variance was 38.4%.

For perceived control results showed a significant, direct and positive relation with instructional data use (\( \beta = .19, p = .01 \)), as was hypothesised in Figure 1. The relation with intention was not shown significant. Additionally, instrumental attitude showed a significant, direct

| Table 2. Descriptive statistics for factors and effects data-based decision-making. |
|----------------------------------|--------|-----------|-----------|
| Instructional data use          | Mean   | SD        | Min       | Max       |
| Attitude                         |        |           |           |           |
| Affective                        | 3.87   | 0.55      | 2.50      | 5.00      |
| Instrumental                     | 3.88   | 0.44      | 2.78      | 5.00      |
| Subjective norms                 | 2.81   | 0.96      | 1.00      | 4.75      |
| Perceived control                | 2.71   | 0.69      | 1.33      | 5.00      |
| Self-efficacy                    | 4.10   | 0.37      | 3.33      | 5.00      |
| Collective efficacy              | 3.99   | 0.54      | 1.67      | 5.00      |
| Intention                        | 4.01   | 0.54      | 2.00      | 5.00      |

Note: \( n = 105 \).
and positive relation with instructional data use ($\beta = .25$, $p = .01$). Results also indicated a positive significant relation with teachers’ intention towards instructional data use ($\beta = .29$, $p = .05$). Lastly, a significant, direct and positive relation was found between teachers’ affective attitude and intention ($\beta = .37$, $p = .01$). Table 4 shows the path coefficients for the direct relationships in the model.

Results indicated one significant, indirect relation for affective attitude to instructional data use, with intention being the mediating factor ($\beta = .06$, $p < .05$, 95% CI [.01, .14]). Table 5 shows the path coefficients for mediated relationships in the hypothesised model (Figure 1).
In summary, the model for this study showed that instructional data use can be predicted by instrumental attitude, perceived control and intention to use data. In addition, intention was determined to be a mediator of the relation between affective attitude and instructional data use.

**Discussion and conclusion**

The goal of this paper was to examine which individual-level psychological factors influence instructional data use among Dutch primary school teachers. Much past research has investigated the benefits that data-based decision-making can yield and the ways in which it should take place, but few attempts have been made to build a structural understanding of possible underlying psychological factors and the relations that these variables have with data-based decision-making. Based on a literature review, we proposed that the factors we identified have a significant relation with instructional data use, mediated by intention to use data. Results supported a model in which teachers’ attitude, perceived control and intention were evidently related to their instructional data use. However, contrary to our expectations and literature (e.g. Bandura, 1986), the roles of subjective norms, collective efficacy and self-efficacy as factors related to data use were not supported significantly in this study.

This study shows that Dutch primary school teachers responded moderately positively to items regarding the application of data-based results to instruction in the classroom. However, there were still teachers who do not use data for instruction in the class, or who keep this to a minimum. The most important conclusion of this study is that instructional data use was predicted by instrumental attitude, perceived control and intention to use data, with an explained variance of 24%. This means that almost a quarter of the variance in instructional data use can be explained by these psychological factors that influence data use.

### Table 4. Path coefficients for direct relationships in the hypothesised model.

<table>
<thead>
<tr>
<th>Path</th>
<th>β</th>
<th>SE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective efficacy → Intention</td>
<td>−.08</td>
<td>.10</td>
<td>.44</td>
</tr>
<tr>
<td>Self-efficacy → Intention</td>
<td>.15</td>
<td>.12</td>
<td>.20</td>
</tr>
<tr>
<td>Affective attitude → Intention</td>
<td>.37</td>
<td>.14</td>
<td>.01</td>
</tr>
<tr>
<td>Instrumental attitude → Intention</td>
<td>.29</td>
<td>.15</td>
<td>.05</td>
</tr>
<tr>
<td>Perceived control → Intention</td>
<td>−.10</td>
<td>.08</td>
<td>.24</td>
</tr>
<tr>
<td>Subjective norms → Intention</td>
<td>.04</td>
<td>.08</td>
<td>.56</td>
</tr>
<tr>
<td>Intention → Instructional data use</td>
<td>.16</td>
<td>.08</td>
<td>.04</td>
</tr>
<tr>
<td>Perceived control → Instructional data use</td>
<td>.19</td>
<td>.07</td>
<td>.01</td>
</tr>
<tr>
<td>Instrumental attitude → Instructional data use</td>
<td>.25</td>
<td>.09</td>
<td>.01</td>
</tr>
</tbody>
</table>

### Table 5. Path coefficients for indirect relationships in the hypothesised model.

<table>
<thead>
<tr>
<th>Path</th>
<th>Indirect path coefficient</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective efficacy → Intention → Data use</td>
<td>−.012</td>
<td>−.047</td>
</tr>
<tr>
<td>Self-efficacy → Intention → Data use</td>
<td>.023</td>
<td>−.010</td>
</tr>
<tr>
<td>Affective attitude → Intention → Data use</td>
<td>.060</td>
<td>.005</td>
</tr>
<tr>
<td>Instrumental attitude → Intention → Data use</td>
<td>.047</td>
<td>−.006</td>
</tr>
<tr>
<td>Perceived control → Intention → Data use</td>
<td>−.016</td>
<td>−.064</td>
</tr>
<tr>
<td>Subjective norms → Intention → Data use</td>
<td>.007</td>
<td>−.018</td>
</tr>
</tbody>
</table>

Notes: CI = confidence interval, LL = lower bound, UL = upper bound.
use. The relation of affective attitude and instructional data use was mediated by the intention to use data. This last finding is in line with the Theory of Planned Behaviour (Ajzen, 1991).

**Attitude** seems to be an important predictor of data use, as has also been found in previous research (Ajzen, 1991; Datnow et al., 2012; Hubbard et al., 2014; Jimerson, 2014; Kerr et al., 2006; Schildkamp & Kuiper, 2010; Schildkamp & Teddlie, 2008; Schildkamp & Visscher, 2009, 2010; Schildkamp et al., 2012, 2014; van der Kleij & Eggen, 2013; Vanhoof et al., 2012; Wayman et al., 2012; Yan & Cheng, 2015). In essence, a primary school teacher’s instrumental attitude regarding the consequences of data use was confirmed as an important predictor of his or her use of data to inform classroom instruction. This finding is directly relevant for the design of professional development initiatives. It is necessary to further demonstrate the importance and usefulness of instructional data use among primary school teachers. This could be done, by, for example, providing opportunities for discussion and sharing of experiences (Vanhoof, Verhaeghe, Verhaeghe, Valcke, & Van Petegem, 2011) with data use for the purpose of improving instruction.

Affective attitude also turned out to be an important predictor of intention to use data, which in turn was a significant predictor of instructional data use. Thus, teachers’ confidence and enthusiasm, interest and enjoyment related to data use should be increased. However, previous research has shown that increasing the affective component of attitude is a really difficult task (Vanhoof et al., 2011). A safe environment needs to be created, based on professionalism and respect, in which the teachers’ enthusiasm can grow (Vanhoof et al., 2011).

**Perceived control** was also found to be a significant predictor of data use in the current study. Levels of perceived control were relatively low. In the Dutch educational system, schools are allowed to choose the religious, ideological and pedagogical principles on which their education is based and that organise their teaching activities. However, although teachers have a lot of freedom, apparently they perceived this differently, as also stated by Schildkamp et al. (2014). Providing opportunities for discussions and sharing of experiences with colleagues and the school board could probably contribute to higher perceived control, as teachers would be able to share opinions and gain ideas regarding the implementation of data-based decision-making.

In contrast to the literature, we found no significant relation with instructional data use for self-efficacy, collective efficacy and subjective norms. This means that, at least for a similar sample of primary school teachers, self- and collective efficacy may need less attention in initiatives to accomplish a behaviour change regarding data-based decision-making, compared to the psychological factors that were found significant. In our sample, self- and collective efficacy had a high mean value with a relatively small standard deviation. Apparently, teachers are confident in their own and others’ abilities regarding data use, and the low variation in self-efficacy scores may explain why no effects were found. A ceiling effect might explain the small role these factors play in instructional data use in this study. Concerning subjective norms, the literature showed that the social pressure of following subjective norms was mainly related to data use. In this study, however, we examined the teachers’ perception of important others’ views as a precursor of data use, and did not directly assess the resulting social pressure that is assumed to be important in the literature. This might explain the lack of significant contribution to instructional data use.

Data use involves an interpretive process in which data must be identified, collected, analysed and interpreted to become meaningful and useful for action. All factors are interlinked and can influence each other (Schildkamp et al., 2014). Identifying the relevant
psychological factors behind instructional data use reveals another piece of the puzzle, and initiatives to enhance instructional data use can be adjusted and incorporate these findings. This study gives insight in what the key priorities should be to accomplish a behaviour change among primary school teachers.

Teachers should be supported in using data effectively. Data teams have proven to be a promising way to enhance the effectiveness of data use (Earl & Katz, 2006; Schildkamp, Poortman, & Handelzalts, 2015; Wayman, Midgley, & Stringfield, 2007). This study showed that such interventions should take the impact of perceived control and instrumental attitude into account. Interventions could start with exchanging experiences around instructional data use and discussion of the value of data-based decision-making. To enhance teachers’ perceived control, the school leader could be involved in the intervention by giving teachers more autonomy regarding how much time they spend on data use and how they decide to use the data. The school leader could also facilitate distributed leadership, meaning that the school leader delegates leadership roles to some teachers to lead data-based decision-making in the school (Katz & Earl, 2010; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). Teachers can then be considered formal leaders themselves. This might lead to feelings of empowerment, perceived control and a more positive attitude.

Limitations and implications

When interpreting and generalising the results, we should keep in mind that the Dutch contextual factors (i.e. freedom in choosing religious, ideological, and pedagogical principles) may have influenced perceptions of control and subjective norms, for example. As stated by Schildkamp et al. (2014), although schools and teachers in the Netherlands have a lot of autonomy and freedom to make decisions, teachers and schools sometime perceive this differently. This means that, for factors like perceived control, even more variations may exist, as a discrepancy has been shown between the objective and subjective autonomy teachers and schools have. Psychological factors, such as lack of self-efficacy and low perception of control, may prevent teachers from using data to make data-based instructional improvements.

Moreover, several aspects have to be acknowledged that limit the generalizability of the findings in this study. First, the findings derived from the regression analyses are averages and are therefore not controlled for other characteristics on which primary school teachers may differ (e.g. controlling for gender, or socio-economic status). Pierce, Chick, and Gordon (2013), for example, showed that males were more positive towards engagement with statistical reports, and reported that previous professional learning training or studying statistics influenced the levels of the psychological factors. Determining whether psychological factors influence data use after controlling for background factors could inform future research and intervention development as to the relative importance of such factors for data use.

Similarly, other user characteristics, as well as organisational and school characteristics were not taken into account in the present study. Sociocultural norms, for example, can be assumed to have influenced perceptions of control and self-efficacy to adjust instruction following data-based findings. The explained variance of 24% shows that some other factors are responsible for the variance remaining to be explained, which implies further research is needed.
Second, participants in this study were recruited by means of convenience sampling. Presumably, schools and teachers that already frequently use data to improve instruction participated in this study. This may also explain the ceiling effects and low variance for collective efficacy and self-efficacy. Based on this study we developed a framework for the psychological factors influencing data use. This framework should be further tested. In future research, for example, the sample should be randomised to be able to generalise results.

Lastly, we used a quantitative approach to examine the psychological factors related to instructional data use. Future research should apply a mixed methodology, in which qualitative data can be used to further explain the relation between these constructs and data use and to examine implications for practice in order to enhance instructional data use among primary school teachers.

**Conclusion**

Primary school teachers apply instructional data use in the classroom regularly. The present study indicates that teachers’ perceived control of data use, their attitude regarding its benefits and consequences and their intention to use data positively influence their instructional data use. This means that the design of initiatives aimed at improving instructional data use in the classroom should take these factors into account in order to achieve optimal professional development and eventually, enhanced student results.

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