Martin Stump, Olga Zlatkin-Troitschanskaia & Olga Mater

The effects of transformational leadership on teachers' data use

Abstract

Data-driven decision making has become increasingly important in education in Germany and in many other countries around the world. Teachers are expected to interpret and employ data to improve their instructional decisions and schooling in general. It has been argued that transformational leadership in schools leads to teachers making an additional effort and commitment to change. In this study we examine teachers' data use and the effects of school principals' transformational leadership behavior on their teachers' data use. We based our findings on data from the project Evidence-based actions within the multilevel system of schools – requirements, processes, and effects (EviS) involving 1,387 teachers from 124 schools in Germany. Results of structural equation modeling indicate that transformational leadership has a highly significant positive effect on teachers' various uses of data. Implications for research and practice are discussed.

Keywords

Effekte transformationaler Führung auf evidenzbasiertes Entscheiden

Zusammenfassung

Das Konzept Evidenzbasierung spielt in Deutschland und einer Vielzahl weiterer Länder eine bedeutende Rolle bei der Reformierung der Bildungssysteme. Es sieht vor, dass Lehrkräfte empirisch gewonnene Daten (bspw. aus Evaluationen) zum Zwecke der Schul- und Unterrichtsentwicklung nutzen. Verschiedene Studien konnten zeigen, dass dem Führungsstil transformationale Führung im Rahmen von Schulentwicklung besondere Bedeutung zukommt. Beispielsweise

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wirken sich transformationale Führungsverhaltensweisen positiv auf zusätzliches Engagement von Lehrkräften im Rahmen von Veränderungsprozessen aus. Mittels Strukturgleichungsmodellierung untersucht der Artikel den Einfluss transformationaler Führung auf evidenzbasiertes Entscheiden. Es werden die Daten des Projekts Evidenzbasiertes Handeln im schulischen Mehrebensystem – Bedingungen, Prozesse und Wirkungen (EviS) von 1387 Lehrkräften von 124 Schulen analysiert. Es kann gezeigt werden, dass transformationale Führung einen hoch signifikanten positiven Einfluss auf evidenzbasiertes Entscheiden hat.

Schlagworte
Transformationale Führung; Evidenzbasiertes Entscheiden; Strukturgleichungsmodellierung

1. Introduction

Teachers are expected to base their classroom practices and instructional decisions on empirically proven knowledge such as evaluation data (see Schildkamp & Lai, 2013). In recent years, international empirical research has addressed the questions of whether and to what extent teachers make decisions and take action based on empirical data rather than on everyday knowledge and experience and what specific influences and factors determine this behavior (see Levin & Datnow, 2012; Schildkamp & Kuiper, 2010). However, school teachers often cannot or do not want to draw conclusions from such data and are not prepared to adjust their professional behavior accordingly. Hence, empirical evaluation measures often fail to impact teaching and school improvement processes (see e.g., Bach, Wurster, Thillmann, Pant, & Thiel, 2014). In this context, the question arises as to how data use among teachers can be promoted systematically by different actors in the school system. Recent international research examining the principals' role in data-driven decision making highlights that school leadership is the key to successful implementation of data-based actions (Leithwood & Sun, 2012; Wayman, Brewer, & Stringfield, 2009).

According to Levin and Datnow (2012), there are various single strategies on how principals can promote data use among teachers, for example, by encouraging cooperation and formulating goals. However, there are few studies that connect leadership style to data use. Therefore, the aim of this article is to link the concept of transformational leadership to data use. It is currently the most prominent approach to leadership in general (Felfe, Tartler, & Liepmann, 2004; Geijsel, Sleegers, Leithwood, & Jantzi, 2003) and to school leadership in particular (Davies, 2005). Transformational leadership facilitates organizational change, which makes it essential to school autonomy as one of the central strategies of the New Governance Model in Germany (Harazd & van Ophuysen, 2011).

Numerous studies have confirmed a positive correlation between transformational leadership[1] and various indicators on the individual and organizational levels in schools. For example, Harazd and van Ophuysen (2011) found that transformational leadership at schools correlated with a high degree of commitment, job satisfaction, and satisfaction with the principal.

The study by Schäfer (2004) showed a significant positive correlation between transformational leadership and faculty-related variables such as commitment to the school and, in particular, innovativeness of the faculty. Furthermore, Barnett, McCormick, and Conners (2001) found a positive correlation between transformational leadership and teachers' extra efforts.

According to current international research, transformational leadership is of particular importance in the context of data-based decision making since certain transformational leadership behaviors such as developing a vision for the school overlap with factors that promote data use (see e.g., Schildkamp & Kuiper, 2010). However, there are no comprehensive, systematic analyses conducted for the very heterogeneous German school systems in which the effects of transformational leadership on data use are examined. We address this research deficit in the present paper. Based on results from the interdisciplinary research project *Evidence-based actions within the multilevel system of schools – requirements, processes, and effects* (EviS) in Germany, the general question explored in this study is: Does transformational leadership affect teachers' use of data?

In Section 2, transformational leadership and data use, the main theoretical constructs of this study, are explained. In Section 3, the connection between transformational leadership and data use based on empirical findings is presented and forms the basis of the hypotheses for this paper. In Sections 4 and 5, the hypotheses are tested through analysis of empirical results. In Section 6, results are discussed and an outlook for potential implications for research and practice is provided.

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1   There are many different models of transformational leadership (Gebert, 2002; Yu, Leithwood, & Jantzi, 2002; Yukl, 1999; for an overview of various conceptualizations of transformational leadership in the school context and their measurement instruments, see Leithwood & Sun, 2012). Therefore, it is necessary to be as precise as possible when distinguishing the various approaches to defining and measuring transformational leadership. Because this article refers to Bass's model (e.g., Bass & Riggio, 2006; see Section 2.1), in this article only studies that refer to this model are cited. In addition, the selection is limited to studies in which transformational leadership is measured using the Multifactor Leadership Questionnaire (MLQ). This is in line with the instrument used in the present article (cf. Section 4.2.1). This approach allows general comparability of studies and compatibility of the present study with previous research findings.

2. Theoretical framework

2.1 Bass's transformational leadership

Transformational leadership is part of the full range of leadership model, which includes also transactional leadership and laissez-faire (Bass, 1990; Judge, Woolf, Hurst, & Livingston, 2006). In general, the main function of transformational leadership is the active promotion of societal and organizational change (Bass, 1985; Steinle, Eichenberg, & Stolberg, 2008). In addition to promoting change, transformational leadership can improve the performance of members of organizations, which accounts for its increasing popularity (Bass & Avolio, 1994; Bass & Riggio, 2006; Felfe, 2006a). Transformational leaders are able to influence their followers in a way that results in better performance than originally intended or considered possible by the followers (Bass & Avolio, 1994). Transformational leaders exhibit specific behaviors and traits that can be assigned to five dimensions based on theoretical concepts and empirical findings (Bass & Avolio, 1994; Bass & Riggio, 2006). To lead transformationally does not necessarily mean to show all the behaviors or to have all the traits described below. Instead, transformational leaders set priorities in their leadership behavior (Bass, 1990).

Through analysis of the aforementioned large quantitative study in Germany, Harazd and van Ophuysen (2011) concluded that the concept of transformational leadership by Bass is suitable for the school context in Germany. Therefore, Bass's transformational leadership model forms the basis of this study.

According to Felfe et al. (2004), transformational leadership includes the following broad dimensions: (a) Idealized Influence attributed, (b) Idealized Influence behavior, (c) Inspirational Motivation, (d) Intellectual Stimulation, and (e) Individualized Consideration. These dimensions are explained in detail below.

2.1.1 Idealized Influence

The dimension of Idealized Influence involves specific behavior and traits of the leader and is divided into two sub-dimensions: Idealized Influence attributed and Idealized Influence behavior (Felfe et al., 2004).

Transformational leaders act as role models for their followers. The leader is respected and trusted by his or her followers, who accredit him or her with exceptional abilities, endurance and determination. Additionally, followers attribute decision-making risks to transformational leaders and act more predictably. This type of leader is entrusted with doing the right thing (Bass & Riggio, 2006).

2.1.2 Inspirational Motivation

Together with his or her followers, the transformational leader develops an appealing vision for the future which satisfies the followers' material and non-material needs. The leader communicates this vision consistently and convincingly to his or her followers. In doing so, the leader is capable of motivating and inspiring the followers by providing them with the stimulation needed to attain their goals and by communicating the importance of the tasks necessary to achieve the vision (Bass & Riggio, 2006; Felfe et al., 2004).

The transformational leader aims to formulate the vision for the organization in a way that motivates his or her followers and to enable pursuit of entirely new possibilities within the organization (Avolio, 1994; Bass & Avolio, 1994). The vision urges followers to pursue higher intrinsic goals of self-realization and facilitates clear formulation of goals. In the meantime, the leader inspires his or her followers with optimism and enthusiasm (Bass & Avolio, 1994; Steinle et al., 2008) and in this way conveys the belief that the goals are indeed achievable (Felfe et al., 2004). When participating in tasks that are needed to achieve these goals, the leader also shows heightened effort (Bass & Avolio, 1994).

2.1.3 Intellectual Stimulation

Transformational leaders advance the innovative and creative behavior of their followers by encouraging them to question constantly and consistently assumptions and problem-solving approaches. Followers are integrated in decision-making processes and are encouraged to develop, try out, or apply new problem-solving techniques. Mistakes made by followers and disagreements between leader and followers are neither seen as problematic nor publicly criticized (Bass & Riggio, 2006).

Intellectual stimulation means motivating followers to reflect and think critically. In this way, problems can be seen from new perspectives, ongoing ways of thinking can be questioned and new approaches can be developed (Knipfer, 2011; Steinle et al., 2008).

2.1.4 Individualized Consideration

The transformational leader sees all followers as individuals with different needs and abilities (Steinle et al., 2008), and thus treats them accordingly (Bass & Riggio, 2006). The leader pays great attention to the followers' needs while reaching goals by taking the role of mentor and coach. Followers are urged to exploit their full potential. To achieve this, new learning possibilities are actively created and tasks are constantly used as a means of providing followers with the opportunity to develop. Furthermore, the leader seeks direct communication with his or her followers for example by visiting their workstations to converse face-to-face. Active listen-

ing is central to communication for transformational leaders. The leader sees his or her followers not only as co-workers, but as humans with entirely individual beliefs and needs (Bass & Riggio, 2006).

Overall, according to Bass's model, transformational leadership is a multi-dimensional construct. In this article, this point of view is examined by connecting Bass's model of transformational leadership with data use (Section 3) and subsequently testing it empirically (Sections 4 and 5).

2.2 Definition of data use in schools

As the New Governance Model is being implemented in school systems across Germany, data use in schools is becoming increasingly important for school improvement and teaching[2] (see Section 1). In the literature, there is still no internationally uniform definition of the construct of data use in schools. In the literature published in English, the term *data* is employed in key expressions such as *data use* and *data-driven decision-making* (Levin & Datnow, 2012; Schildkamp & Lai, 2013), whereas in the same context in the literature published in German, the term *evidence* is used in key expressions such as *evidence-based actions* and *evidence-based governance* (see Sandkühler, 2011). According to Schildkamp and Lai (2013), data use can be defined as "systematically collected information on students, schools, school leaders, and teachers, which can be obtained from qualitative … and quantitative … methods. Data-based decision making … can be defined as the use of data by teachers … to make decisions" (p. 177; for steps of the data use process, see Boudett & City, 2013).

Dormann et al. (2016) demonstrated that data use is a multi-dimensional construct including the following two dimensions[3]: *External data use*, which means basing decisions on external data such as scientific findings and *internal data use*, which means basing decisions on data which has been generated by the school itself.

3. Linking the concept of transformational leadership to data use

In the following, we identify overlaps between transformational leadership and data use, and we generate the hypotheses for this study. For this purpose, we reviewed studies examining various factors influencing teachers' use of external data

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2   We give only a brief definition of data use in schools highlighting the relevant points for our analysis. For an in-depth discussion of data use in schools, see Dormann et al. (2016).

3   Initially the authors labeled the dimensions *external evidence orientation* and *internal evidence orientation* which closely followed the German scale names and discourse on *evidence* (see Dormann et al., 2016). We propose the altered labels above for greater compatibility with international research on data use.

and internal data, and we identified specific attributes and behaviors of transformational leaders.

3.1 Transformational leadership and factors influencing data use

While very few empirical studies have examined the relationship between transformational leadership and teachers' data use, the effects of various constructs similar to aspects of the transformational leadership concept have been explored.

3.1.1 Idealized Influence and data use

According to this dimension, school principals adopting a transformational leadership style serve as role models for their teachers. Schools in which data is used successfully often are run by a principal who actively sets an example as to how to use data effectively. This means the principals use data in their practices in a way that teachers are able to see, understand, and adopt in their classroom practices (Wayman, Spring, Lemke, & Lehr, 2012). According to Young (2006) and Means, Padilla, DeBarger, and Bakia (2009), such school principals provide their staff with orientation for data use.

In their qualitative review of prior research, Wayman et al. (2012) established 12 successful strategies on how principals can promote data use among teachers. The importance of most of these strategies for promoting data use is confirmed by one of the few theoretical studies in this area (Cosner, 2012). One of the strategies is that principals model data use.

3.1.2 Inspirational Motivation and data use

Developing a vision and setting clear goals is paramount in this dimension of transformational leadership. Many studies have demonstrated that teachers use data more often when school principals develop a vision or set clear goals as to what is to be achieved by means of data awareness and use (Datnow, Park, & Wohlstetter, 2007; Earl & Katz, 2006; Wayman et al., 2012; Wohlstetter, Datnow, & Park, 2008; Young, 2006). Developing a shared vision regarding data use ensures that data is used constantly for inquiry and improvement (Schildkamp & Kuiper, 2010).

3.1.3 Intellectual Stimulation and data use

In this dimension transformational leaders encourage reflection and critical thinking. Several studies have shown that data is more often used when principals motivate teachers to question continuously problem-solving approaches and to reflect critically upon various aspects of school practices. For example, the collaborative project *Evaluation Policies and Practices in Schools: Organisational Preconditions for Developing Evaluative Potential* (StaBil) (Pant & Thiel, 2012) examines how schools use data from school inspections and from the interstate comparison tests of the study *Vergleichsarbeiten in der Schule* (VERA)[4]. The StaBil study showed that when teachers discussed empirical results in depth and the principal encouraged discussion on the results of school inspections, this had a positive effect on data use.

With the help of a study involving 175 teachers from 29 schools in Brandenburg, Germany, Bach et al. (2014) found that collective critical analysis and evaluation had the highest predictive efficiency for the use of VERA results. In other words, the more teachers discussed the VERA results at meetings, the more likely they were to use these results in their classroom practices. As with other influential factors analyzed in this study, collective reflection on results is believed to play a significant role in data use (Bach et al., 2014).

3.1.4 Individualized Consideration and data use

This dimension deals with the assumption that the school principal encourages his or her teachers to hone their skills by providing opportunities for professional development. In various studies, this has been considered important and beneficial to teachers' data use.

Wayman et al. (2012) suggested that providing training in how to use data professionally was an effective strategy for principals to promote data use among their teachers.

Upon reviewing various (inter)national studies on the enhancement of lessons and schooling through the use of data feedback, Altrichter (2010) concluded that the successful use of data feedback as a control instrument depended on teachers' professionalism. Therefore, it is essential to support the development of professional behavior by providing appropriate training opportunities for teachers.

Codding, Skowron, and Pace (2005) investigated the extent to which completion of professional development courses resulted in teachers using data. Such training aimed to enable teachers to interpret data based on curricula and subse-

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4   *Vergleichsarbeiten in der Schule* (VERA), which translates into *comparison tests at schools*, is an annual study conducted in all federal states of Germany that assesses student performance in the 3rd and 8th grades in the main subjects of German, mathematics, and a foreign language.

quently to formulate objective, observable, measurable, and appropriate goals. The results suggested that individual training was effective when it included theory, practical tips, and feedback for participants. Only after participating in such training was the teaching staff able to formulate measurable goals that were relevant for lessons. This effect was amplified when the teachers were given data on their own school as opposed to data from simulations.

We generated the following hypotheses based on the established connection between transformational leadership and data use.

3.2 Hypotheses

Considering the state of theoretical research and especially that of empirical research, we generated two hypotheses on the effects of transformational leadership on the dependent variable of teachers' data use.

Hypothesis 1: Transformational leadership has a positive effect on teachers' internal data use.

Hypothesis 2: Transformational leadership has a positive effect on teachers' external data use.

4. Method

4.1 Study design and sample

We tested our hypotheses using empirical data from the EviS project, a cross-sectional study conducted between 2011 and 2012. In that study, a paper-pencil survey was completed by 297 school principals and 2,640 teachers from 153 schools of different types and sizes in Rhineland-Palatinate, a state in western Germany.

Due to limited testing time, two teacher questionnaire versions were used. Our findings were based on one version of the questionnaire that surveyed teachers' perceptions of principals' transformational leadership behavior and teachers' data use. The subsample included data from 1,410 teachers from 124 schools of different types. The minimum participation quota of teachers was 8.43 % and the maximum participation quota was 100 %.

The percentage of missing values was only 4 % for the analyzed items. Given the low percentage of missing values, multivariate single imputation was used.[5]

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5   A low percentage of missing values (e.g., below 5 %) allows case-wise deletion as well as mean imputation (see Schendera, 2007; Graham, Cumsille, & Elek-Fisk, 2003). Therefore, multivariate single imputation should lead to better estimates for the missing values.

We excluded 15 cases in which less than 50 % of the items had been answered[6] as well as eight cases in which the teachers had not indicated their school affiliation. Hence, the following analyses were based on the responses of 1,387 participants from 124 schools. Schools had an average of 11 teachers.

4.2 Instruments

4.2.1 Assessment of transformational leadership

The construct of transformational leadership was assessed using the Multifactor Leadership Questionnaire (MLQ 5 x Short), which includes scales not only on transformational leadership but also on transactional leadership and laissez-faire (Felfe & Goihl, 2014). The MLQ was translated into German by Felfe and Goihl (2002). Bass's model of transformational leadership forms the theoretical basis of the MLQ. This instrument has proven to be suitable for the school context in Germany (Harazd & van Ophuysen, 2011).

We used the translation by Felfe and Goihl (2002) and adapted it to the school context as follows. The term *employee* was replaced with *colleague*. The introductory phrase "The person I am evaluating ..." was changed to "My principal ..." This means that the teachers rated the transformational leadership of their principals. However, the five-grade rating system remained unchanged (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = regularly or almost always). The original questionnaire comprised five dimensions of transformational leadership with four items each. Due to results of a pretest and limited testing time, the questionnaire used in the present study comprised merely three items in each of the following five dimensions of transformational leadership: Idealized Influence attributed (IIa), Idealized Influence behavior (IIb), Inspirational Motivation (IM), Intellectual Stimulation (IS), and Individualized Consideration (IC). In addition to the item example for each dimension, the means and standard deviations for the analyzed subsample and the values for Cronbach's alpha and composite reliability are shown in Table 1.

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6 In these cases, it would have been necessary to estimate more than 50 % of the responses, which would have resulted in a disproportion that was too great between the available information and the number of values to be estimated for each subject. For these cases, the estimation error with single imputation would have been too large.

Table 1:   Scales of the independent variable of transformational leadership

Scale	Example Item	M	SD	Cronbach's Alpha	Composite Reliability
Idealized Influence attributed	"… makes me proud to be associated with him/her."	3.34	1.06	.92	.90
Idealized Influence behavior	"… talks to others about his/her most important convictions and values."	3.54	0.90	.80	.80
Inspirational Motivation	"… formulates a convincing future vision."	3.43	0.94	.87	.86
Intellectual Stimulation	"… urges me to view problems from different perspectives."	3.15	0.85	.83	.83
Individualized Consideration	"… helps me develop my strengths."	3.07	0.98	.85	.85

Note. Three items for each dimension of transformational leadership.

4.2.2   Assessment of data use

The dependent variable of data use was assessed using the two scales on external data use and internal data use (for information on the validation of these scales, see Dormann et al., 2016). Participants rated the use of data by the teachers in their schools on a five-grade rating system spanning from 1 = *I do not agree with this statement at all* to 5 = *I fully agree*. In addition to the item example for each dimension, the means and standard deviations for the analyzed subsample and the values for Cronbach's alpha and composite reliability are shown in Table 2.

Table 2: Scales of the dependent variable of data use

Scale	Example Item	M	SD	Cronbach's Alpha	Composite Reliability
External Data Use	"In our administration, innovations are proven by scientific study."	2.58	0.78	.84	.85
Internal Data Use	"Before adopting procedures from other administrations, we determine whether our framework conditions are similar."	3.43	0.74	.88	.88

Note. Five items for internal data use; seven items for external data use.

4.3 Method

To test empirically the hypotheses, we calculated several confirmatory factor models as well as a structural equation model (SEM) using Mplus 6.11. Since teachers were nested in schools in our data structure, we selected the *complex* analysis option (Muthén & Muthén, 1998–2010) to avoid a biased estimation due to the design effect. Furthermore, we used the MLR estimator for our analysis. Standard errors and chi-square tests of model fit were adjusted in this way for non-normality and non-independence of observations in our estimations (Muthén & Satorra, 1995). Thus, for nested model comparison, we also used the Satorra-Bentler scaled chi-square (SB-scaled chi²) difference test (see Satorra & Bentler, 1999).

5. Results

5.1 Factorial structure

First, we examined whether the independent variable of transformational leadership was indeed a five-dimensional construct in accordance with the theoretical assumption of Bass's model. To this end, we examined several models using confirmatory factor analysis (CFA). The results for all CFA models are shown in Table 3.

Table 3: Fit indices for Models 1–4 ($N = 1{,}387$)

Model	χ^2 (*df*)	c	RMSEA	CFI	SRMR	AIC	BIC	SB-scaled (Δdf)
1[a]	781.678** (80)	1.325	.080	.950	.036	45633.863	45921.782	
2	1008.918** (85)	1.322	.089	.935	.040	45921.952	46183.697	
3	1549.324** (90)	1.303	.108	.897	.044	46596.745	46832.316	698.959** (5)
4	816.519** (83)	1.316	.080	.948	.035	45665.972	45938.187	

Note. Model 1 = five-factorial model [(IIa), (IIb), (IM), (IS), (IC)]; Model 2 = five first-order factors [(IIa), (IIb), (IM), (IS), (IC)] and one second-order factor (TL); Model 3 = general factor model (TL); Model 4 = five first-order factors [(IIa), (IIb), (IM), (IS), (IC)], one second-order factor (TL), and two correlated residual variances [(tl13; tl11), (tl17; tl16)]; c = Scaling Correction Factor for the MLR; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Square Residual. AIC = Akaike's Information Criterion; BIC = Bayesian Information Criterion. [a] Problems arose in the estimation. ** $p < .01$.

While modeling the five-factorial model (Model 1), problems arose in the estimation because of relatively high latent correlations between the factors (.816–.980, see Table A1). These high values of the latent factor correlations are consistent with those in current research (see, e.g., Felfe, 2006b; Harazd & van Ophuysen, 2011).

At least two factors were, therefore, very similar in content. To avoid multi-collinearity in the following SEM, we estimated a second order factor in addition to the five-dimensional model (Model 2) and compared it to a one-dimensional model (Model 3). As can be clearly seen in Table 3, the fit values for Model 2 were closer to what is deemed an acceptable model fit (see, e.g., Browne & Cudeck, 1993; Hu & Bentler, 1999). The SB-scaled chi² difference test confirmed a significant improvement of Model 2 (as did the AIC and BIC, both indices being smaller for Model 2). Overall, the results suggested that Model 2 was a better match than Model 3, but the fit values were not optimal.

We respecified the model to include two correlations of two residual variances for the item pairs[7] tl13 and tl11 as well as tl17 and tl16 (Model 4). Model 4 showed a good model fit (see Table 3).[8] The new Root Mean Square Error of Approximation (RMSEA) of .080 was satisfactory, while indicating a reasonable error of approximation (Browne & Cudeck, 1993). The Comparative Fit Index (CFI) was only slightly below the threshold of .95 for a very good fit. Also, the Standardized Root Mean Square Residual (SRMR) suggested a good data fit. The factor loadings of the items on the first-order factors and the factor loadings of the first-order factors on the second-order factor were considerably high (.736 to .884; .917 to .985, respectively). Furthermore, the proportion of explained variance by the second-order factor was at least 84.1 % (for IM); thus, the second-order factor explained most of the variance in the subscales. To summarize, the findings suggest that the indicators used in the present study measured a superior transformational leadership factor.

5.2 Effects of transformational leadership on teachers' data use

The results from the CFA (Model 4) did not allow distinction among effects of the individual dimensions in the SEM. To test Hypotheses 1 and 2, we investigated the overall effects of transformational leadership on teachers' external data use and internal data use. To do so, we first extended the previous CFA model by including the dependent variables in the model. This new CFA model (Model 5) consisted of a two-dimensional measurement model for teachers' data use (see Dormann et al., 2016) and a second-order measurement model for transformational leadership. Both RMSEA (.056) and SRMR (.039) were below the critical values and indicated a good model fit. A CFI of .941 indicated an almost satisfactory model fit.

For the subsequent analysis of the effects of transformational leadership on both dimensions of teachers' data use we estimated an SEM (Model 6). In Model 6, we specified directional relationships between the dependent and the indepen-

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7   In Model 4, we allowed for correlations between the residual variances of item pairs tl13 "My principal exudes strength and trust" and tl11 "My principal acts in a way that inspires respect in me" as well as tl17 "My principal helps me develop my strengths" and tl16 "My principal urges me to view problems from different perspectives."
8   Both item pairs shared an additional common proportion of variance which could not be explained by the respective dimension of transformational leadership.

dent latent variables instead of using correlational relationships as in Model 5. This adaptation, however, had no effect on the accuracy of the models, seeing as both models were empirically equivalent. Figure 1 illustrates the structure and results of the SEM.

Figure 1: SEM of the effects of transformational leadership on teachers' data use
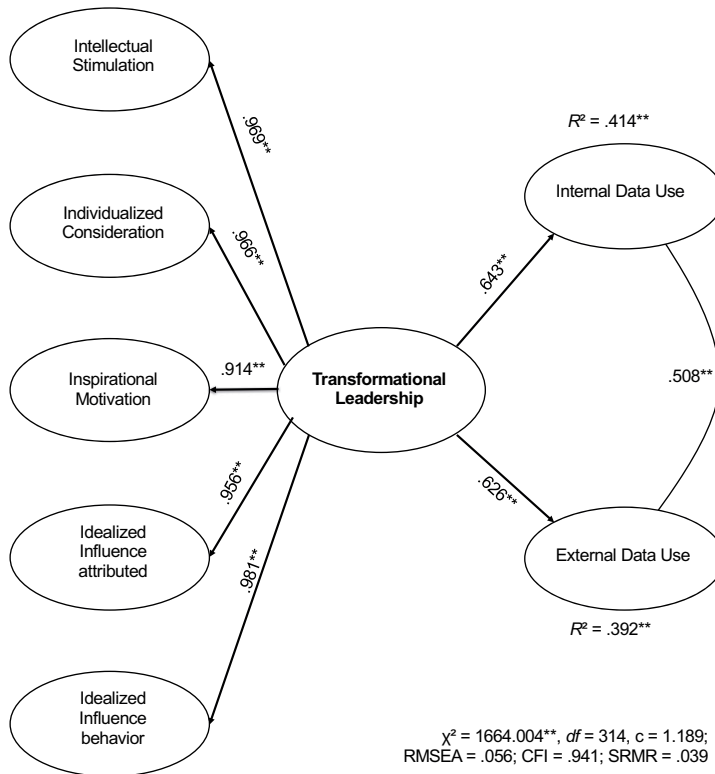
Note. Completely standardized robust maximum likelihood parameter estimates. c = Scaling Correction Factor for the MLR; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Square Residual.
**$p < .01$.

Transformational leadership explained approximately 39 % of the variance of external data use and approximately 41 % of the variance of internal data use. Taken as a whole, transformational leadership showed a highly significant and positive effect on both dimensions. The independent variable had slightly more effect on teachers' internal data use ($\beta_1 = .643$, $SE = .022$) than on teachers' external data use ($\beta_2 = .626$, $SE = .025$). Thus, both hypotheses were confirmed. Furthermore, the SEM indicated that both dimensions of teachers' data use correlated positively ($r = .508$, $SE = .036$). This finding suggests that teachers who used more exter-

nal data also tended to use more internal data and vice versa (see also Dormann et al., 2016).

6. Conclusion

6.1 Discussion

It is important to know which leadership behavior school principals can adopt in order to promote data use among their teachers. In this study, we analyzed the effects of transformational leadership on teachers' data use.

The results of this study show that transformational leadership promotes external as well as internal data use to an almost equal extent. This means that, through transformational leadership behavior, principals can encourage teachers to use data to improve their teaching in particular and schooling in general.

In light of the New Governance Model, it would be reasonable to have principals systematically develop transformational leadership skills through regular, appropriate training. Preliminary empirical results have shown that transformational leadership is generally learnable (Felfe, 2006b; see also Kirkbride, 2006).

As our findings show, transformational leadership comprises various behaviors and traits of leaders that can encourage data-driven decision-making among teachers. Follow-up studies could examine in greater detail the influence of individual components of transformational leadership and determine which specific behaviors and traits best promote data use among teachers. However, in our study, we could not carry out more detailed analyses on the influence of specific dimensions on teachers' data use due to high correlations between the dimensions of transformational leadership. This secondary finding marks a critical point for future research. According to Felfe (2006b), this problem has arisen in a number of studies and it might explain why the influence of transformational leadership for specific dimensions has not been analyzed (for the problem of the construct validity of the MLQ, see, e.g., Yukl, 1999). The correlation problem needs to be addressed in order to generate more accurate findings on how teachers' data use is influenced by specific components of transformational leadership.

6.2 Limitations

There are several limitations to this study. First, data were limited to public schools in Rhineland-Palatinate, a state in western Germany, and to only one school year. In addition, the sample in the EviS study is not representative of the entire body of teachers in Rhineland-Palatinate, or in Germany.

There are several important variables that should have been included as mediators and control variables in the analysis. Variables such as tenure of the principal

in each school and attitudes and characteristics of teachers could have affected the teachers' perception of their principals' leadership behavior (see also Felfe, 2006a; Keller-Schneider & Albisser, 2012). In this way, the same leadership behavior could be evaluated differently by different followers (Wegge & von Rosenstiel, 2014).

Another critical point is that transformational leadership of school principals was evaluated externally by teaching staff, whereas data use among teachers was evaluated internally by the teachers themselves. This raises common questions about the validity of self-reports. Furthermore, the reduction of items on the transformational leadership scale limits the comparability of this study to other studies on transformational leadership in schools.

Our findings have to be interpreted keeping in mind that transformational leadership was not operationalized in the context of data use. The items on the transformational leadership scale questioned general aspects of leadership without a specific link to principals' data use practices.

6.3 Outlook

Transformational leadership of school principals should be examined more closely to determine whether there are internal differences between or within single dimensions.

In view of the results of the present study, the next challenge will be to conduct longitudinal analyses in order to test the results of the current cross-sectional study and to investigate causal relations. The implications of such empirical data would be relevant for educational policy and school practices. For example, the data might indicate the most suitable organizational level for improvement measures (i.e., the school administration level or the teacher level). Moreover, the results of this study indicate a need for more detailed analyses of the role of variables mediating and moderating the influence of transformational leadership.

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Appendix A

Table A1: Estimated correlation coefficients of the latent variables

	IS	IM	IC	IIb
IM	.84*			
IC	.98*	.82*		
IIb	.94*	.98*	.90*	
IIa	.87*	.85*	.91*	.88*

Note. N = 1,387.
* $p < .05$