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Text-picture integration – Teachers’ attitudes, motivation and self-related cognitions in diagnostics

Abstract

Especially in secondary school, students need to learn from multi-representational material. For integrating information from different sources, students need specific competencies, which are seldom explicitly fostered. Teaching and learning with text-picture material is not systematically embedded in teacher education at German universities, but teachers have to deal with this material and its inherent challenges. For initiating successful learning processes teachers need to judge students’ learning prerequisites and the level of difficulty of text-picture material. This raises the need for investigating teachers’ attitudes, motivation and their self-related cognitions in diagnostics, which are assumed to impact teachers’ diagnostic activities.

The presented study aims at examining teachers’ attitudes towards diagnostics, motivation towards diagnostics, self-efficacy beliefs and self-reflection in diagnostics with regard to teaching with multi-representational learning material. CFAs support the superiority of a four-factor model. Structural equation models reveal that teachers’ experience is positively related to their motivation in diagnostics. Teachers’ attitudes and self-related cognitions are positively related to their diagnostic behavior. The study provides evidence of the structure and importance of teachers’ attitudes, motivation and self-related cognitions.

Keywords

Text-picture integration; Diagnostics; Teacher characteristics; Secondary school

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Text-Bild-Integration – Einstellungen, Motivation und selbstbezogene Kognitionen von Lehrkräften im Bereich Diagnostik

Zusammenfassung

Besonders in der Sekundarstufe werden Schülerinnen und Schüler mit multirepräsentationalen Lernmaterialien konfrontiert. Um Informationen aus zwei verschiedenen Quellen zu integrieren, benötigen Schülerinnen und Schüler spezifische Kompetenzen, die selten explizit gefördert werden. Lehren mit Bild-Text-Material ist nicht systematisch in der Lehrerbildung verankert, dennoch müssen Lehrkräfte mit diesem Material unterrichten. Um erfolgreiche Lehr-Lernprozesse zu initiieren, müssen Lehrkräfte die Lernvoraussetzungen der Schülerinnen und Schüler und das Schwierigkeitsniveau des Bild-Text-Materials diagnostizieren. Als Voraussetzung für akkurate diagnostische Urteile werden Einstellungen, Motivation und selbstbezogene Kognitionen von Lehrkräften untersucht.

Die hier vorgestellte Studie zielt auf die Analyse von Einstellungen zur Wichtigkeit von Diagnostik, Motivation bei der Diagnostik, diagnostischen Selbstwirksamkeitserwartungen und Selbstreflexion bei der Diagnostik im Bereich Bild-Text-Integration ab. Konfirmatorische Faktorenanalysen bestätigen die Überlegenheit eines 4-Faktoren-Modells. Strukturgleichungsmodelle weisen auf positive Zusammenhänge zwischen der Erfahrung von Lehrkräften und ihrer Motivation hin; Einstellungen und selbstbezogene Kognitionen stehen in positiver Beziehung zu diagnostischen Aktivitäten der Lehrkräfte. Die Studie liefert damit Evidenz für die Bedeutung von Einstellungen, Motivation und selbstbezogene Kognitionen von Lehrkräften.

Schlagworte

Bild-Text-Integration; Diagnostik; Lehrkraftvoraussetzungen; Sekundarstufe

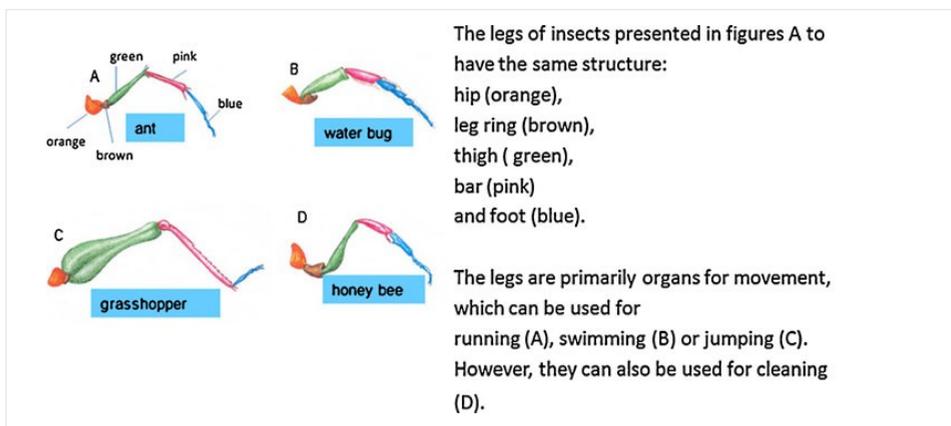
1. Challenges of learning from multi-representational material

After the transition from elementary to secondary school, students are increasingly required to gain knowledge from written material. Multi-representational material is omnipresent in classrooms. This learning material in secondary school often includes additional instructional pictures such as graphs, diagrams or maps to communicate content (Hochpöchler et al., 2012). Presenting information with multi-representational material bears several advantages as well as challenges (e.g., Mayer, 1989); for example, two different sources can complement each other or simplify each other's interpretation (e.g., van der Meij & de Jong, 2006). On the other hand, integrating information from different representations is a cognitively demanding process for students (Ayres & Sweller, 2005).

Multi-representational material – as it is understood in this paper – refers to material consisting of words and pictures (Mayer, 2001). *Words* in this context means written information in the form of texts, and *pictures* are instructional pictures, transferring information, like graphs, maps or similar illustrations. Whenever information is presented by different representations, the recipient needs to make use of different channels (here: verbal and pictorial) in order to extract information from both sources for constructing a mental model of the given information (Schnotz & Bannert, 2003). Since each channel has limited capacities of transporting information, learners have to undergo several cognitive processes, which are complex with regard to cognitive load. For texts and instructional pictures there is a high load on the visual working memory since both sources of information are presented in a visual form. Furthermore, information needs to be drawn from words and graphics, which means students' cognitive resources have to be split up (Brünken, Plass, & Leutner, 2003).

Nevertheless, learning from texts and pictures bears a high potential for effective learning, when material is adequately offered to the students (e.g., Ainsworth, 2006; Mayer, 2001). The theory of multimedia learning – or learning from multi-representational material – claims that certain principles can help learners to process information from different sources (Mayer & Gallini, 1990; Mayer, 1989; Paivio, 1986). Linking two sources – in this case texts and instructional pictures – can occur on two levels of complexity: the surface structure and the semantic deep structure (Schnotz & Bannert, 2003; Schnotz, 2002). On the surface structure level, elements from text and instructional picture(s) are linked by identical colors, references like numbers or letters or common symbols. In the example given in Figure 1, the colors and letters link the charts of insect legs to the text, explaining structure and function of the insects' legs.

Figure 1: Example for text-picture material (Hochpöchler et al., 2012)



On the semantic deep structure level, students have to draw more complex conclusions from the text-picture material. The complexity of tasks ranges from extracting basic information from text and picture to extracting complex relations between elements from text and picture (Schnotz, 2002).

2. Importance of diagnostics for teaching with text-picture material and teachers' contributions

In order to initiate successful learning processes, teachers have to take the complex process of learning from multi-representational material into account and have to provide students with learning strategies, if necessary. Several models illustrate these general relations between teachers, students, instructional quality and context, which can be assumed to be also valid for teaching and learning from text-picture material (e.g., Lipowsky, 2006). Since learning from text-picture material is demanding for students, accurate teacher judgments on students' abilities and on the material itself are crucial. Teachers need to judge the difficulties and chances of text-picture material for lesson preparation as well as post processing lessons for ensuring instructional quality. Thus, teachers need to spend time on diagnostic activities outside the classroom. A successful offer and usage of learning material serve both – students with rather high and students with low presuppositions (e.g., Vogt & Rogalla, 2009). For providing adequate learning opportunities teachers' judgments need to be as accurate as possible with regard to students and material. Diagnostic competence is regarded a requirement for accurate teacher judgments, and it is described as one of the four core components of teachers' competencies besides pedagogical content knowledge, classroom management skills, and didactic competence (Weinert, Schrader, & Helmke, 1990). It has to be noted that the term 'diagnostics' is used in order to refer to teachers' ability to judge their students' characteristics, such as achievement, or the learning materials. Thus, it has to be dissociated from the clinical term 'diagnostics'. There is evidence that teachers' accuracy in judging their students achievement should not be mistaken for a general ability of judgment (Spinath, 2005).

In Germany, neither teaching nor learning from texts with instructional pictures nor diagnostics in this field has so far been an integral and systematic part of teacher education at university. Nevertheless, teachers are challenged daily to enable students to learn from text-picture material and to judge student performance accurately. There is evidence that teachers are well aware of the importance of text-picture material for their classrooms. They are also highly motivated to teach with this kind of material and show high self-efficacy beliefs, but their knowledge about text-picture integration is rather low and shows a negative relation to emotional distance (McElvany et al., 2010). Regarding teachers' diagnostic judgments in the field of text-picture integration, research has shown a weak to moderate accuracy of teacher judgments, which is not consistently related to teaching experi-

ence (McElvany et al., 2009). Since text-picture material has varying relevance for different subjects, teachers' diagnostic skills have also been investigated comparing German teachers and geography/biology teachers, assuming the latter to have more experience with text-picture material and therefore, be more accurate in their judgments. This hypothesis could not be confirmed; there was no significant difference between both groups of teachers (McElvany et al., 2012).

3. Conceptualizing teachers' attitudes, motivation and self-related cognitions in diagnostics

We assume that teachers' attitudes, motivation and self-related cognitions are fundamentally important for their judgment activities: besides professional knowledge, teachers' attitudes, motivation and self-related cognitions are supposed to be the basis for initiating successful learning processes and are embedded in various definitions of teachers' competencies (in general: e.g., Kunter et al., 2013). According to Weinert's general definition of competence, teachers' competence needs to include motivational, volitional and cognitive factors (Weinert, 2001). Likewise, Bromme argues that teachers' competence is an example for the interaction between sub-domains of teachers' professional competence, such as attitudes, knowledge and beliefs (Bromme, 1997). Teachers' attitudes, motivation and self-related cognitions have also been used successfully as relevant components among others to describe mathematics teachers' general professional competence in a German large scale assessment (Kunter et al., 2013). For diagnostic competence we assume a similar structure. Though there is little research on teachers' attitudes, motivation and self-related cognitions for diagnostics in particular, their meaning for teacher professionalism is described in closing. Teachers' emotional awareness, attitudes, motivation and beliefs are supposed to have a positive impact on students' emotions and self-related cognitions, which are also an important outcome of teaching and learning processes (Jennings & Greenberg, 2009). It seems reasonable that these general theories can also be adapted for teaching and diagnostics in the specific field of instruction with text-picture material.

Teachers' *attitudes* are an aspect of their value commitments (Pajares, 1992), and they are regarded as a central component of professionalism in general and teacher professionalism in particular (Ernest, 1989). Teachers' general attitudes towards teaching and learning have been described as an influencing factor for instructional quality and students' outcomes (for general attitudes about instructional vs. constructivist teaching: e.g., Staub & Stern, 2002; for attitudes about teaching strategies with text-picture material: Schroeder et al., 2011).

Teachers' *motivation* can be expected to be a core aspect of teachers' ability to perform and influence students' outcomes (for teacher motivation in general: e.g., Brophy, 1986; Hattie, 2002; Kunter, 2011). It is assumed, that this statement is not only true for teachers' acting in the classroom, but it can also be extended to teach-

ers' diagnostic activities during the entire teaching process. Among other things, it is essential to judge students' prerequisites for appropriate lesson preparation in order to offer the students adequate learning materials and tasks. Therefore, teachers' motivation towards diagnostics is not limited to classroom interactions; it also includes diagnostic activities before and after lessons.

Teachers' *self-efficacy beliefs* are part of their self-related cognitions (Bandura, 1986). They are therefore assumed to be a component of teachers' diagnostic competence. A teacher's self-efficacy belief is the "teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplishing a specific teaching task in a particular context" (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998, p. 233). Teachers' general self-efficacy beliefs are relevant for their behavior in the classroom (e.g., Tschannen-Moran & Hoy, 2001); they are also relevant for their stress-management (Schwarzer & Hallum, 2008).

Self-reflection describes teachers' attempts to reflect their activities and is also part of their self-related cognitions (Shulman & Shulman, 2004). There is evidence that simple diagnostic practice is not sufficient for increasing teachers' competencies. Practical experience can only be fruitful for the development of (diagnostic) competence and its cognitive, emotional-motivational prerequisites, if teachers systematically reflect their diagnostic experiences (Ericsson & Charness, 1994).

4. Importance of teacher demographics and practical implications of teachers' attitudes, motivation and self-related cognitions

Assuming that these four components are suitable for describing teachers' attitudes, motivation and self-related cognitions in diagnostics, there is need for further clarification: Are teachers' attitudes, motivation and self-related cognitions impacted by core background characteristics, such as teachers' educational background or teaching experience? Do teachers' attitudes, motivation and self-related cognitions impact their diagnostic practice? Answers are needed in order to gain indications of how attitudes, motivation and self-related cognitions can be developed and fostered. There is evidence that teacher demographics such as educational background (*university major*) and teaching experience have an impact on aspects such as teachers' self-efficacy beliefs, motivation, and job satisfaction (Klassen & Chiu, 2010). Regarding teachers' educational background, it can be assumed that teachers gain their professional competencies during their studies at university (e.g., Blömeke, 2011; Cochran-Smith & Zeichner, 2005). In Rhineland-Palatinate (Germany) teachers in our sample had to study 3.5 years for elementary or lower secondary school (*Grundschule, Hauptschule* and *Realschule*), while teachers from upper secondary school (*Gymnasium*) had to study 4.5 years (Ministerium der Justiz und für Verbraucherschutz des Landes Rheinland-Pfalz, 1982a, 1982b, 1982c). In two additional semesters, teachers from *Gymnasium*

might have more opportunities to extend their professional competencies than their colleagues from elementary or lower secondary school and therefore they form a distinct group of teachers in the sample. Besides teacher trainings, teachers' gained experience with diagnostics over time is a possible source for diagnostic activity and competence. After graduating from university, all teachers have to complete a 1.5-year in-service teacher training, during which they begin to gather experience. In the context of teaching and learning with text-picture material and accuracy of teacher judgments, contrary relations between teachers could be found: teaching experience correlated positively with the judgment accuracy of students, but correlated negatively with the accuracy of judging item difficulty (McElvany et al., 2009). On the other hand, diagnostics have not been systematically taught in teacher education in the past. This holds true especially for diagnostics in the field of teaching and learning with text-picture material, which is taught only rudimentarily, if at all. Therefore, teachers' attitudes, motivation and self-related cognitions in diagnostics with regard to text-picture material might be acquired substantially during educational practice while teaching in schools (*teaching experience*). While teachers' general attitudes towards teaching and learning are not assumed to be subject-specific, there is empirical evidence for teachers' attitudes towards the importance of text-picture material to vary between subjects (McElvany et al., 2012). It also seems reasonable that the relevance of text-picture-material varies between subjects. Therefore, teachers teaching natural science subjects such as biology or geography will be much more confronted with having to diagnose students' abilities and difficulty levels of learning materials in the area of text-picture integration than teachers, teaching predominantly subjects such as German or other non-natural science subjects. Therefore it seems plausible that teachers' *taught subjects* impact their attitudes, motivation and self-related cognitions in diagnostics.

Up to now, research has mostly focused on teachers' ability to judge students' performance. A description of teachers' attitudes, motivation and their self-related cognitions as basis for performing judgments on students' achievement is still missing. There is strong empirical evidence that teachers' general competencies and expertise influence their instructional behavior as well as students' achievement and motivation (e.g., Kunter et al., 2013; Hattie, 2002). For text-picture integration there is evidence for a positive relation between teachers' motivation and instructional quantity of text-picture integration on the one hand, on the other hand teachers' self-efficacy beliefs are positively related to their engagement (McElvany et al., 2012). One core aspect of diagnostic activities is linked to the extent of attention given to diagnostics before, during and after class. The time, spent focusing on diagnostic aspects of teaching can be seen as precondition for the quality of teaching, accuracy of teacher judgments and consequential students' outcomes.

5. Research questions and hypotheses

The research aim of the present study was to empirically evaluate the structure of teachers' attitudes, motivation and self-related cognitions in diagnostics, to examine influencing factors, and to investigate the impact on diagnostic practice. Three research questions guided the research:

1. Can the theoretical structure of teachers' attitudes, motivation and self-related cognitions in diagnostics be validated empirically in the context of teaching and learning with text-picture material?

It is assumed that teachers' *attitudes towards diagnostics, motivation towards diagnostics, self-efficacy beliefs in diagnostics, and self-reflection in diagnostics* are components of teachers' competence in general. Hence, these components should be distinct, but correlated.

Although diagnostics are not always explicitly taught at university, the relation between teachers' education and their attitudes, motivation and self-related cognitions in diagnostics should be investigated, above and beyond other potential influencing factors:

2. What relations can be identified between components of teachers' attitudes, motivation and self-related cognitions in diagnostics and their university major, subject taught and length of teaching experience?

For teachers' university major, no directed hypotheses are stated. For teachers' subject we assume that teachers who teach natural science subjects (such as biology, physics, geography, etc.), show higher attitudes, motivation and self-related cognitions than teachers who teach non-natural science subjects, such as languages or social science, since text-picture material is used more often in natural science subjects. Teaching experience is supposed to be positively related to teachers' motivation, because teachers – being confronted with teaching from text-picture material – might recognize the importance of diagnostics and are therefore more motivated.

The third research question investigates the relations between teachers' attitudes, motivation and self-related cognitions in diagnostics and their diagnostic activities before, during and after class.

3. Is there a relation between teachers' attitudes, motivation and self-related cognitions and their diagnostic activities?

Regarding models for teaching and learning processes, teachers' attitudes, motivation and self-related cognitions are supposed to crucially influence classroom interactions. Hence, it is assumed that these components also have a positive impact on the reported diagnostic activities (time spent on diagnostics).

6. Methods

6.1 Design and sample

Data and results presented in this paper have been collected within the BiTe-project (Development and Evaluation of Competency Models for Integrated Processing of Texts and Pictures; short: “*Bild-Text-Integration*” in German). The aim of this longitudinal study was the investigation of teaching and learning from texts with integrated pictures in lower secondary schools. Data for the analyses were collected in schools in Rhineland-Palatinate, Germany, in February 2009, 2010 and 2011. The sample was randomly drawn from three secondary school tracks. Altogether, $N = 48$ classes from *Hauptschule* (lower secondary school track), *Realschule* (middle secondary school track) und *Gymnasium* (upper secondary school track) participated in two cohorts. In the first cohort classes 5 to 7 and in cohort two classes 6 to 8 participated. Teachers teaching these classes in biology, geography and German were asked to voluntarily take part in the study. From all participating teachers, $N = 121$ completed the questionnaire for their attitudes, motivation and self-related cognitions and filled in the demographics questionnaire at one point of time in the course of the longitudinal study. The mean age of teachers was 43.60 years ($SD = 11.54$), 66.10 % were female, and the whole sample had a mean teaching experience of 14.50 years ($SD = 11.58$). 47.70 % of teachers had a degree for teaching at *Gymnasium* and upper secondary school level and 52.30 % had a degree for teaching at *Hauptschule*, *Realschule* or elementary school. Regarding the subjects, which those teachers taught, 53.70 % mainly taught German or other non-natural science subjects and 36.40 % mainly taught natural science subjects (missing information for 9.90 %) during the last three years.

6.2 Measures

6.2.1 Teachers’ attitudes, motivation and self-related cognitions in regard to diagnostics

In the presented study, one teacher questionnaire was utilized for assessing teachers’ attitudes, motivation and self-related cognitions in diagnostics, teacher characteristics, and self-reports about diagnostic activities. Items, assessing these measures, have been developed within the BiTe-project¹ as adaptation from parallel items examining these teacher measures in regard to teaching with text-picture materials in general (see McElvany et al., 2010), which in turn had been inspired by the *COACTIV* study (“Professional Competence of Teachers, Cognitively Activating Instruction, and Development of Students’ Mathematical Literacy”; Baumert et al., 2009). For assessing teachers’ attitudes towards diagnostics, self-efficacy beliefs,

1 Special acknowledgement to Katrin Lintorf

self-reflection, and motivation, teachers had to rate four to five statements on a four-point Likert-scale ranging from 1 = “strongly disagree” to 4 = “strongly agree”. All four scales showed a satisfying reliability, measured with Cronbach’s Alpha. Table 1 provides an overview of all scales including example items.

Table 1: Instrument for assessing teachers’ attitudes, motivation, self-related cognitions and diagnostic activities

Scale	Item Example	Number of Items	α	M	SD
Attitudes towards diagnostics	<i>In general it is important for teaching and learning processes, to meticulously analyze the difficulty of text-picture material for students in advance.</i>	4	.77	3.18	0.48
Motivation towards diagnostics	<i>I take delight in estimating the adequacy of text-picture material for my class.</i>	4	.83	2.78	0.54
Diagnostic self-efficacy beliefs	<i>I am confident to estimate the difficulty of text-picture material adequately.</i>	4	.77	3.00	0.37
Self-Reflection in diagnostics	<i>When learning material contains texts and instructional pictures, I usually scrutinize the adequacy of text-picture material which I selected for my class.</i>	5	.78	3.14	0.47
Diagnostic activities	<i>I spend time on estimating the challenges of text-picture material during lesson preparation.</i>	4	.85	4.40	0.74

6.2.2 Teachers’ demographics

The questions about teachers’ demographics have been adapted from PISA 2003 (PISA-Konsortium Deutschland, 2006). Teachers were asked about their *university major* (recoded as dummy-variable 0 = “others”, 1 = “Gymnasium”), which *subjects* they mainly taught during the last three years (recoded as dummy-variable 0 = “Non-Natural science subjects”, 1 = “Natural science”), and their *teaching experience* (in years, including in-service teacher training; data available for). Data was available for $n = 109$ teachers.

6.2.3 Teachers’ diagnostic activities

Data on teachers’ self-reported diagnostic activities was collected by using four items and a six-point Likert-scale, rating how often they perform diagnostic activities before, during or after class (1 = “never” to 6 = “very often”). This scale also showed satisfying reliability (see Table 1).

6.3 Statistical methods

Teachers' attitudes, motivation and self-related cognitions were analyzed by using latent modeling for all components (Mplus® 5.21). Due to the limited sample size of $N = 121$ teachers, the components *attitudes towards diagnostics*, *motivation towards diagnostics*, *self-efficacy beliefs in diagnostics* and *self-reflection in diagnostics* were modeled using randomly compiled parcels of 2 to 3 items, which is a frequently used method in studies dealing with small sample sizes (Bandalos & Finney, 2001).² All parcels showed reliabilities measured with Cronbach's Alpha $.62 < \alpha < .76$. Also, the teachers' *diagnostic activities* was modeled by two parcels with reliabilities of $\alpha = .65$ and $\alpha = .74$.

Since all dependent and independent variables have been assessed by teachers' self-report questionnaires, our data might have single source bias (Söhnchen, 2009). For checking Common Method variance, we used Harman's single factor test (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Confirmatory factor analyses showed poor model fit parameters when a method factor was included ($\chi^2 = 163.61$; $df = 35$; $p = 0.00$; CFI = 0.72; BIC (adjusted) = 1703.06; RMSEA = 0.17). For evaluating the structure of teachers' attitudes, motivation and self-related cognitions in diagnostics (research question 1), three models were tested by using confirmatory factor analysis (CFA). Model 1 (higher order factor model with four sub-factors) assumes that teachers' attitudes, motivation and self-related cognitions can be described by one general factor with four sub-factors. Model 2 (four-factor model) describes the assessed components by four correlated components: *attitudes towards diagnostics*, *motivation towards diagnostics*, *self-efficacy beliefs in diagnostics* and *self-reflection in diagnostics* without a common general factor. Model 3 (general factor model) describes teachers' attitudes, motivation and self-related cognitions by one general factor without sub-factors. Models were compared by their fit indices and chi-square difference tests. Technically speaking, those three models are not nested (Model 1 and 2 vs. Model 3). Therefore, the BIC is the most important fit index, since it can be used for non-nested model comparisons (Schreiber, Nora, Stage, Barlow, & King, 2006).

For analyzing relations between teachers' demographics and their attitudes, motivation and self-related cognitions in diagnostics (research question 2), we included all demographics and diagnostic components in a comprehensive structural equation model; correlations between the diagnostic components were allowed also.

In order to answer research question 3, we tested a latent model with all four components of teachers' attitudes, motivation and self-related cognitions as predictors for teachers' diagnostic activities. Correlations between components of teachers' attitudes, motivation and self-related cognitions were allowed. Persons with missing data were not excluded from analyses, and FIML-estimation was used,

2 Models with three parameters for each construct have been tested as well, but due to a non-positive definite first-order derivative product matrix, standard errors were not trustworthy and fit indices were poor.

which is an adequate procedure, if missing data are completely at random. Little’s MCAR test (Enders, 2010) confirmed that missings in our data set are completely at random ($\chi^2 = 131.89$, $df = 173$, $p = .99$). For testing our hypotheses we used the significance level of $p = .05$ (5 %-level).

7. Results

As shown in Table 1, the means of teachers’ attitudes, motivation and self-related cognition scales were between $M = 2.78$ ($SD = 0.54$) and $M = 3.18$ ($SD = 0.48$) on the four-point scale. Means of all four scales differed significantly from the scale-mean (2.5).

7.1 Conceptualizing teachers’ attitudes, motivation and self-related cognitions in diagnostics

We dealt with the first hypothesis – assuming that teachers’ cognitive, emotional-motivational and self-related prerequisites can be described by four components – by testing three models by CFA. The following table provides fit indices for the tested models and results of chi-square difference tests for comparing the models:

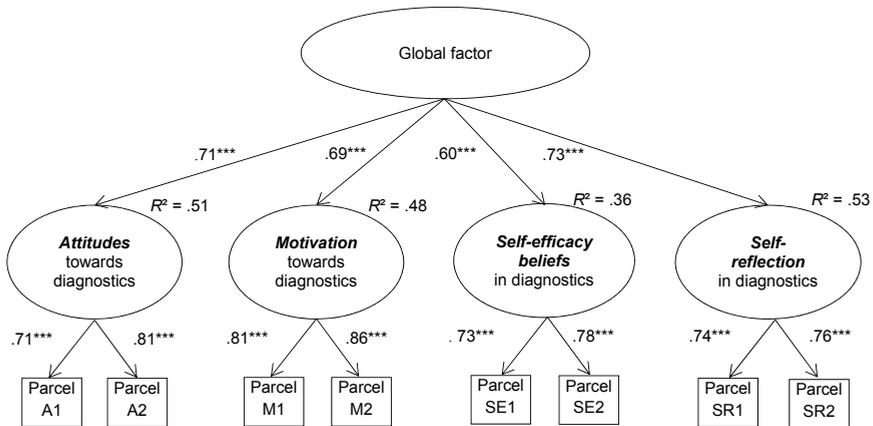
Table 2: Results of Confirmatory Factor Analyses and Chi-Square Difference Tests

Model	χ^2	<i>df</i>	<i>p</i>	<i>BIC (adjusted)</i>	<i>CFI</i>	<i>RMSEA</i>	<i>SRMR</i>	χ^2_{diff}
1. Higher order factor with four sub-components	12.20	16	.72	1188.77	1.00	0.00	.03	
2. Four factors	12.15	14	.59	1192.00	1.00	0.00	.03	
3. General factor without sub-components	109.38	20	.00	1279.43	0.68	0.19	.10	
Model comparison								
4. Comparison Model 1 and Model 2								0.05
5. Comparison Model 1 and Model 3								97.18***
6. Comparison Model 2 and Model 3								97.23***

Note. *** $p < .001$

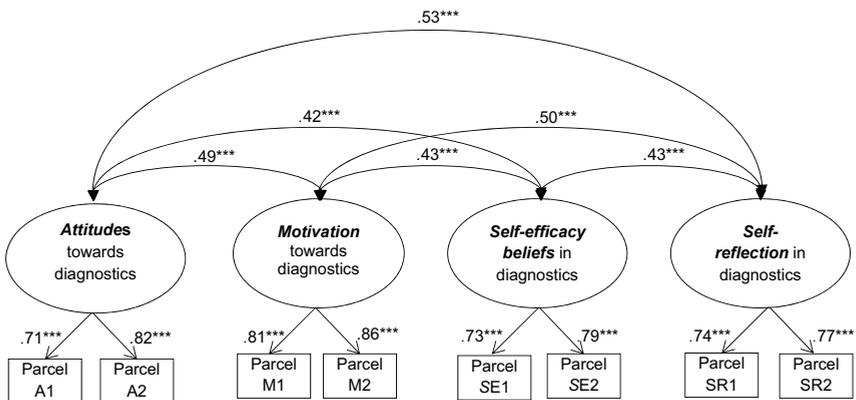
Fit indices indicated a better fit of model 1 and model 2 compared to model 3. Chi-square-difference-tests supported this. Comparing the higher order factor model (see Figure 2) to the four-factor model (see Figure 3) the Chi-square difference test revealed a non-significant difference between both models.

Figure 2: Higher order factor model for teachers' attitudes, motivation and self-related cognitions



Note. *** $p < .001$

Figure 3: Four-factor model for teachers' attitudes, motivation and self-related cognitions



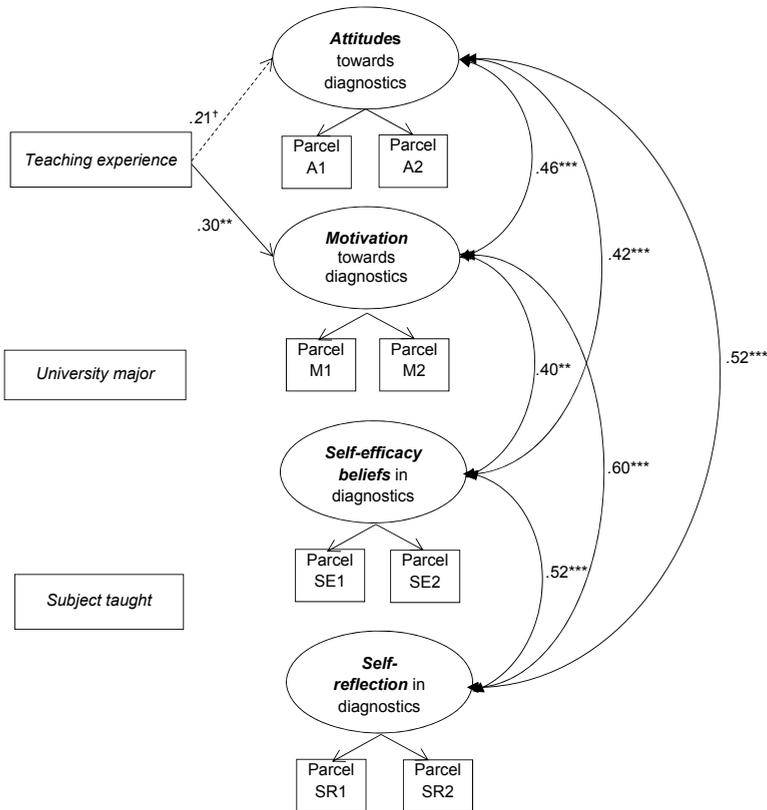
Note. *** $p < .001$

Due to the correspondence with the theoretical framework and higher potential for informative analyses and conclusions, the four-factor model was used for further analyses. The four components of teachers' attitudes, motivation and self-related cognitions showed the expected substantial correlations among each other ($r = .42 - .53$).

7.2 Relations between teachers' demographics and their attitudes, motivation and self-related cognitions in diagnostics

A second goal of this study was the evaluation of relations between teachers' demographics and their attitudes, motivation and self-related cognitions. In a comprehensive model (see Figure 4) using all teacher demographics simultaneous-

Figure 4: Impact of teachers' demographics on attitudes, motivation and self-related cognitions



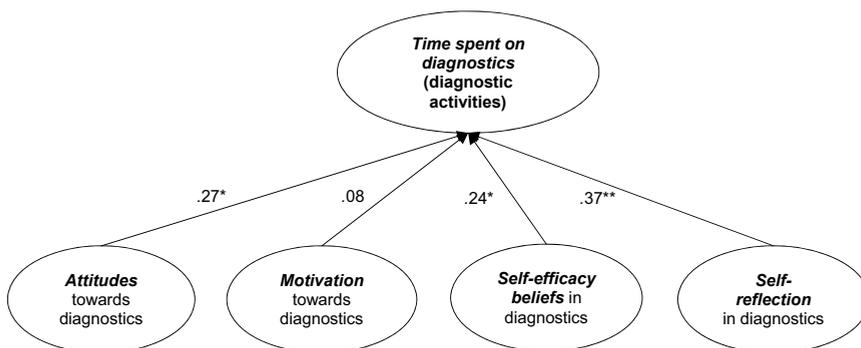
Note. *** $p < .001$; ** $p < .01$; * $p < .10$; $\chi^2 = 22.56$; $df = 26$; $p = .78$; CFI = 1.00; RMSEA = .00; $N = 121$; R^2 (Attitude) = .05; R^2 (Motivation) = .09

ly as predictors, teachers' teaching experience was statistically significantly positively related to the motivation towards diagnostics. Also, teaching experience showed tendentially significant positive relations to teachers' attitudes towards diagnostics. Neither teachers' university major nor the most frequently taught subject showed significant relations to their attitudes, motivation and self-related cognitions. Considering all findings, the second hypothesis could be confirmed only partially. The following illustration provides an overview and more detailed information about the presented relations.

7.3 Relations between teachers' attitudes, motivation, self-related cognitions and their diagnostic activities

The third research question of this study focused on the relations between teachers' attitudes, motivation and self-related cognitions and their diagnostic activities before, during and after class (time spent on diagnostics). A structural equation model (see Figure 5), with all components used as predictors simultaneously, showed a positive relation between teachers' attitudes and self-related cognitions (self-efficacy, self-reflection) and the amount of time they spent on diagnostics. Teachers, who think that diagnostics are important for teaching and learning with text-picture material and who possess high self-efficacy beliefs and high self-reflection in diagnostics report spending more time on diagnostics than teachers with low self-efficacy beliefs and self-reflection in diagnostics do. Also, teachers who value the importance of diagnostics less, spent less time with diagnostic behavior. The relation between teachers' motivation and their diagnostic activities failed to reach the 5 % significance level.

Figure 5: Impact of teachers' attitudes, motivation and self-related cognitions on diagnostic activities



Note. ** $p < .01$; * $p < .05$; $\chi^2 = 26.73$; $df = 25$; $p = .37$; CFI = 1.00; RMSEA = .02; $R^2 = .58$

8. Discussion

8.1 Context of the study

Teaching and learning from multi-representational material bears a lot of challenges for both – teachers and students. Teachers who were not explicitly educated for teaching with this kind of material (as it is the case for teachers in Germany) must, nevertheless, offer adequate learning materials for their students. Therefore, their ability of judgment is essential. This raises the question of teachers' prerequisites as the basis for diagnostic activities. Research on teacher professionalism showed that teachers' attitudes, motivation and self-related cognitions are important for enabling successful teaching and learning processes. Up to now, only little research has been done on teachers' attitudes, motivation and self-related cognitions in diagnostics in the context of text-picture integration. Against this background, the project BiTe aimed at investigating teaching and learning with text-picture material in German lower secondary school classes. The presented study, which was a part of the BiTe-project, contributes a theoretically and empirically based structure of teachers' attitudes, motivation and self-related cognitions in diagnostics. The study further investigated moderating factors of these components as well as their relation to teachers' diagnostic activities in the specific context of teaching and learning with text-picture material.

8.2 The structure of teachers' attitudes, motivation and self-related cognitions and relations to their demographic background

Teachers' attitudes, motivation and self-related cognitions in diagnostics have been assessed by four components: *attitudes towards diagnostics*, *motivation towards diagnostics*, *self-efficacy beliefs in diagnostics* and *self-reflection in diagnostics*. Confirmatory factor analyses revealed the superiority of a higher order factor model and a four-factor model compared to a general factor model without sub-components of teachers' attitudes, motivation and self-related cognitions. All four components can be conceptualized and operationalized as distinct, but correlated components. Regarding the relations between the four components named above, teachers who find diagnostics important for teaching and learning with text-picture material are higher motivated and show higher self-related cognitions than teachers, harboring critical attitudes towards diagnostics. Teachers' *motivation* is a core aspect of teachers' ability to perform (Patrick, Hisley, & Kempler, 2000), and therefore it is not surprising that a positive attitude towards diagnostics is correlated with a high motivation to practice diagnostics during teaching and lesson-preparation. Teachers who find diagnostics important for their teaching are higher motivated to use diagnostics. The positive correlation between teachers' motivation to-

wards diagnostics and their attitudes towards diagnostics allows the interpretation that teachers experience diagnostics as a helpful and necessary tool for successful teaching and learning processes. Furthermore, highly motivated teachers, who find diagnostics important for teaching and learning, show high self-efficacy beliefs and self-reflection in diagnostics. These results are expectable since motivation is widely seen as motor for teachers' actions (for teacher motivation in general: e.g., Brophy, 1986; for the relation between motivation and self-efficacy beliefs: Tschannen-Moran et al., 1998).

The conceptualization of teachers' attitudes, motivation and self-related cognitions in diagnostics by four factors allows for detailed analyses of relations between those components and teachers' demographic background. One result of the presented study reveals that experienced teachers are higher motivated to perform diagnostics than less experienced teachers. A plausible explanation is that teachers gain experiences in teaching with text-picture material and due to the inherent learning difficulties see the need for providing adequate material and scaffolds in order to initiate fluent learning processes, which also might explain that the experienced teachers' find diagnostics very important. Results of structural equation models (slope-coefficient is $\beta > .10$, $p = .06$) miss the 5 %-level of significance though. It is surprising that teaching experience is not related to the other components. As Klassen and Chiu (2010) showed, teachers' self-efficacy beliefs do not develop linearly; self-efficacy beliefs tend to decline after about 23 years of teaching (in our sample $n = 24$ teachers have more than 23 years of experience). This non-linear development could also be true for teachers' self-reflection. It seems plausible that young and inexperienced teachers reflect their behavior more often than teachers' with more experience do. This assumption needs to be confirmed though. Furthermore there is no information on teachers' evaluation and feedback strategies available, which makes our operationalization of teaching experience (duration) disputable (Schrader, 2009). We stated no directed hypothesis for the relation between teachers' university major and their attitudes, motivation and self-related cognitions. In our data no relations at all have been found. Again, teaching and learning from text-picture material is not part of teacher education. Therefore a longer study period does not necessarily increase the dependent variables named above. These results are in line with bivariate correlations.

As argued in the theory chapter, teachers are often confronted with texts and instructional pictures in natural science classes. Therefore we assumed teachers, who teach natural science subjects, to show higher values on the assessed components than teachers, who teach languages or social science. This hypothesis could not be confirmed. Again, information about how teachers' behavior is evaluated or if teachers receive feedback from others might be a more powerful predictor for the dependent variables than just the mainly taught subjects.

8.3 Relations between teachers' attitudes, motivation and self-related cognitions and their diagnostic activities

The third research question focused on the important aspect of the relevance of teachers' attitudes, motivation and self-related cognitions for their diagnostic activities. As the results showed, both – teachers' attitudes and their self-related cognitions – are related to the amount of time teachers' report to spend on diagnostics when teaching with text-picture material. Altogether 58 % of all variance could be explained by teachers' attitudes, self-efficacy beliefs and self-reflection. As elaborated in the theory section, teachers' attitudes and motivation are vital for their activities in the classroom (and also before and after class). This result is conforming to general research on teacher professionalism, describing attitudes as an essential aspect of teachers' beliefs (Pajares, 1992) and an influencing factor for instructional quality and students' outcomes (e.g., Schroeder et al., 2011). It is surprising though that teachers' motivation showed no significant relation to their diagnostic activities. Teachers' general self-efficacy beliefs are relevant for their behavior in the classroom (Schulte, Bögeholz, & Watermann, 2008) and therefore it can be expected to find this relation between teachers' self-efficacy beliefs in diagnostics and their diagnostic practice. Also, the strong relation between teachers' self-reflection and the time spent on diagnostics seems logical and conform to our expectations. It shows that teachers do not just spend time on preparing adequate learning material but also spend time on reflecting their own diagnostic activities. The self-reported amount of time spent on diagnostics is just one piece of teachers' diagnostic activities, but the results strengthen the assumption that teachers' attitudes and self-related cognitions are important for teachers' actions and a cautious hint for instructional quality.

9. Gains and limitations

9.1 Theory and methods

The presented study provides empirical evidence for the structure of teachers' attitudes, motivation and self-related cognitions in diagnostics and its practical relevance. Nevertheless, some restrictions have to be kept in mind, when interpreting the results. With regard to the sample size and reliability of item parcels, only cautious interpretation of results is allowed. As Marsh and colleagues pointed out, the use of item parcels may inflate the correlations between factors and may disguise model misspecifications (Marsh, Lüdtke, Nagengast, Morin, & von Davier, 2013). Furthermore, the study focused only on secondary school teachers and the very specific domain of text-picture integration. All data presented in this study have been assessed using questionnaires. This might be problematic since the use of one single method might impact the results. Results of the Harman's single factor test

confirmed poor model fit criteria and therefore we assume that data can be interpreted without common method bias. Controlling for effects of an unmeasured latent methods factor would have been more appropriate, but due to the sample size and model complexity the model could not be estimated.

Furthermore, the proposed structure of teachers' attitudes, motivation and self-related cognitions needs to be validated: the relation between these components and the accuracy of teachers' judgments must be investigated. Up to now, there has been little research on relations between teacher characteristics and their judgment accuracy (Südkamp, Kaiser, & Möller, 2012). Do teachers with a positive attitude and motivation towards diagnostics and high self-reflection and self-efficacy beliefs judge students' achievement and task difficulty more accurately than teachers with lower distinct attitudes, motivation and self-related cognitions do? What relations can be found between the different components and the accuracy of their judgments? Time spent on diagnostic is an initial hint of the practical impact of teachers' attitudes, motivation and self-related cognitions, but further studies need to evaluate the relevance for teachers' actions inside and outside of the classroom. In our study, diagnostic activities was assessed by teachers' self-reports. This might be problematic due to the objectivity of the assessed data; teachers' might have answered according to social desirability. Another perspective for future research is the evaluation of the proposed structure of teachers' attitudes, motivation and self-related cognitions in other school forms such as elementary school. Assessing teachers' attitudes, motivation and self-related cognitions for diagnostics in general could also be a valuable gain for supporting the assumed structure. On such a basis a comparison to text-picture integration specific components would be interesting.

9.2 Practice

The presented study is basic research and therefore, practical implications are limited. Nevertheless, the positive relations between teachers' attitudes and self-related cognitions towards diagnostic and their diagnostic behavior can bear implications for future teacher education. If further research can confirm the presented results, fostering teachers' attitudes, motivation towards diagnostics and their self-related cognitions might be a powerful tool to improve teachers' diagnostic activities.

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