European Journal of Psychology of Education
https://doi.org/10.1007/s10212-023-00744-y

Longitudinal relations between teacher self-efficacy and student motivation through matching characteristics of perceived teaching practice

Katharina Hettinger[1] · **Rebecca Lazarides**[1] · **Ulrich Schiefele**[2]

Received: 8 March 2023 / Revised: 24 August 2023 / Accepted: 30 August 2023

Abstract
Theoretically, teacher self-efficacy relates to student outcomes through teaching behavior. However, underlying pathways through which specific teacher self-efficacy facets longitudinally relate to student motivation and emotion in classrooms remain unclear. This study aims to overcome this research gap by investigating whether student- and teacher-reported classroom discipline and social relatedness explain the longitudinal relations between teacher self-efficacy for classroom management and for emotional support and student self-efficacy and enjoyment. Multilevel analyses were carried out with data from 959 students and their 50 teachers. Results revealed that teacher self-efficacy for classroom management at the beginning of Grade 9 (T1) related indirectly to student enjoyment in the middle of Grade 10 (T3) through student-perceived class-level discipline at the beginning of Grade 10 (T2). Teachers' self-efficacy for emotional support (T1) related positively to teacher- and student-reported social relatedness (T2); the latter related to student enjoyment (T3). Implications for future teacher motivation research are discussed.

Keywords Longitudinal analyses · Perceived teaching quality · Teacher self-efficacy · Student self-efficacy · Enjoyment

Katharina Hettinger and Rebecca Lazarides share first authorship on this paper.

✉ Rebecca Lazarides
rebecca.lazarides@uni-potsdam.de

Katharina Hettinger
katharina.hettinger@uni-potsdam.de

Ulrich Schiefele
ulrich.schiefele@uni-potsdam.de

[1] Department of Education, University of Potsdam, Karl-Liebknecht-Straße 24-25, 14476 Potsdam, Germany

[2] Department of Psychology, University of Potsdam, Karl-Liebknecht-Straße 24-25, 14476 Potsdam, Germany

Published online: 15 September 2023

Introduction

Teacher self-efficacy is considered to be important for effective teaching, as well as for students' academic achievement and motivation (Lauermann & ten Hagen, 2021; Zee & Koomen, 2016). However, the instructional processes through which teacher self-efficacy relates to student motivation and emotions are far from clear. The few existing longitudinal studies show inconclusive results (Holzberger et al., 2013; Oppermann & Lazarides, 2021; Praetorius et al., 2017). Some longitudinal findings indicate that teacher self-efficacy indirectly relates to student interest through student-reported teacher support (Oppermann & Lazarides, 2021). Other longitudinal studies do not show significant relations between teacher self-efficacy and student-reported classroom management, learning support, or cognitive activation (Holzberger et al., 2013; Praetorius et al., 2017). A potential explanation for these inconsistent findings might be that teacher self-efficacy in these studies is assessed on a general level referring to different school-related tasks, such as social interaction with students or coping with job stress, and are thus not aligned with the teaching tasks under investigation. Prior conceptual work has pointed out that matching teacher motivation facets to teaching tasks might help explain the instructional processes that underlie the relations between aspects of teacher motivation and student motivation (Bardach & Klassen, 2021). Against this background, the present study aims to investigate longitudinally how specific teacher self-efficacy facets relate to students' self-efficacy and enjoyment via aligned student- and teacher-reported teaching quality characteristics.

Teachers' self-efficacy and perceived teaching quality

On a theoretical level, Fives and Buehl (2008, 2014) have indicated that teachers' beliefs filter information and guide their perceptions and actions in classrooms. Self-efficacy, defined as a person's conviction that he or she is capable of successfully performing an action in order to produce a certain outcome (Bandura, 1977), is one such belief, and is assumed to relate to teacher behavior. Teacher self-efficacy refers to teachers' belief in their ability to successfully perform teaching tasks, like engaging and motivating students to learn, even students who demonstrate challenging behaviors or experience academic difficulties (Tschannen-Moran & Woolfolk Hoy, 2001). Theoretically, teacher self-efficacy is assumed to affect teachers' cognitive, emotional, and motivational processes and, through these links, to drive and guide the teachers' instructional behaviors in class (Bandura, 1997). Through its effects on instructional behaviors, on a theoretical level, teachers' self-efficacy is proposed to indirectly affect student academic outcomes (Tschannen-Moran et al., 1998).

Theoretical work has indicated that self-efficacy should be assessed specifically in reference to the behavior of interest (Bandura, 2006; Pajares, 1996). Tschannen-Moran and Woolfolk Hoy (2001) accordingly define three facets of teacher self-efficacy: teacher self-efficacy for classroom management, for student engagement, and for instructional strategies. Zee and Koomen (2016) expanded this distinction between facets of the teacher self-efficacy construct by adding teacher self-efficacy for emotional support in order to have an aligned self-efficacy dimension for the social relationships that teachers create in their classrooms. In the present study, we focus on teacher self-efficacy for classroom management and for emotional support because we are interested in teacher competence beliefs that are interrelated with perceived social interactions in classrooms.

Teacher self-efficacy for classroom management is defined as teachers' beliefs regarding their ability to successfully manage classrooms and provide discipline and time to learn without disruptions (see e.g., Emmer & Stough, 2001; Pfitzner-Eden et al., 2014). On a theoretical level, it can be assumed that teachers who feel highly competent to manage students' behavior in challenging classroom situations are also likely to transform their beliefs into teaching behavior such as preventing disruptions and providing discipline because – according to Banduras' postulations about the nature of self-efficacy – they are more likely to set themselves higher goals and put more effort into achieving these goals (see e.g., Bandura, 1991). Empirically, these theoretical assumptions are supported by cross-sectional results which show that teacher self-efficacy for classroom management relates to rater-reported organization in class (Ryan et al., 2015) and to teacher-reported classroom management in terms of a disciplinary climate (Holzberger & Prestele, 2021). Accordingly, longitudinal research has shown that teacher self-efficacy for classroom management relates positively to class-level student-reported monitoring (Hettinger et al., 2021) and class-level student-perceived classroom discipline (Lazarides et al., 2022), and negatively to teacher-reported classroom disturbances (Dicke et al., 2014).

Teacher self-efficacy for emotional support comprises teachers' belief in their ability to maintain caring relationships with their students, acknowledge students' feelings, and create a secure class climate (Zee et al., 2016b). From a theoretical perspective, one might assume that teacher self-efficacy for emotional support relates to teacher-reported social relatedness – as teachers' beliefs matter for their aligned teaching behavior (Bandura, 1997; Pajares, 1996). According to self-determination theory (SDT), students experience relatedness when feeling a sense of belonging to their peers or teacher (Ryan & Deci, 2000). Thus, when teachers feel capable of developing caring relationships with their students, this can be expected to translate into actual warm and caring teaching behavior and then enhance students' perceptions of belonging to the class and their feelings of relatedness. Along with these theoretical links, cross-sectional research supports such relations by showing that teacher self-efficacy for emotional support relates to teacher-reported students' social–emotional behaviors such as prosocial behavior (Zee et al., 2016a). Longitudinally, findings have shown that teacher self-efficacy for emotional support relates positively to teacher-reported emotional closeness with students (Zee et al., 2017). However, existing studies do not take *both* – students' and teachers' – perceptions of teaching characteristics into account.

Perceived teaching quality and student motivation and emotion

The model of the three basic dimensions of Klieme et al. (2009) is an established theoretical framework to describe teaching quality, and distinguishes between three generic dimensions of high-quality teaching, namely classroom management, a supportive climate, and cognitive activation. In this study, we focus on the social interactions in classrooms and thus only include classroom management and a supportive climate. *Classroom management* involves establishing and maintaining order and effectively handling class discipline (Emmer & Stough, 2001; Praetorius et al., 2018). Discipline in class, in turn, is highly valuable for on-task behavior and thus for successful learning (Emmer & Stough, 2001). Other important aspects of classroom management include rule clarity, the absence of disruptions, and efficient use of time (Praetorius et al., 2018), resulting in greater productivity during lessons (Pianta & Hamre, 2009). Cross-sectional findings have shown that student-perceived classroom management positively relates to student self-efficacy (Burić

& Kim, 2020). Further results indicate that classroom management – assessed via student- and teacher-reported subscales – relates positively to class-level student enjoyment (Kunter et al., 2013). Longitudinal findings have revealed that class-level perceived classroom management does not significantly relate to student enjoyment (Lazarides & Buchholz, 2019). However, from a theoretical standpoint, links between structured learning experiences and student academic outcomes can be expected because structured classrooms provide students with learning opportunities without disruptions and thus more time on task, which might increase their enjoyment of the learning experience and foster self-efficacy beliefs by increasing mastery experiences.

A supportive climate in class is created when teachers care about students and encourage them to interact and support one another (Brophy, 2000). Further, it includes various aspects of teacher-student interaction such as positive, constructive feedback from the teacher and a positive approach to student errors and misconceptions (Lipowsky et al., 2009). In the present study, we examine social relatedness as one aspect of a supportive climate, which is described theoretically in SDT (Ryan & Deci, 2000) as a friendly class atmosphere in which everyone perceives belonging and closeness (Pianta, 1999). Given that experiencing relatedness enhances learners' motivation (Ryan & Deci, 2020), we consider it important to investigate social relatedness as a characteristic of a supportive climate with regard to student academic outcomes. Empirically, research has shown positive relations between student-perceived social relatedness and student- and class-level student enjoyment – both constructs were measured at the same measurement occasion (Hettinger et al., 2021). Furthermore, cross-sectional results have revealed that when students perceive themselves to belong to their peer group (as in school belongingness) they show high levels of self-efficacy (Zysberg & Schwabsky, 2021). Moreover, cross-sectional results show positive associations between student-perceived classroom discipline and student self-efficacy (Cheema & Kitsantas, 2014), and between student-perceived classroom management and student enjoyment (Chen & Lu, 2022). Longitudinal results indicate that student enjoyment is positively related to student-perceived peer support (Forsblom et al., 2021). Thus, meaningful relations between classroom discipline and social relatedness and student self-efficacy and enjoyment have been found by existing empirical work. However, little is known about the longitudinal pathways between these perceived teaching quality characteristics and student academic outcomes.

The present study

Currently, studies rarely investigate *longitudinally* how specific teacher self-efficacy facets relate to student motivation and emotion through theoretically aligned teaching quality dimensions (Bardach & Klassen, 2021; Lauermann & ten Hagen, 2021). In the present study, we match specific teacher self-efficacy facets with aligned teaching characteristics, assuming relations between teacher self-efficacy for classroom management and student- and teacher-reported classroom discipline, and between teacher self-efficacy for emotional support and student- and teacher-reported social relatedness. We include both students' *and* teachers' perspectives on teaching quality because student-reported characteristics of teaching quality are particularly strongly related to students' academic outcomes (Wagner et al., 2016), although they might be biased by relationships with teachers (Göllner et al., 2018), and teachers are reported to be particularly able to accurately describe teaching characteristics that relate to instructional settings (Clausen, 2002). The unique contribution of the present study to current research is that it (i) goes beyond prior research that often

assesses general teacher self-efficacy by investigating how two specific teacher self-efficacy facets – teacher self-efficacy for classroom management and for emotional support – relate to *conceptually aligned* student- and teacher-reported teaching practices; (ii) uses *longitudinal data* from three measurement occasions to examine indirect longitudinal relations in temporal order instead of relying on cross-sectional results; and (iii) includes *simultaneously* both student and teacher perceptions when examining teaching practices to analyze whose perceptions of teaching behavior matter regarding the relations between teacher self-efficacy and student self-efficacy and emotions. We focus on mathematics classrooms in this study because students' competence in this subject is a life skill enabling their participation in society (OECD, 2018). Against this background, we examine the following hypotheses:

H1: We expect that teacher self-efficacy facets (T1) will positively relate to aligned student- and teacher-reported teaching practices (T2) at the student and class levels.
H2: We expect that student- and teacher-reported teaching practices (T2) at the student and class levels will positively relate to students' self-efficacy and enjoyment (T3) at the student and class levels – however we expect stronger relations between student-reported teaching practices and students' self-efficacy and enjoyment compared to teacher-reported teaching practices.
H3: We expect that teacher self-efficacy facets (T1) will positively and indirectly relate to student self-efficacy and enjoyment (T3) through student- and teacher-reported teaching practices (T2) when controlling for previous levels of student mathematics self-efficacy and enjoyment at T1.

Empirical evidence has shown that students' mathematical competence is related to their self-efficacy (Kriegbaum et al., 2015). Further, research shows that boys report higher levels of enjoyment in mathematics (Frenzel et al., 2007). In regard to teacher characteristics, research indicates that teachers' professional knowledge matters for teaching practices (Lohse-Bossenz et al., 2015). Moreover, years of teaching experience are related with teaching behavior in classrooms (Graham et al., 2020). Research also shows that girls report better relationships with female teachers (Martin & Marsh, 2005). Given the importance of these variables for teaching behavior and student motivation and emotions, we include students' mathematics competence, students' gender, teachers' educational knowledge, teachers' years of experience, and teachers' gender as covariates in our models.

Method

Participants and procedure

Longitudinal data were drawn from the [removed for reviewing purposes] study.[1]

[1] This manuscript is based on the same data as other publications (Hettinger et al., 2021; Lazarides & Schiefele, 2021; Lazarides et al., 2022) of the [blinded for review purposes] project which are, however, concerned with different research questions and have different objectives. In a previous study, we also included teacher self-efficacy for classroom management (Hettinger et al., 2021), but focused on different research questions – thus, we did not examine how teacher self-efficacy for classroom management at T1 was related to student- and teacher-reported social relatedness and discipline at T2.

To recruit the sample, letters were sent out to all public schools at the secondary level in the federal states of Berlin and Brandenburg providing information about the study. Subsequently, research staff called all the school principals. Only schools that agreed to participate were included in the study. No compensation was given to participating teachers or students. From the original sample of the study ($N = 2095$), the present study, included only students who participated in the questionnaire assessments in at least two waves (T1 and T2 OR T2 and T3 OR T1 and T3), whose teachers filled in the teacher questionnaire at T1 and who kept the same mathematics teachers across all three measurement occasions. This selection process resulted in a subsample of 50 secondary school mathematics teachers (66.0% female; 94.0% born in Germany) and their 959 students (48.7% girls; $M_{age} = 14.20$, $SD = 0.62$; Range: 13–17 years; 91.7% born in Germany; 18.8% learned German as their second language) from 52 classrooms in 30 public schools in Germany (52.8% 'Gymnasium' academic track; 47.2% other types of schools). Two teachers taught in two classrooms instead of one. The average number of students per classroom was 18.44.

Student and teacher data were assessed in Fall 2019 (T1), Fall 2020 (T2), and Spring 2021 (T3). At each measurement occasion, students filled out questionnaires on student motivation, teacher motivation, and teaching quality in mathematics, and completed a standardized mathematics competence test. Teachers filled out a questionnaire on their teaching quality in mathematics, their motivation and beliefs, and student motivation, and completed a standardized knowledge test. Data collection was carried out by trained research assistants. All students and teachers were informed about the voluntary nature of their participation.

Students and teachers filled out their questionnaires simultaneously. One week after the questionnaire assessment, students took a standardized competence test, which was curriculum-sensitive for mathematics, while their teachers participated in a standardized knowledge test. Students and their teachers had approximately 40 min to complete the survey measures at each data assessment. The data assessments were carried out in congruence with the guidelines for empirical research in schools provided by the local authorities [removed for reviewing purposes]. The study was further approved by the ethics committee of the university.

Measures

Information on scale reliabilities and descriptive data are depicted in Table 1 for each measure. In this study, we included the facets of teacher self-efficacy for classroom management and for emotional support, as well as teacher knowledge (T1), students' enjoyment and self-efficacy (T1 and T3), and student- and teacher-reported classroom discipline and social relatedness (T2).

Teacher self-efficacy facets

We assessed two teacher self-efficacy facets: self-efficacy for classroom management and for emotional support. The measures of self-efficacy for classroom management (three items; e.g., "How certain are you that you can get students to follow classroom rules?") were translated from the established scale by Tschannen-Moran and Woolfolk Hoy (2001) with the minor adaptation of changing the word "children" to "students" in one item. Teacher self-efficacy for emotional support (three items; e.g., "How certain are you that you can adjust learning tasks to the students needs and interests?")

Table 1 Descriptive statistics: ranges, mean values, standard deviations, reliabilities, and intraclass correlations

	Range	*M*	*SD*	α	ICC(1)	ICC(2)		
L1: student level								
Classroom discipline T2	1–5	3.63	0.96	0.89	0.37	0.91		
Social relatedness Time 2	1–5	3.27	0.98	0.89	0.27	0.86		
Math enjoyment Time 1	1–5	2.47	1.01	0.87	0.15	0.75		
Math enjoyment Time 3	1–5	2.46	1.06	0.89	0.07	0.52		
Math self-efficacy Time 1	1–5	3.24	0.95	0.90	0.07	0.57		
Math self-efficacy Time 3	1–5	3.27	1.02	0.93	0.02	0.27		
Math competence Time 1	-*	0.01	1.48	-	-	-		
L2: Classroom Level	*Teacher-reported*					*Student-reported*		
	Range	*M*	*SD*	A		*M*	*SD*	α
Classroom discipline Time 2	1–5	4.17	0.70	0.86	-	3.55	0.63	0.98
Social relatedness Time 2	1–5	3.90	0.72	0.84	-	3.29	0.53	0.96
Self-efficacy for CM Time 1	1–5	4.02	0.68	0.90	-	-	-	-
Self-efficacy for ES Time 1	1–5	3.89	0.56	0.66	-	-	-	-
Teachers' knowledge Time 1	0–23	14.66	2.33	-	-	-	-	-
Math enjoyment Time 1	1–5	-	-	-	-	2.53	0.44	0.94
Math enjoyment Time 3	1–5	-	-	-	-	2.49	0.39	0.92
Math self-efficacy Time 1	1–5	-	-	-	-	3.22	0.34	0.93
Math self-efficacy Time 3	1–5	-	-	-	-	3.25	0.36	0.94
Math competence Time 1	-	-	-	-	-	-0.19	1.04	-

$N_{Teacher} = 50$, $N_{Students} = 959$. *CM* Classroom management; *ES* Emotional support. *The empirical range of the weighted likelihood estimate was -4.33 (Min.) to 4.46 (Max)

was assessed with a measure translated from the established scale of Zee et al. (2016b) starting with the phrase "How certain are you that you can…" for all three items. The answering format ranged from 1 (*not certain at all*) to 5 (*totally certain*).

Student- and teacher-reported teaching quality

Students' and teachers' reports of teaching quality were assessed with equivalently worded items. Classroom discipline was assessed using four items (e.g., student measure: "It's often noisy and chaotic in class"; teacher measure: "In my mathematics lessons in this class it's noisy and chaotic") from Hertel et al. (2014) from the students' perspective and adapting them to the teachers' perspective. Based on Kramer (2002) and Rakoczy (2006), we used five items for social relatedness (e.g., student measure: "Our teacher promotes a sense of class community"; teacher measure: "I promote a sense of class community"). The answering format for all items ranged from 1 (*does not apply at all*) to 5 (*fully applies*). Both students and teachers were asked to think about their mathematics lessons when responding to the statements. The wording of the introduction phrase read for students "To what extent do the following statements apply to your mathematics lessons?" and for teachers "Do the following statements apply to your mathematics class?".

Student enjoyment in mathematics

Student mathematics enjoyment was measured using four items (e.g., "I'm looking forward to mathematics lessons") from Ramm et al. (2006). The answering format ranged from 1 (*does not apply at all*) to 5 (*fully applies*).

Student mathematics self-efficacy

Student mathematics self-efficacy was assessed with four items (e.g., "I'm convinced that I can master the skills which are taught in mathematics") given by Ramm et al. (2006). The answering format ranged from 1 (*does not apply at all*) to 5 (*fully applies*).

Covariates

Teachers' educational knowledge was assessed by the "classroom instruction" subscale (23 multiple-choice items) from a teachers' standardized knowledge test (Kunina-Habenicht et al., 2020). In the present study, the original version of the knowledge test was used, which was developed in the German language. Test item responses were summed up to a final score, which indicated the individual knowledge level. The test scores of the present study ranged from 9.50 to 19.50 (Range: 0 – 23) with satisfactory reliability ($\omega = 0.62$).

Students' mathematics competence was measured by a curriculum-sensitive standardized test which was developed in cooperation with the Institute for Educational Quality Improvement (IQB), Germany. Test responses were scaled by means of item response analysis, resulting in weighted likelihood estimates (WLEs) as person parameters. A composite reliability[2] was computed through comparison of averaged square standard errors to the trait score variance – here, the test score variance. The mathematics competence test demonstrated a good level of reliability in the present study ($r = 0.84$).

Teachers' years of work experience were measured with the question: "How long have you been teaching? Please state the number of years teaching."

Teachers' gender (1 = male; 2 = female) and *students' gender* (0 = male; 1 = female) were also included in the analyses.

Statistical analyses

Given that we used longitudinal and hierarchically structured data with students nested in classrooms, we conducted multilevel modelling. At the student level (L1), we included student mathematics enjoyment or student mathematics self-efficacy (T1 and T3), student-perceived classroom discipline and social relatedness (T2), and students' mathematics competence (T1) and student gender as covariates. At the classroom level (L2), teacher-reported self-efficacy for classroom management and for emotional support (T1), student-perceived and teacher-reported classroom discipline and social relatedness (T2),[3] and student enjoyment or student self-efficacy (T3) were included, controlling for student enjoyment or student self-efficacy at T1. We included years of teaching experience, teachers' gender,

[2] For the formula, see e.g., Embretson and Reise (2000, p.18).

[3] Negatively worded classroom discipline items were recoded before the analyses.

teachers' educational knowledge, and classroom aggregates of students' mathematics competence as covariates at the class level.

Prior to analysis, we carried out data cleaning, analzsed outliers, and performed missing data analyses. In order to test our hypotheses, we performed analyses using the latent-manifest approach (Marsh et al., 2009). Thus, at the student level (L1) and classroom level (L2), the constructs were included as latent factors involving multiple factor indicators. This approach allowed us to control for measurement error. At the classroom level, the multiple item indicators for each latent factor were manually aggregated at the group level. In line with Marsh et al (2009), the latent-manifest approach is useful in small samples. Because we had an appropriate but still relatively small sample size of 50 groups (L2) for multilevel analysis (Maas & Hox, 2005), we decided to apply the latent-manifest approach. All latent variables were allowed to correlate within time points. Students' enjoyment and self-efficacy (T1) and student-reported classroom discipline and social relatedness (T2) at the student level were group-mean-centered (Marsh et al., 2009). Due to the complexity of the data, we tested four separate models: Model 1 tested the interrelations among teacher self-efficacy for classroom management, teacher- and student-reported classroom discipline, and student enjoyment; Model 2 tested the interrelations among teacher self-efficacy for classroom management, teacher- and student-reported classroom discipline, and student self-efficacy; Model 3 tested the interrelations among teacher self-efficacy for emotional support, teacher- and student-reported social relatedness, and student enjoyment; and Model 4 tested the interrelations among teacher self-efficacy for emotional support, teacher- and student-reported social relatedness, and student self-efficacy.

Intraclass correlations (ICC) were calculated for students' enjoyment, students' self-efficacy, and student-perceived teaching quality (Raudenbush & Bryk, 2002). ICC_1 describes the observed rating variance among students due to their group membership, thus an ICC_1 greater than 0.05 indicates that more than 5% of the variance in individual ratings can be attributed to group membership (LeBreton & Senter, 2008). ICC_2 reflects the class-mean ratings accuracy and should be above 0.70 (LeBreton & Senter, 2008). The average reliability of the class mean ratings were low for students' enjoyment at T3, self-efficacy at T1, and self-efficacy at T3 (see Table 1 for an overview of all ICC values). Thus, the results show that only 7% of students' enjoyment at T3 and 2% of the variance in students' self-efficacy at T3 were attributable to students' classroom membership. However, achievement emotions and other motivational-affective characteristics frequently have low ICC values (e.g., Goetz et al., 2021). Further, there are no standard values for acceptable reliability using ICC (Koo & Li, 2016), as a low ICC value might reflect a low degree of rater agreement, but may also be caused by a lack of variability among the sampled subjects, or by the small number of cases per group (Lee et al., 2012). According to the statistical literature, ignoring an ICC – even if it is small – can lead to underestimation of standard errors (Murray et al., 2004). Given these considerations, the variables with low ICC values remained in the present analyses. All ICC_1 and ICC_2 values are reported in Table 1.

Before conducting longitudinal multilevel analyses, we performed invariance testing across levels and time for student-reported enjoyment and student self-efficacy, and invariance testing across levels for student-reported classroom discipline and social relatedness. Results confirmed the strong factorial invariance of constructs in this study (see Appendix 1, Tables 4, 5, and 6). All analyses were carried out with M*plus* 8.6 using a maximum likelihood estimator with robust standard errors and chi-squares (Muthén & Muthén, 1998–2017). We handled missing data by using full-information maximum likelihood estimation. We were interested in how teacher motivation might transfer to students' emotion and motivation through perceived teaching quality at both the student

Table 2 Manifest bivariate correlations among all study variables at the student level

	1	2	3	4	5	6	7
1. Classroom discipline Time 2	-						
2. Social relatedness Time 2	0.19**	-					
3. Mathematics enjoyment Time 1	0.11*	0.31***	-				
4. Mathematics enjoyment Time 3	0.16***	0.35***	0.56***	-			
5. Mathematics self-efficacy Time 1	0.13**	0.19***	0.50***	0.42***	-		
6. Mathematics self-efficacy Time 3	0.17***	0.24***	0.35***	0.54***	0.57***	-	
7. Girls[a]	0.05	0.02	−0.02	−0.03	−0.17***	−0.12**	-
8. Mathematics competence Time 1	0.19**	0.07	0.07	0.15***	0.31***	0.36***	0.01

$N = 959$. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-tailed; [a]students' gender: male = 0, female = 1

and class levels, which is why we analysed cross-level mediation effects (Pituch & Stapleton, 2012). Goodness of model fit was evaluated by applying the following criteria (Tanaka, 1993): Yuan-Bentler scaled χ^2 (YB χ^2, mean-adjusted test statistic robust to non-normality), comparative fit index (CFI), Tucker and Lewis index (TLI), root mean square of approximation (RMSEA), and standardized root mean residual (SRMR). TLI and CFI values greater than 0.95 (Hu & Bentler, 1999), RMSEA values lower than 0.06, and SRMR values lower than 0.08 (Hu & Bentler, 1999) were considered indicators of sufficient model fit.

Results

Descriptive statistics and correlations

Descriptive statistics for the variables of the present study are reported in Table 1. All manifest bivariate correlations are reported in Tables 2 and 3. At the classroom level, teacher self-efficacy for classroom management (T1) was significantly and positively associated with both student and teacher perceptions of classroom discipline (Time 2). Teacher self-efficacy for emotional support (Time 1) was significantly and positively associated with student-reported and teacher-reported social relatedness (Time 2). Student-reported classroom discipline (Time 2), in turn, was significantly and positively associated with student self-efficacy and enjoyment (Time 3). However, teacher-reported classroom discipline (T2) was not significantly associated with student self-efficacy or enjoyment (Time 3). Student- and teacher-reported social relatedness (Time 2) were significantly and positively associated with student enjoyment (Time 3), but was not significantly associated with student self-efficacy (Time 3). Student-reported classroom discipline was significantly and positively associated with teacher-reported classroom discipline. Student-reported social relatedness was significantly and positively associated with teacher-reported social relatedness. Moreover, the teacher self-efficacy facets for classroom management and emotional support were significantly and positively interrelated. At the student level, student perceptions of classroom discipline (Time 2) and social relatedness (Time 2) were significantly and positively associated with both student self-efficacy and enjoyment (Time 3).

Table 3 Manifest bivariate correlations among variables at the classroom level

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Classroom discipline Time 2 (T)	-												
2. Social relatedness Time 2 (T)	0.36**	-											
3. Self-efficacy for CM Time 1 (T)	0.67***	0.35**	-										
4. Self-efficacy for ES Time 1 (T)	0.33**	0.46***	0.40**	-									
5. Teachers' knowledge Time 1 (T)	0.20	−0.07	−0.05	0.04	-								
6. Classroom discipline Time 2 (S)	0.78***	0.26*	0.51***	0.23	0.18	-							
7. Social relatedness Time 2 (S)	0.17	0.44***	0.18	0.44***	−0.03	0.30	-						
8. Mathematics enjoyment Time 1 (S)	0.21*	0.21	0.16	0.21	−0.28*	0.23*	0.41***	-					
9. Mathematics enjoyment Time 3 (S)	0.15	0.28*	0.13	0.14	−0.31**	0.33**	0.48***	0.53***	-				
10. Mathematics self-efficacy Time 1 (S)	0.01	0.12	−0.01	−0.05	−0.07	0.28*	0.16	0.40***	0.36**	-			
11. Mathematics self-efficacy Time 3 (S)	0.07	0.01	0.11	0.17	−0.01	0.27*	0.09	0.08	0.38***	0.63***	-		
12. Mathematics competence Time 1 (S)	0.22	−0.06	0.04	−0.02	0.21	0.39***	−0.10	−0.11	0.01	0.46***	0.55***	-	
13. Female teachers[a]	−0.02	−0.05	−0.16	−0.23	0.18	−0.01	−0.13	−0.34**	−0.10	−0.12	0.01	−0.04	-
14. Teacher work experience (T)	0.24	−0.01	0.09	0.04	0.15	0.37**	−0.11	0.01	0.11	0.18	0.24	0.23	0.34**

Note. $N_{Teachers} = 50$, $N_{Classrooms} = 52$. Classroom level; * $p < 0.05$, ** $p < 0.01$,***, $p < 0.001$, two-tailed. *S* Student-reported; *T* Teacher-reported, [a] teachers' gender: male = 1, female = 2, *CM* Classroom management; *ES* Emotional support

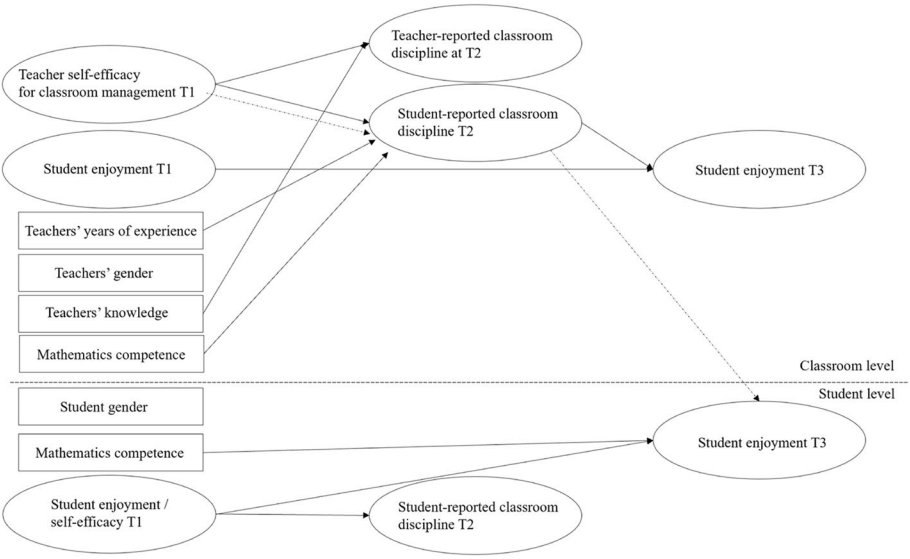

Fig. 1 Model 1: interrelations among teacher self-efficacy for classroom management, student- and teacher-reported classroom discipline, and student enjoyment. *Note.* Solid arrows are significant direct paths. Dashed arrows are significant indirect paths. Only significant regression coefficients are depicted. All covariates and T1 constructs are allowed to correlate

Teachers' self-efficacy facets, aligned perceived teaching practices, and students' motivation

In the following section, we only report significant standardized regression parameters structured alongside the teachers' self-efficacy facets. The complete set of standardized coefficients for each of the models is reported in Appendix 2 (see Tables 7, 8, 9, and 10). A schematic depiction of Models 1 – 4 is provided in Figs. 1, 2, 3, and 4.

Results of Model 1 showed that *teachers' self-efficacy for classroom management* at T1 positively and significantly related to teacher-reported classroom discipline at T2. ($\beta = 0.70$, $SE = 0.12$, $p < 0.001$; [CI 95% 0.474 0.933]) and to student-reported classroom discipline at T2 ($\beta = 0.46$, $SE = 0.11$, $p < 0.001$; [CI 95% 0.240 0.684]). Student-reported classroom discipline at T2 positively and significantly related to student enjoyment at T3 ($\beta = 0.66$, $SE = 0.30$, $p = 0.028$; [CI 95% 0.070 1.251]). We found a unique class-level indirect effect from teachers' self-efficacy for classroom management at T1 to class-level enjoyment at T3 through class-level student-reported classroom discipline at T2 ($b$ind $= 0.15$, $SE = 0.08$, $p = 0.050$; [CI 95% 0.000 0.303]). The model fit was good, χ^2 (df) = 5327.31 (276). CFI/ TLI = 0.97/0.96, RMSEA = 0.028, SRMRwithin/between = 0.024/0.087.

Results of Model 2 showed that *teachers' self-efficacy for classroom management* at T1 positively and significantly related to teacher-reported classroom discipline at T2 ($\beta = 0.72$, $SE = 0.12$, $p < 0.001$; [CI 95% 0.483 0.956]), as well as to student-reported classroom discipline at T2 ($\beta = 0.50$, $SE = 0.10$, $p < 0.001$; [CI 95% 0.300 0.709]). The model fit was acceptable, χ^2 (df) = 7758.61 (344), CFI/ TLI = 0.94/0.92, RMSEA = 0.042, SRMRwithin/between = 0.027/0.124.

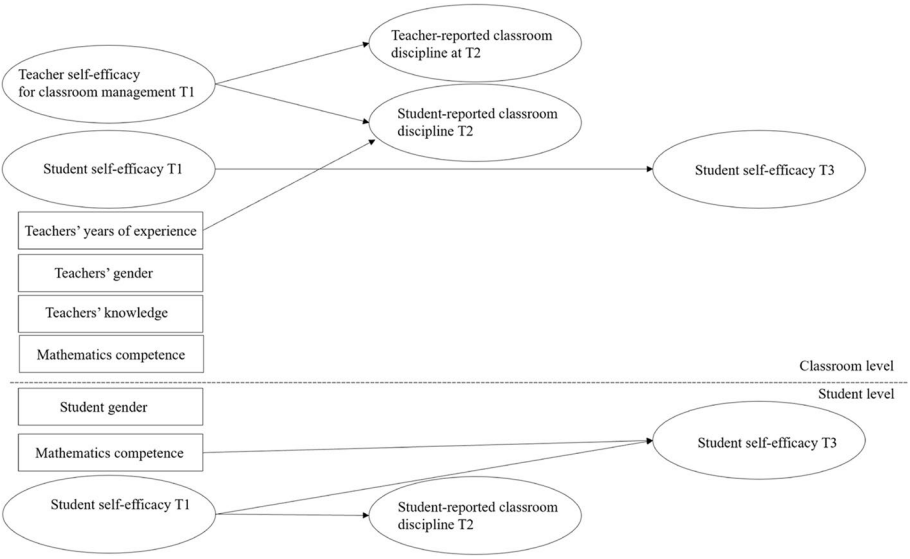

Fig. 2 Model 2: interrelations among teacher self-efficacy for classroom management, student- and teacher-reported classroom discipline, and student self-efficacy. *Note.* Solid arrows are significant direct paths. Only significant regression coefficients are depicted. All covariates and T1 constructs are allowed to correlate

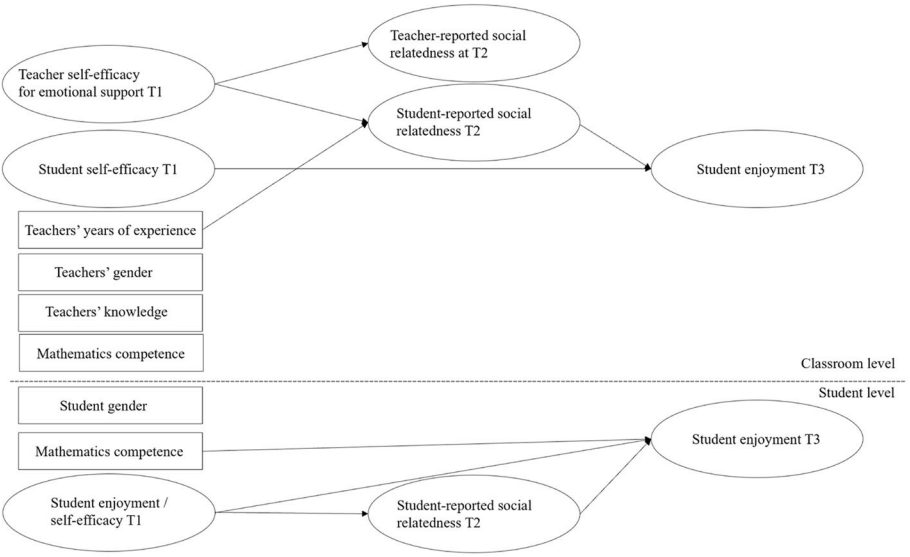

Fig. 3 Model 3: interrelations among teacher self-efficacy for emotional support, student- and teacher-reported social relatedness, and student enjoyment. *Note.* Solid arrows are significant direct paths. Only significant regression coefficients are depicted. All covariates and T1 constructs are allowed to correlate

Results of Model 3 showed that *teachers' self-efficacy for emotional support* at T1 positively and significantly related to both teacher-reported ($\beta = 0.66$, $SE = 0.15$, $p < 0.001$; [CI 95% 0.368 0.945]) and student-reported social relatedness at T2 ($\beta = 0.55$,

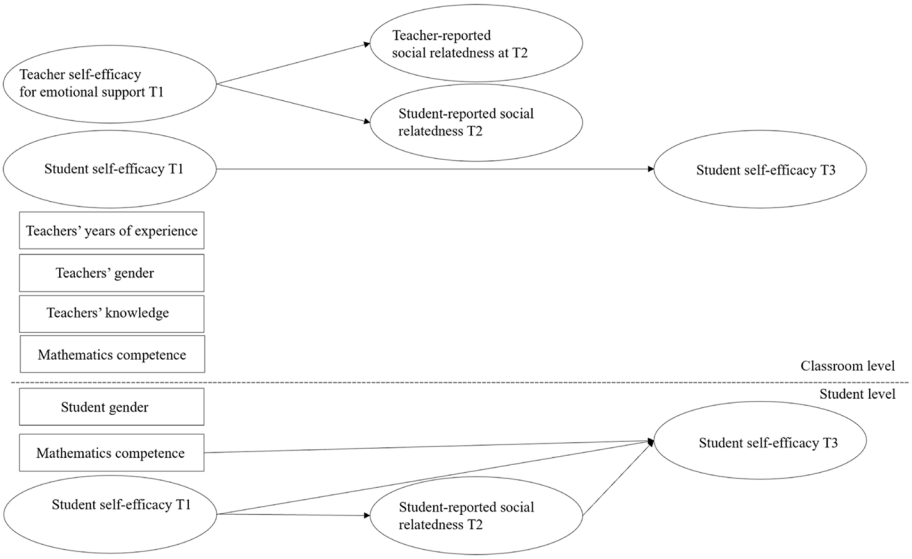

Fig. 4 Model 4: interrelations among teacher self-efficacy for emotional support, student- and teacher-reported social relatedness, and student self-efficacy. *Note.* Solid arrows are significant direct paths. Only significant regression coefficients are depicted. All covariates and T1 constructs are allowed to correlate

SE = 0.14, $p < 0.001$; [CI 95% 0.277 0.826]). Student-reported social relatedness at T2 in turn related to student enjoyment at T3 at the classroom level (β = 0.49, *SE* = 0.13, $p < 0.001$; [CI 95% 0.234 0.740]). The model fit was good, χ^2 (*df*) = 5985.92 (331), CFI/TLI = 0.96/0.95, RMSEA = 0.030, SRMRwithin/between = 0.024/0.099.

Results of Model 4 showed that *teachers' self-efficacy for emotional support* at T1 positively and significantly related to both teacher-reported (β = 0.68, *SE* = 0.14, $p < 0.001$; [CI 95% 0.418 0.950]) and student-reported social relatedness at T2 (β = 0.62, *SE* = 0.13, $p < 0.001$; [CI 95% 0.358 0.874]). Individual (not class-level) student reports of social relatedness related to their self-efficacy at T3 (β = 0.15, *SE* = 0.04, $p = 0.001$; [CI 95% 0.063 0.227]). The model fit was good, χ^2 (*df*) = 8327.43 (405), CFI/TLI = 0.95/0.94, RMSEA = 0.035, SRMRwithin/between = 0.028/0.130.

Discussion

This study aimed to examine longitudinally how specific teacher self-efficacy facets relate through theoretically aligned teaching quality facets to student self-efficacy and enjoyment. We found a pathway from teacher self-efficacy for classroom management to student enjoyment through student-reported classroom discipline. Teacher self-efficacy for emotional support substantially related to student-reported social relatedness, which in turn related to student enjoyment, but indirect effects were not significant.

Teachers' self-efficacy and perceived teaching

According to our hypothesis (H1), each teacher self-efficacy facet related positively to the aligned *student- and teacher-reported* teaching behavior. Our results show that matching teacher motivation constructs with theoretically aligned teaching practices helps to better understand instructional processes (Bardach & Klassen, 2021) because, in contrast to prior studies that did not show longitudinal links between teacher self-efficacy assessed at a general level and student-reported teaching support (Holzberger et al., 2013; Praetorius et al., 2017), we found consistent effects of specific teacher self-efficacy facets on aligned teaching practices. In line with prior research (Lauermann & Berger, 2021; Lazarides & Schiefele, 2021), in each of our four models, teacher self-efficacy beliefs revealed greater effect sizes for the relations between teacher self-efficacy and *teachers' perception* of their own teaching practices compared to students' perception of the same teaching practices. One reason for this finding might be, from a methodological standpoint, the common method bias (Podsakoff et al., 2003) – assessing the teachers' efficacy beliefs and behavior from the same source. Interestingly, our findings showed that teachers' and students' perceptions of teaching were strongly associated with one another for classroom discipline (0.78, see Table 3) and comparatively weakly for social relatedness (0.44, Table 3). Classroom discipline items assessed disturbances in the social interactions among the group of students that were maybe easy to capture for both students and teachers ("It's often noisy and chaotic in class"), whereas social relatedness items referred to the social atmosphere in class ("Our teacher creates a friendly and relaxed atmosphere in class"), which might be more subjective and provide more room for interpretation. Lauermann and ten Hagen (2021) describe in their review on teachers' competence beliefs that "The more closely aligned teachers' and students' perceptions of the teacher's instructional practices are, the more likely it is for these practices to function as a channel through which teachers' competence beliefs affect students" (p. 12). In this study, we accordingly showed that indirect effects were significant for the classroom discipline model with enjoyment, in which teacher self-efficacy for classroom management was indirectly linked to students' class-level enjoyment via students' class-level perceptions of classroom discipline. Thus, it appears that the benefit obtained from including both perspectives of a rather clearly perceivable and less ambiguous teaching quality dimension (such as discipline) leads to uncovering mediational pathways; however, when considering less clearly perceivable teaching quality dimensions (such as social relatedness) mediational links seem unclear. Consequently, the question remains unanswered as to how to assess the less clearly perceivable mediating teaching practice in order to uncover the relations between teacher self-efficacy and student motivation.

Perceived teaching and students' motivation

Partly in line with our expectations (H2), student- but not teacher-reported teaching quality related to student enjoyment and self-efficacy. Discipline as perceived by the group mattered for class-level enjoyment. Moreover, individual evaluations of social relatedness were linked to individual student self-efficacy, whereas individual and class-mean aggregated student perceptions of social relatedness related to individual and class-level enjoyment. Thus, group-level processes seemed to matter more for students' enjoyment than for their self-efficacy. Further, our findings support previous work suggesting that particularly

students' perspective on teaching practices matters for their academic development (see e.g., Wagner et al., 2016). It is also interesting that student-reported class-level discipline related to the class mean of student enjoyment, whereas especially individual student perceptions of social relatedness appear to matter for their self-efficacy. One possible explanation might be that classroom discipline is rather perceived in the context of a group experience and therefore as relating to class-level enjoyment in a shared environment, whereas the individual perceptions of being part of a social group encourages the growth of students' *own* efficacy beliefs in mathematics.

Indirect relations between teacher self-efficacy and student motivation and emotions

The main aim of this study was to investigate potential indirect effects of teacher self-efficacy and student self-efficacy and enjoyment via perceived teaching practices. Partly confirming our assumptions (H3), results showed significant indirect relations. Teacher self-efficacy for classroom management related to student class-level enjoyment through group-level perceived classroom discipline via a unique class-level indirect effect – thus indicating the indirect impact of teacher self-efficacy on student enjoyment via the average level of students' discipline in the classroom. This result indicates that it is beneficial to consider multiple levels of analysis to gain a more detailed understanding of how teacher self-efficacy facets relate to students' academic ourcomes through perceived instruction practices. In the present study, teacher self-efficacy for classroom management indirectly was related to the average level of students' enjoyment in the classroom through classroom discipline as perceived by the group of students in class. Possible processes underlying this pathway might be that teachers who believe in their ability to efficiently create a calm, quiet, and disruption-free learning environment set themselves realistic goals with regard to the management of their classrooms, invest substantial effort into reaching these goals, even in difficult teaching situations, and thus are more likely to create a calm and effective learning environment in which students have enough time to learn, feel respected by the group, and thus enjoy learning in class.

Extending previous longitudinal results that did not find significant indirect effects of teacher self-efficacy for classroom management at the beginning of the school year on student enjoyment at mid-year through student-reported monitoring at mid-year (Hettinger et al., 2021), the present study's findings are based on and thus consider three waves of data, and the classroom effects had more time to become established over two school years (1.5 years). From a theoretical perspective, this study contributes to the current understanding of whether highly self-efficacious teachers demonstrate efficient teaching practices for students to perceive as a group or whether teaching practices are more likely perceived by individuals, as well as how such perceptions relate to their individual- or class-level means of enjoyment and self-efficacy. Therefore, these results underline the impotance of differentiating between perceived teaching quality dimensions (Klieme et al., 2009) with regard to the relevance for groups of students or individual students. Moreover, the results add knowledge to the complex question of under which circumstances the specific teacher self-efficacy beliefs matter for student academic outcomes (Bardach & Klassen, 2021) like self-efficacy and enjoyment. Therefore, conceptually, this study contributed to current work by showing how the "temporal precedence of predictors can be established" (Zee & Koomen, 2016, p.1010) when it comes to the relations between specific teacher self-efficacy facets and student self-efficacy and enjoyment.

Limitations and future research

There are a few limitations that need to be considered when interpreting these results. First, we focused on self-reported data for teacher self-efficacy, perceived teaching quality, and student self-efficacy and enjoyment. Relying on student reports of instruction, however, can be criticized because students lack pedagogical expertise regarding the correct evaluation of certain classroom processes and their evaluations of teaching quality are biased by their relationships with specific teachers (Göllner et al., 2018), whereas teacher reports have been shown to often fail in correctly estimating the tempo in class (Kunter & Baumert, 2006). Consequently, future studies should consider objectively measured teaching quality in mathematics classrooms – as student and teacher ratings have their weaknesses.

Second, we did not include moderating variables like student or classroom characteristics. Current research, however, shows that learners in classrooms with, for example, a highly heterogeneous language background perceived being especially cognitively challenged when their teachers pursued an individual reference norm orientation (Hachfeld & Lazarides, 2020). Similar effects might also be plausible for the investigated relations of this study. Thus, future research might investigate transmitting effects from teacher self-efficacy beliefs and students' self-efficacy and enjoyment with regard to class composition variables such as students' socio-economical status or language background.

Third, another limitation pertains to the items for classroom discipline and relatedness, as both teaching quality dimensions include additional subfacets like, for example, rule clarity or monitoring (for classroom management) and student–teacher relationships (for relatedness), which need to be examined in future studies.

Conclusions

In the present study, we show that teacher self-efficacy for classroom management and for emotional support relate longitudinally to aligned student- and teacher-reported classroom discipline and social relatedness, and students' perceptions in turn relate to their self-efficacy and enjoyment. We provide initial insights into mediational effects at the student and class levels and thus extend existing research by identifying processes that provide a more detailed understanding of the levels of perception through which teacher self-efficacy relates to students' self-efficacy and enjoyment. This is important, because it provides insights into the origins of the relations between how and through which pathways teacher self-efficacy can relate to student self-efficacy and enjoyment. We also address the question of whose perception matters for students' characteristics – the teachers' or the students' view of teaching quality. A practical implication of our finding that the students' perspective on teaching quality matters most for students' academic outcomes might be that teachers need to strengthen their evaluation practices and assess their students' feedback on their lessons regularly. Further, our findings indicate that in teacher training and professional development teachers' self-efficacy should be fostered in addition to their educational knowledge. This could be realized by implementing systematic mastery experiences in university courses, for example, fostering supervised practical experiences in schools early in teacher education, or reflecting on critical situations in classrooms collaboratively as part of teachers' professional routines. Our findings contribute to current theoretical work by differentiating between the effects of specific teacher self-efficacy facets, which helps determine how teachers may

efficiently support students' academic development. Our findings support the assumption that a matching of aligned teacher motivation and teaching-quality constructs is important when aiming to better understand the role that teacher self-efficacy plays for teaching quality and student outcomes.

Appendix 1

Table 4 Level and time invariance testing of student-reported mathematics enjoyment (T1 and T3)

Step	χ^2	*df*	CFI	Δ CFI	RMSEA	ΔRMSEA	SRMRb	ΔSRMRb
1	64.856	16	0.984		0.056		0.021	
2	76.885	22	0.982	−0.002	0.051	−0.005	0.160	0.139
3	92.314	28	0.979	−0.003	0.049	−0.002	0.144	−0.016

CFI Comparative fit index; *RMSEA* Root mean square error of approximation; *SRMRb* Standardized root mean square residual for between level; 1 = no constrained parameters; 2 = factor loadings constrained to be invariant across levels and across time; 3 = intercepts constrained to be invariant across levels and across time

Table 5 Level and time invariance testing of student-reported mathematics self-efficacy (T1 and T3)

Step	χ^2	*df*	CFI	Δ CFI	RMSEA	ΔRMSEA	SRMRb	ΔSRMRb
1	157.082	29	0.969		0.068		0.055	
2	184.949	38	0.964	−0.005	0.064	−0.004	0.213	0.158
3	215.048	47	0.959	−0.005	0.061	−0.003	0.215	0.002

CFI Comparative fit index; *RMSEA* Root mean square error of approximation; *SRMRb* Standardized root mean square residual for between level; 1 = no constrained parameters; 2 = factor loadings constrained to be invariant across levels and across time; 3 = intercepts constrained to be invariant across levels and across time

Table 6 Level invariance testing of student-reported teaching quality characteristics

Step	χ^2	*df*	CFI	Δ CFI	RMSEA	ΔRMSEA	SRMRb	ΔSRMRb
1	132.343	52	0.983		0.042		0.076	
2	142.102	59	0.983	0.000	0.040	−0.002	0.093	0.017
3	157.997	66	0.981	−0.002	0.040	0.000	0.092	−0.001

CFI Comparative fit index; *RMSEA* Root mean square error of approximation; SRMRb = standardized root mean square residual for between level; 1 = no constrained parameters; 2 = factor loadings constrained to be invariant across levels and across time; 3 = intercepts constrained to be invariant across levels and across time

Appendix 2

Table 7 Model 1: standardized regression coefficients for teacher self-efficacy for classroom management relating to perceived classroom discipline and enjoyment

Classroom level	Classroom discipline (S) T2			Classroom discipline (T) T2			Mathematics enjoyment T3		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Teacher self-efficacy CM T1	**0.46**	**(0.11)**	**0.000**	**0.70**	**(0.12)**	**0.000**			
Mathematics competence test	**0.30**	**(0.10)**	**0.002**	0.13	(0.11)	0.233	−0.29	(0.18)	0.111
Teachers' years of experience	**0.22**	**(0.11)**	**0.042**	0.11	(0.12)	0.358	0.06	(0.15)	0.694
Female teachers[a]	0.07	(0.10)	0.475	0.11	(0.13)	0.379	0.09	(0.16)	0.576
Teacher educational knowledge	0.15	(0.12)	0.217	**0.25**	**(0.12)**	**0.040**	−0.14	(0.15)	0.334
Mathematics enjoyment T1	**0.27**	**(0.10)**	**0.008**	0.22	(0.12)	0.061	**0.56**	**(0.16)**	**0.000**
Classroom discipline (S) T2							**0.66**	**(0.30)**	**0.028**
Classroom discipline (T) T2							−0.36	(0.29)	0.204
R^2	0.54			0.68			0.66		
Student level	Classroom discipline (S) T2			Mathematics enjoyment T3					
	β	*SE*	*p*	β			*SE*		*p*
Mathematics competence test	0.04	(0.03)	0.248	**0.11**			**(0.05)**		**0.038**
Girls[b]	0.02	(0.04)	0.623	−0.03			(0.03)		0.381
Classroom discipline T2				0.04			(0.04)		0.401
Mathematics enjoyment T1	**0.13**	**(0.05)**	**0.004**	**0.62**			**(0.03)**		**0.000**
R^2	0.02			0.43					
χ^2 (*df*)	5327.31 (276)								
CFI/ TLI	0.97/0.96								
RMSEA/ $SRMR_{within/between}$	0.028/0.024/0.087								

$N_{Teacher}$ = 50, $N_{Students}$ = 959. S = student-reported, T = teacher-reported; [a]Teachers' gender: male = 1, female = 2; [b]Students' gender: male = 0, female = 1; T1 = T1, T2 = T2, T3 = T3, *CM* Classroom management. Bold values are significants

Table 8 Model 2: standardized regression coefficients for teacher self-efficacy for classroom management relating to perceived classroom discipline and self-efficacy

Classroom level	Classroom discipline (S) T2			Classroom discipline (T) T2			Mathematics self-efficacy T3		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Teacher self-efficacy CM T1	**0.50**	**(0.10)**	**0.000**	**0.72**	**(0.12)**	**0.000**			
Mathematics competence test	0.21	(0.12)	0.080	0.16	(0.15)	0.290	−0.24	(0.28)	0.385
Teachers' years of experience	**0.26**	**(0.11)**	**0.013**	0.17	(0.12)	0.176	0.20	(0.17)	0.221
Female teachers[a]	−0.02	(0.11)	0.826	0.01	(0.14)	0.986	0.16	(0.16)	0.294
Teacher educational knowledge	0.12	(0.13)	0.334	0.19	(0.12)	0.100	0.09	(0.22)	0.691
Mathematics self-efficacy T1	**0.15**	**(0.13)**	**0.228**	−0.06	(0.14)	0.663	**0.96**	**(0.25)**	**0.000**
Classroom discipline (S) T2							−0.17	(0.81)	0.839
Classroom discipline (T) T2							0.21	(0.69)	0.758
R^2	0.52			0.65			0.81		
Student level	Classroom discipline (S) T2			Mathematics self-efficacy T3					
	β	*SE*	*p*	β				*SE*	*p*
Mathematics competence test	0.03	(0.04)	0.353	**0.20**				**(0.06)**	**0.001**
Girls[b]	0.05	(0.04)	0.277	−0.03				(0.03)	0.291
Classroom discipline T2				0.05				(0.05)	0.266
Mathematics self-efficacy T1	**0.13**	**(0.05)**	**0.004**	**0.55**				**(0.05)**	**0.000**
R^2	0.02			0.41					
χ^2 (*df*)	7758.61 (344)								
CFI/ TLI	0.94/0.92								
RMSEA/ $SRMR_{within/between}$	0.042/0.027/0.124								

$N_{Teacher} = 50$, $N_{Students} = 959$. S = student-reported, T = teacher-reported; [a]Teachers' gender: male = 1, female = 2; [b]Students' gender: male = 0, female = 1; T1 = T1, T2 = T2, T3 = T3, *CM* Classroom management. Bold values are significant

Table 9 Model 3: standardized regression coefficients for teacher self-efficacy for emotional support relating to perceived social relatedness and enjoyment

Classroom level	Social relatedness (S) T2			Social relatedness (T) T2			Mathematics enjoyment T3		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Teacher self-efficacy ES T1	**0.55**	**(0.14)**	**0.000**	**0.67**	**(0.15)**	**0.000**			
Mathematics competence test	0.01	(0.12)	0.933	−0.02	(0.14)	0.892	−0.09	(0.16)	0.559
Teachers' years of experience	−0.25	(0.16)	0.108	−0.17	(0.18)	0.351	0.23	(0.14)	0.085
Female teachers[a]	0.20	(0.16)	0.200	0.11	(0.21)	0.610	0.03	(0.15)	0.849
Teacher educational knowledge	−0.01	(0.13)	0.958	−0.05	(0.17)	0.774	−0.21	(0.14)	0.154
Mathematics enjoyment T1	**0.37**	**(0.16)**	**0.019**	0.17	(0.22)	0.440	**0.44**	**(0.17)**	**0.008**
Social relatedness (S) T2							**0.49**	**(0.13)**	**0.000**
Social relatedness (T) T2							−0.02	(0.18)	0.934
R^2	0.48			0.47			0.73		
Student level	Social relatedness (S) T2			Mathematics enjoyment T3					
	β	*SE*	*p*	β				*SE*	*p*
Mathematics competence test	0.04	(0.04)	0.213	**0.11**				**(0.05)**	**0.031**
Girls[b]	0.01	(0.04)	0.830	−0.03				(0.03)	0.363
Social relatedness T2				**0.16**				**(0.04)**	**0.000**
Mathematics enjoyment T1	**0.34**	**(0.04)**	**0.000**	**0.57**				**(0.04)**	**0.000**
R^2	0.12			0.45					
χ^2 (*df*)	5985.92 (331)								
CFI/ TLI	0.96/0.95								
RMSEA/ $SRMR_{within/between}$	0.030/0.024/0.099								

$N_{Teacher} = 50$, $N_{Students} = 959$. S = student-reported, T = teacher-reported; [a]teachers' gender: male = 1, female = 2; [b]students' gender: male = 0, female = 1; T1 = T1, T2 = T2, T3 = T3, *ES* Emotional support. Bold values are significant

Table 10 Standardized regression coefficients for teacher self-efficacy for emotional support relating to perceived social relatedness and self-efficacy

Classroom level	Social relatedness (S) T2			Social relatedness (T) T2			Mathematics self-efficacy T3		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Teacher self-efficacy ES T1	**0.62**	**(0.13)**	**0.000**	**0.68**	**(0.14)**	**0.000**			
Mathematics competence test	−0.17	(0.14)	0.245	−0.16	(0.17)	0.347	−0.18	(0.23)	0.431
Teachers' years of experience	−0.25	(0.16)	0.118	−0.20	(0.16)	0.205	0.27	(0.15)	0.070
Female teachers[a]	0.09	(0.17)	0.577	0.09	(0.16)	0.598	0.14	(0.16)	0.385
Teacher educational knowledge	−0.03	(0.14)	0.836	−0.03	(0.15)	0.866	0.09	(0.19)	0.629
Mathematics self-efficacy T1	0.31	(0.16)	0.051	0.29	(0.20)	0.161	**0.84**	**(0.16)**	**0.000**
Social relatedness (S) T2							0.37	(0.23)	0.115
Social relatedness (T) T2							−0.10	(0.22)	0.655
R^2	0.44			0.50			0.92		
Student level	Social relatedness (S) T2			Mathematics self-efficacy T3					
	β	*SE*	*p*	β				*SE*	*p*
Mathematics competence test	0.05	(0.03)	0.164	**0.20**				**(0.07)**	**0.003**
Girls[b]	0.05	(0.05)	0.346	−0.05				(0.03)	0.138
Social relatedness T2				**0.15**				**(0.04)**	**0.001**
Mathematics self-efficacy T1	**0.18**	**(0.04)**	**0.000**	**0.54**				**(0.04)**	**0.000**
R^2	0.04			0.43					
χ^2 (*df*)	8327.43 (405)								
CFI/ TLI	0.95/0.94								
RMSEA/ $SRMR_{within/between}$	0.035/0.028/0.130								

$N_{Teacher}$ = 50, $N_{Students}$ = 959. S = student-reported, T = teacher-reported; [a]teachers' gender: male = 1, female = 2; [b]students' gender: male = 0, female = 1; T1 = T1, T2 = T2, T3 = T3, *ES* Emotional support. Bold values are significant. Bold values are significant

Acknowledgements This research was supported by grants from the German Research Foundation (Deutsche Forschungsgemeinschaft). The grants were awarded to Rebecca Lazarides and Ulrich Schiefele (project numbers: LA 3522/5-1, SCHI 283/17-1). We would like to thank Marthe Frommelt for her contribution to scale development, data collection, and statistical analyses, Sebastian Weirich for his support in designing and analyzing the mathematics achievement test, and Nathalie Karrasch, Joyce Ruden, André Seidel and other graduate students for their help in the data collection process.

Funding Open Access funding enabled and organized by Projekt DEAL.

Data Availability Data is available on request from the authors.

Declarations

Conflict of interest No potential conflict of interest was reported by the authors.

Competing interests The authors declare that they have no conflict of interest

References

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.), *Self-efficacy beliefs of adolescents* (Vol. 5, pp. 307–337). Information Age Publishing.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes, 50*(2), 248–287. https://doi.org/10.1016/0749-5978(91)90022-L

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Bardach, L., & Klassen, R. M. (2021). Teacher motivation and student outcomes: Searching for the signal. *Educational Psychologist, 56*(4), 283–297. https://doi.org/10.1080/00461520.2021.1991799

Brophy, J. (2000). *Teaching*. International Academy of Education.

Burić, I., & Kim, L. E. (2020). Teacher self-efficacy, instructional quality, and student motivational beliefs: An analysis using multilevel structural equation modeling. *Learning and Instruction, 66*, Article 101302. https://doi.org/10.1016/j.learninstruc.2019.101302

Cheema, J. R., & Kitsantas, A. (2014). Influences of disciplinary classroom climate on high school student self-efficacy and mathematics achievement: A look at gender and racial–ethnic differences. *International Journal of Science and Mathematics Education, 12*(5), 1261–1279. https://doi.org/10.1007/s10763-013-9454-4

Chen, X., & Lu, L. (2022). How classroom management and instructional clarity relate to students' academic emotions in Hong Kong and England: A multi-group analysis based on the control-value theory. *Learning and Individual Differences, 98*, Article 102183. https://doi.org/10.1016/j.lindif.2022.102183

Clausen, M. (2002). Unterrichtsqualität: Eine Frage der Perspektive? [Quality of classroom learning environments - a question of perspective?] (Vol. 29), Waxmann.

Dicke, T., Parker, P. D., Marsh, H. W., Kunter, M., Schmeck, A., & Leutner, D. (2014). Self-efficacy in classroom management, classroom disturbances, and emotional exhaustion: A moderated mediation analysis of teacher candidates. *Journal of Educational Psychology, 106*(2), 569–583. https://doi.org/10.1037/a0035504

Embretson, S. E., & Reise, S. P. (2000). *Item response theory for psychologists*. Lawrence Erlbaum Associates.

Emmer, E. T., & Stough, L. M. (2001). Classroom management: A critical part of educational psychology, with implications for teacher education. *Educational Psychologist, 36*(2), 103–112. https://doi.org/10.1207/S15326985EP3602_5

Fives, H., & Buehl, M. M. (2008). What do teachers believe? Developing a framework for examining beliefs about teachers' knowledge and ability. *Contemporary Educational Psychology, 33*(2), 134–176. https://doi.org/10.1016/j.cedpsych.2008.01.001

Fives, H., & Buehl, M. M. (2014). Exploring differences in practicing teachers' valuing of pedagogical knowledge based on teaching ability beliefs. *Journal of Teacher Education, 65*(5), 435–448. https://doi.org/10.1177/0022487114541813

Forsblom, L., Peixoto, F., & Mata, L. (2021). Perceived classroom support: Longitudinal effects on students' achievement emotions. *Learning and Individual Differences, 85*, Article 101959. https://doi.org/10.1016/j.lindif.2020.101959

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Girls and mathematics —A "hopeless" issue? A control-value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education, 22*(4), 497–514. https://doi.org/10.1007/BF03173468

Goetz, T., Bieleke, M., Gogol, K., van Tartwijk, J., Mainhard, T., Lipnevich, A. A., & Pekrun, R. (2021). Getting along and feeling good: Reciprocal associations between student-teacher relationship quality and students' emotions. *Learning and Instruction, 71*, 101349. https://doi.org/10.1016/j.learninstruc.2020.101349

Göllner, R., Wagner, W., Eccles, J. S., & Trautwein, U. (2018). Students' idiosyncratic perceptions of teaching quality in mathematics: A result of rater tendency alone or an expression of dyadic effects between students and teachers? *Journal of Educational Psychology, 110*(5), 709–725. https://doi.org/10.1037/edu0000236

Graham, L. J., White, S. L. J., Cologon, K., & Pianta, R. C. (2020). Do teachers' years of experience make a difference in the quality of teaching? *Teaching and Teacher Education, 96*, Article 103190. https://doi.org/10.1016/j.tate.2020.103190

Hachfeld, A., & Lazarides, R. (2020). The relation between teacher self-reported individualization and student-perceived teaching quality in linguistically heterogeneous classes: An exploratory study. *European Journal of Psychology of Education, 36*(4), 1159–1179. https://doi.org/10.1007/s10212-020-00501-5

Hertel, S., Hochweber, J., Mildner, D., Steinert, B., & Jude, N. (2014). *PISA 2009 Skalenhandbuch* [PISA 2009 Measures]. Waxmann.

Hettinger, K., Lazarides, R., Rubach, C., & Schiefele, U. (2021). Teacher classroom management self-efficacy: Longitudinal relations to perceived teaching behaviors and student enjoyment. *Teaching and Teacher Education, 103*, 103349. https://doi.org/10.1016/j.tate.2021.103349

Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. *Journal of Educational Psychology, 105*(3), 774–786. https://doi.org/10.1037/a0032198

Holzberger, D., & Prestele, E. (2021). Teacher self-efficacy and self-reported cognitive activation and classroom management: A multilevel perspective on the role of school characteristics. *Learning and Instruction, 76*, Article 101513. https://doi.org/10.1016/j.learninstruc.2021.101513

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling A: Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Klieme, E., Pauli, C., & Reusser, K. (2009). The Pythagoras study: Investigating effects of teaching and learning in Swiss and German mathematics classrooms. In T. Janik & T. Seidel (Eds.), *The power of video studies in investigating teaching and learning in the classroom* (pp. 137–160). Waxmann.

Koo, T. K., & Li, M. Y. (2016). A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *Journal of Chiropractic Medicine, 15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012

Kramer, K. (2002). *Die Förderung von motivationsunterstützendem Unterricht: Ansatzpunkte und Barrieren* [Fostering motivation-supportive teaching: starting points and barriers] Retrieved September 5, 2023 from https://macau.uni-kiel.de/receive/diss_mods_00000752

Kriegbaum, K., Jansen, M., & Spinath, B. (2015). Motivation: A predictor of PISA's mathematical competence beyond intelligence and prior test achievement. *Learning and Individual Differences, 43*, 140–148. https://doi.org/10.1016/j.lindif.2015.08.026

Kunina-Habenicht, O., Maurer, C., Wolf, K., Holzberger, D., Schmidt, M., Dicke, T., Teuber, Z., Koc-Januchta, M., Lohse-Bossenz, H., Leutner, D., Seidel, T., & Kunter, M. (2020). Der BilWiss-2.0-Test [The BilWiss-2.0-Test]. *Diagnostica, 66*(2), 80–92. https://doi.org/10.1026/0012-1924/a000238

Kunter, M., & Baumert, J. (2006). Who is the expert? Construct and criteria validity of student and teacher ratings of instruction. *Learning Environments Research, 9*(3), 231–251. https://doi.org/10.1007/s10984-006-9015-7

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., & Hachfeld, A. (2013). Professional competence of teachers: Effects on instructional quality and student development. *Journal of Educational Psychology, 105*(3), 805–820. https://doi.org/10.1037/a0032583

Lauermann, F., & Berger, J.-L. (2021). Linking teacher self-efficacy and responsibility with teachers' self-reported and student-reported motivating styles and student engagement. *Learning and Instruction, 76*, Article 101441. https://doi.org/10.1016/j.learninstruc.2020.101441

Lauermann, F., & ten Hagen, I. (2021). Do teachers' perceived teaching competence and self-efficacy affect students' academic outcomes? A closer look at student-reported classroom processes and outcomes. *Educational Psychologist, 56*(4), 265–282. https://doi.org/10.1080/00461520.2021.1991355

Lazarides, R., & Buchholz, J. (2019). Student-perceived teaching quality: How is it related to different achievement emotions in mathematics classrooms? *Learning and Instruction, 61*, 45–59. https://doi.org/10.1016/j.learninstruc.2019.01.001

Lazarides, R., & Schiefele, U. (2021). The relative strength of relations between different facets of teacher motivation and core dimensions of teaching quality in mathematics - A multilevel analysis. *Learning and Instruction, 76*, 101489. https://doi.org/10.1016/j.learninstruc.2021.101489

Lazarides, R., Schiefele, U., Hettinger, K., & Frommelt, M. C. (2022). Tracing the signal from teachers to students: How teachers' motivational beliefs longitudinally relate to student interest through student-reported teaching practices. *Journal of Educational Psychology. Advance online publication*. https://doi.org/10.1037/edu0000777

LeBreton, J. M., & Senter, J. L. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods, 11*(4), 815–852. https://doi.org/10.1177/1094428106296642

Lee, K. M., Lee, J., Chung, C. Y., Ahn, S., Sung, K. H., Kim, T. W., . . ., & Park, M. D. (2012). Pitfalls and important issues in testing reliability using intraclass correlation coefficients in orthopaedic research. *Clinics in Orthopedic Surgery, 4*(2), 149–155.

Lipowsky, F., Rakoczy, K., Pauli, C., Drollinger-Vetter, B., Klieme, E., & Reusser, K. (2009). Quality of geometry instruction and its short-term impact on students' understanding of the Pythagorean Theorem. *Learning and Instruction, 19*(6), 527–537. https://doi.org/10.1016/j.learninstruc.2008.11.001

Lohse-Bossenz, H., Kunina-Habenicht, O., Dicke, T., Leutner, D., & Kunter, M. (2015). Teachers' knowledge about psychology: Development and validation of a test measuring theoretical foundations for teaching and its relation to instructional behavior. *Studies in Educational Evaluation, 44*, 36–49. https://doi.org/10.1016/j.stueduc.2015.01.001

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology, 1*(3), 86–92. https://doi.org/10.1027/1614-1881.1.3.86

Marsh, H. W., Lüdtke, O., Robitzsch, A., Trautwein, U., Asparouhov, T., Muthén, B., & Nagengast, B. (2009). Doubly-latent models of school contextual effects: Integrating multilevel and structural equation approaches to control measurement and sampling error. *Multivariate Behavioral Research, 44*(6), 764–802. https://doi.org/10.1080/00273170903333665

Martin, A., & Marsh, H. (2005). Motivating boys and motivating girls: Does teacher gender really make a difference? *Australian Journal of Education, 49*(3), 320–334. https://doi.org/10.1177/000494410504900308

Murray, D. M., Varnell, S. P., & Blitstein, J. L. (2004). Design and analysis of group randomized trials: A review of recent methodological developments. *American Journal of Public Health, 94*(3), 423–432.

Muthén, L., & Muthén, B. (1998–2017). *Mplus user's guide*. Muthen & Muthen.

OECD. (2018). *PISA for development assessment and analytical framework: Reading, mathematics and science*. OECD Publishing. https://doi.org/10.1787/9789264305274-en

Oppermann, E., & Lazarides, R. (2021). Elementary school teachers' self-efficacy, student-perceived support and students' mathematics interest. *Teaching and Teacher Education, 103*, Article 103351. https://doi.org/10.1016/j.tate.2021.103351

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543–578.

Pfitzner-Eden, F., Thiel, F., & Horsley, J. (2014). An adapted measure of teacher self-efficacy for preservice teachers: Exploring its validity across two countries. *Zeitschrift für Pädagogische Psychologie, 28*(3), 83–92. https://doi.org/10.1024/1010-0652/a000125

Pianta, R. C. (1999). Enhancing relationships between children and teachers. *American Psychological Association*. https://doi.org/10.1037/10314-000

Pianta, R. C., & Hamre, B. K. (2009). Conceptualization, measurement, and improvement of classroom processes: Standardized observation can leverage capacity. *Educational Researcher, 38*(2), 109–119. https://doi.org/10.3102/0013189X09332374

Pituch, K. A., & Stapleton, L. M. (2012). Distinguishing between cross- and cluster-level mediation processes in the cluster randomized trial. *Sociological Methods & Research, 41*(4), 630–670. https://doi.org/10.1177/0049124112460380

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Praetorius, A.-K., Klieme, E., Herbert, B., & Pinger, P. (2018). Generic dimensions of teaching quality: The German framework of Three Basic Dimensions. *ZDM, 50*(3), 407–426. https://doi.org/10.1007/s11858-018-0918-4

Praetorius, A.-K., Lauermann, F., Klassen, R. M., Dickhäuser, O., Janke, S., & Dresel, M. (2017). Longitudinal relations between teaching-related motivations and student-reported teaching quality. *Teaching and Teacher Education, 65*, 241–254. https://doi.org/10.1016/j.tate.2017.03.023

Rakoczy, K. (2006). Motivationsunterstützung im Mathematikunterricht. Zur Bedeutung von Unterrichtsmerkmalen für dieWahrnehmung von Schülerinnen und Schüler.[Support for motivation in mathematics. About the meaning of teaching characteristics for the perception of students]. *Zeitschrift für Pädagogik, 52*(6), 822–843.

Ramm, G., Prenzel, M., Baumert, J., et al. (Eds.). (2006). *PISA 2003. Dokumentation der Erhebungsinstrumente [PISA 2003. Scale documentation]*. Waxmann.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Sage.

Ryan, A. M., Kuusinen, C. M., & Bedoya-Skoog, A. (2015). Managing peer relations: A dimension of teacher self-efficacy that varies between elementary and middle school teachers and is associated with observed classroom quality. *Contemporary Educational Psychology, 41*, 147–156. https://doi.org/10.1016/j.cedpsych.2015.01.002

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, Article 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Tanaka, J. S. (1993). Multifaceted conceptions of fit in structural equation models. In K. A. Bollen & S. J. Long (Eds.), *Testing structural equation models* (pp. 10–39). Sage.

Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*(2), 202–248. https://doi.org/10.3102/00346543068002202

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783–805. https://doi.org/10.1016/S0742-051X(01)00036-1

Wagner, W., Göllner, R., Werth, S., Voss, T., Schmitz, B., & Trautwein, U. (2016). Student and teacher ratings of instructional quality: Consistency of ratings over time, agreement, and predictive power. *Journal of Educational Psychology, 108*(5), 705–721. https://doi.org/10.1037/edu0000075

Zee, M., de Jong, P. F., & Koomen, H. M. Y. (2016a). Teachers' self-efficacy in relation to individual students with a variety of social–emotional behaviors: A multilevel investigation. *Journal of Educational Psychology, 108*(7), 1013–1027. https://doi.org/10.1037/edu0000106

Zee, M., de Jong, P. F., & Koomen, H. M. Y. (2017). From externalizing student behavior to student-specific teacher self-efficacy: The role of teacher-reported conflict and closeness in the student–teacher relationship. *Contemporary Educational Psychology, 51*, 37–50. https://doi.org/10.1016/j.cedpsych.2017.06.009

Zee, M., & Koomen, H. M. Y. (2016). Teacher self-efficacy and its effects on classroom processes, student academic adjustment, and teacher well-being: A synthesis of 40 years of research. *Review of Educational Research, 86*(4), 981–1015. https://doi.org/10.3102/0034654315626801

Zee, M., Koomen, H. M. Y., Jellesma, F. C., Geerlings, J., & de Jong, P. F. (2016b). Inter- and intra-individual differences in teachers' self-efficacy: A multilevel factor exploration. *Journal of School Psychology, 55*, 39–56. https://doi.org/10.1016/j.jsp.2015.12.003

Zysberg, L., & Schwabsky, N. (2021). School climate, academic self-efficacy and student achievement. *Educational Psychology, 41*(4), 467–482. https://doi.org/10.1080/01443410.2020.1813690

Authors' current themes of research

Dr. Katharina Hettinger is interested in teacher self-efficacy and student motivation. Prof. Dr. Rebecca Lazarides is full professor for school and instructional research at the University of Potsdam, interested in instruction and motivational-affective development. Prof. Dr. Ulrich Schiefele is full professor for educational psychology at the University of Potsdam, interested in motivation, interest and mind wandering.

Most relevant publications in the field of Psychology of Education (alphabetical)

Hettinger, K., Lazarides, R., Rubach, C. & Schiefele, U. (2021). Teacher classroom management self-efficacy: Longitudinal relations to perceived teaching behaviors and student enjoyment. *Teaching and Teacher Education*, *103*, 103349. 10.1016/j.tate.2021.103349.

Lazarides, R., Buchholz, J. & Rubach, C. (2018). Teacher enthusiasm and self-efficacy, student-perceived mastery goal orientation, and student motivation in mathematics classrooms. *Teaching and Teacher Education*. *69*, 1-10. 10.1016/j.tate.2017.08.017.

Lazarides, R., Schiefele, U., Hettinger, K. & Frommelt, M. (2022). Tracing the signal from teachers to students: How teachers' motivational beliefs longitudinally relate to student interest through student-reported teaching practices. *Journal of Educational Psychology*. Advance online publication. 10.1037/edu0000777.

Lazarides, R. & Watt, H. M (2015). Girls' and boys' perceived mathematics teacher beliefs, classroom learning environments and mathematical career intentions. *Contemporary Educational Psychology*, *41*, 51-61. 10.1016/j.cedpsych.2014.11.005.

Schiefele, U. & Schaffner, E. (2015). Teacher interests, mastery goals, and self-efficacy as predictors of instructional practices and student motivation. *Contemporary Educational Psychology*, *42*, 159-171. 10.1016/j.cedpsych.2015.06.005.