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Dynamics of classroom motivation: Teacher enthusiasm and the development of math interest and teacher support

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A B S T R A C T

Interest is important for successful student learning, but little is known about the developmental dynamics between interest and social support in classrooms. Based on the stage-environment fit theory, this study investigated the interrelation of developmental changes in student class-level interest and perceived teacher support in mathematics classes over one school year after the students transitioned to secondary school. We also examined how teacher-reported enthusiasm was related to these changes. Data of 1000 students (53.6% male) and their classroom teachers ($N = 42$), who were surveyed at the beginning of Grades 5 and 6, were analyzed. The results showed a significant decline in class-level mathematics interest and perceived teacher support. Teacher-reported enthusiasm buffered the decline in class-level mathematics interest. When including bidirectional relationships between perceived teacher support and the students' interest, perceived class-level teacher support in Grade 5 positively predicted the change in student interest and, thus, buffered the decline.

1. Introduction

Longitudinal studies have shown that students' interest in mathematics declines consistently throughout adolescence (Fredricks & Eccles, 2002; Frenzel, Goetz, Pekrun, & Watt, 2010; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Watt, 2004). Interest is highly important for students' academic development as it is related to their academic self-concepts (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005) and achievements (Renninger & Hidi, 2016). Given its relevance to successful learning processes, it is important for teachers to find ways to maintain students' interest. Research has highlighted the crucial role of teacher support in maintaining students' academic interest (Dietrich, Dicke, Kracke, & Noack, 2015; Wentzel, 1998; Wentzel, Battle, Russell, & Looney, 2010). However, little is known about how a decline in interest is related to developmental changes in teacher support. Theoretical models of teacher competence (Epstein & Hundert, 2002; Kunter, Baumert, & Blum, 2011) have, furthermore, emphasized the importance of teacher enthusiasm for students' motivation and teacher support in class. However, researchers have rarely investigated how teacher enthusiasm is related to developmental changes in teaching practices or student interest (for exceptions see Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009; Kunter et al., 2013).

This study addressed these gaps in the current research by examining how developmental changes in students' class-level interest and perceived teacher support are interrelated and how teacher-reported enthusiasm is related to these changes. The study particularly focused on developmental processes at the classroom level, because no studies so far have applied both a multilevel *and* a developmental perspective to investigate the relationships among students' shared classroom perceptions and their level of interest in the classroom. Such studies, however, would help extend knowledge that is highly relevant for teacher education and practice by showing how teachers can create classrooms in which not only individual students are interested in a topic or domain but classrooms that are characterized by an overall high level of interest. This study focuses on the domain of mathematics, because mathematical competencies are important preconditions for more general capabilities, such as systematic problem solving and analytic skills, which are important prerequisites of social participation (Ball, Goffney, & Bass, 2005). Furthermore, it has been found that students' interest declines particularly strongly in the domain of mathematics during the course of secondary school (Jacobs et al., 2002).

1.1. *Conceptualization and development of student interest*

Individual interest is defined as a more or less enduring

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predisposition to reengage with particular content over time (Krapp, 2007; Renninger & Hidi, 2016). An individual's interest is defined in relation to an object of interest, which can be a topic or a subject matter but also an abstract idea (Krapp, 2007; Renninger, 2000; Schiefele, 1991). Consequently, content-specificity is the main criterion of this theoretical concept. In this study, we focus on the later phases of interest development by investigating individual interest, which is important for successful learning processes (Krapp, 2007; Renninger & Hidi, 2016).

Many studies have provided empirical evidence for the positive relationship between students' interests and their academic self-concepts (Marsh et al., 2005), self-regulation in learning (Hidi, Renninger, & Krapp, 2004; Sansone, Thoman, & Fraughton, 2015), and educational choices (Nagy, Trautwein, Baumert, Köller, & Garrett, 2006; Watt et al., 2012). Given its high importance for adaptive learning processes, it is concerning that students' interest declines consistently throughout secondary school, particularly in mathematics (Fredricks & Eccles, 2002; Jacobs et al., 2002; Watt, 2004). Various explanations for this phenomenon have been considered. The stage-environment fit theory (Eccles & Roeser, 2009; Eccles et al., 1993) postulates that the developmental decline in students' interest can be explained by a mismatch between the developmental needs of early adolescents and the characteristics of their learning environments after their transition to secondary school. Over the past few decades, research has, therefore, broadly investigated how student-perceived characteristics of their learning environments in school are related to a decline in adolescents' interest (for an overview see for example Bergin, 1999; Renninger & Su, 2012). Much is known about the relationships between classroom characteristics and students' interests at the individual level (for an overview see for example Hidi & Renninger, 2006; Renninger & Hidi, 2016). However, only a few studies have longitudinally investigated how students' shared perceptions of classroom characteristics interrelate with their level of interest in a classroom. Multilevel data analyses allow the disentangling of the within-class and between-class effects of student-perceived classroom characteristics on student outcomes, such as, for example, their level of interest (Lüdtke, Robitzsch, Trautwein, & Kunter, 2009; Marsh et al., 2012). Students' class-level interest represents the amount of variance in their interest that is explained by their membership in a joint classroom. It does not necessarily represent the "motivational climate" of the class because the composite level of interest in a class can be high, but other factors such as classroom disturbances can lead to a moderate motivational climate. However, class-level interest goes beyond the interest of individual students because they express their interests in a specific domain to each other and talk about their experiences while learning in a specific classroom –through this interaction and communication they influence each other in the classroom.

1.2. Interrelations between the development of perceived teacher support and interest

Research has shown that student-perceived teacher support is critical for the adaptive development of students' academic interest (e.g., Dietrich et al., 2015; Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Ruzek et al., 2016; Wentzel et al., 2010). Teacher support is defined as the degree to which teachers provide adaptive explanations and respond constructively to errors; the degree to which students perceive the pace of the class as being adequate; and the extent to which the teacher-student interactions are respectful and caring (Hamre & Pianta, 2006; Kunter et al., 2013). It is commonly known that perceived teacher support tends to decrease as students move from elementary to secondary school (De Wit, Karioja, & Rye, 2010; Furrer & Skinner, 2003; Reddy, Rhodes, & Mulhall, 2003). This might be due to the new organizational structures in schools and classrooms that inhibit close relationships between students and teachers (De Wit et al., 2010; Eccles & Roeser, 2009). The present study focuses on students in Grades 5 and 6 of secondary schools in Germany, where students are selected for different secondary tracks at the end of Grades 4 or 6 (Maaz, Trautwein, Lüdtke, & Baumert, 2008). The students in our sample experienced the transition to secondary school after Grade 4 and were assessed after the transition at the beginning of Grade 5. Consequently, declines in students' class-level interest and perceived teacher support can be expected. According to the stage-environment fit theory (Eccles & Roeser, 2009; Eccles et al., 1993), the decline in student-perceived teacher support might be associated with the decline in the students' academic interest after their transition to secondary school. Such *teacher-driven processes* are based on the assumption that the level of student-perceived teacher support predicts changes in the students' interest. However, one might also expect *class-driven processes,* in which the level of interest in the classroom predicts changes in student-perceived teacher support. Hamre and Pianta (2006) describe the relationships between students and their teachers as a reciprocal interactive process in which both teachers and students participate actively. Hughes, Luo, Kwok, and Loyd (2008) accordingly showed that the student-perceived teacher-student relationship quality in first grade mathematics classrooms predicted positive changes in the students' engagement from Grade 1 to 2, which, in turn, predicted positive changes in the teacher-student relationships from Grade 2 to 3. Skinner and Belmont (1993) showed a statistically significant relationship between elementary students' perceived teacher support and their behavioral engagement and between student engagement and their subsequent perceived teacher support. The reviewed studies (Hughes et al., 2008; Skinner & Belmont, 1993), however, examined such interrelations only at the level of individual students. The present study examines whether such processes can be applied to the classroom level. Multilevel analyses on teacher support and its effects on classroom learning processes are needed because relations between perceived teaching behaviors and student academic outcomes at the level of the individual student can differ to those found at the classroom-level. To implement interventions targeting learning processes at the group-level successfully, for example in the context of teacher professional development, knowledge is needed about class-level learning processes (see for example Gersten, Dimino, Jayanthi, Kim, & Santoro, 2010). Only few studies, however, examined class-level perceived teacher support and its effects on student academic outcomes. Kunter et al. (2013), for example, showed that class-level teacher support is positively related to the overall level of enjoyment in mathematics classrooms. However, classroom-driven processes can also be expected because teachers *and* students actively participate in student-teacher interactions (Hamre & Pianta, 2006). In classrooms that are characterized by a high level of interest, students might talk a lot with each other and with the teacher about their interests, resulting in interactions with the teacher that are perceived as supportive by many students.

1.3. Teacher enthusiasm and the development of interest and teacher support

Besides the students' perceptions of their teachers' instructional behaviors, such as the amount of support shown, the teachers' characteristics also play an important role in the students' classroom experiences. One of the factors that has been found to be highly relevant for students' motivational experiences is the teachers' enthusiasm for teaching, which is closely related to the level of enjoyment (Frenzel et al., 2009; Kunter et al., 2013) and interest the students experience in the class (Carmichael, Callingham, & Watt, 2017; Keller, Goetz, Becker, Morger, & Hensley, 2014; Keller, Neumann, & Fischer, 2017; Kim & Schallert, 2014).

Teachers' enthusiasm is defined as a trait-like emotion that refers to "the degree of enjoyment, excitement, and pleasure that teachers typically experience in their professional activities" (Kunter et al., 2008, p. 470). From a theoretical perspective, it has been described as a decisive component of teachers' motivation (Kunter et al., 2008). Together with their professional knowledge, beliefs, and ability for professional self-regulation, teacher motivation is a central aspect of teachers' professional competence (Brunner et al., 2006; Kunter et al., 2011, 2013).

Two underlying processes can be assumed to explain the transmission of teachers' enthusiasm to their students' motivation. First, a direct transmission is described by theoretical models of emotional contagion (Frenzel et al., 2009; Hsee, Hatfield, Carlson, & Chemtob, 1990)—studies have shown a direct transmission of teachers' enthusiasm to their students' class-level interest, wherein the direct effect is mediated through student-perceived enthusiasm (Keller et al., 2014, 2017). Frenzel et al. (2010) have shown that students' perceptions of their mathematics teacher's enthusiasm was related to their own level of interest. The authors also showed that the students' perceived enthusiasm of their mathematics teachers was not significantly related to the patterns of changes in their interest development throughout secondary school. However, Frenzel et al. (2010) focused on Grades 5 to 9, and the coefficient of the linear change in their study represented the slope of the trajectories at Grade 7; thus, the students were older than those in the present study. At the end of secondary school, students' interest plateaus (Watt, 2004). In contrast, this study focused on classrooms shortly after the transition to secondary school in Grades 5 and 6. It is well known that students' motivation declines particularly strongly during the time after the transition (Watt, 2004). Because there is a greater rate of change in the students' interest during this time period, external influences may have a greater relevance in predicting motivational change (Gniewosz, Eccles, & Noack, 2012).

The second mechanism that may explain the relationship between teacher enthusiasm and student interest is the indirect effect through classroom practices (Kunter et al., 2008, 2013; Praetorius et al., 2017). Research has shown that teachers who are enthusiastic about teaching are more likely to create classrooms that are characterized by high levels of student-perceived learning support (Kunter et al., 2008, 2013). These findings are typically cross-sectional and examine classrooms at the end of secondary school. Regarding the longitudinal effects of teachers' enthusiasm on class-level learning support, Praetorius et al. (2017) showed no significant relationships between teacher-reported enthusiasm and class-level student-perceived learning support in 5th Grade classrooms for a time span of 12 months. The relationship between the teachers' enthusiasm and the students' perceptions of the teachers' classroom practices therefore may depend on the time lag and on the age of the students. Classroom compositions are re-organized after the transition to secondary school and students may not yet have a common agreement regarding their perception of the teachers' classroom practices. Thus, the direct transmission of enthusiasm to the students may be more pronounced among this age group than the indirect effect of the teachers' enthusiasm on changes in students' shared perceptions of their classroom practices.

1.4. The present study

Previous research has shown that students' perceptions of their teachers' support are related to changes in the students' interests and motivations (Dietrich et al., 2015; Fauth et al., 2014; Ruzek et al., 2016; Wentzel et al., 2010). This study extended this developmental perspective and went beyond past research by focusing on developmental changes at the classroom level; the study investigated how such changes in students' interest in mathematics were associated with developmental changes in class-level student-perceived teacher support.

It is important to note that this study focused on adolescents in the first year following their transition from elementary to secondary school (Time 1: Grade 5; Time 2: Grade 6). Given that adolescents face substantial changes in their classroom learning environments and have to adapt to new teachers and teaching methods, this developmental period is often associated with a decline both in interest and in their perception of teacher support (Eccles & Roeser, 2009; Eccles et al., 1993). Therefore, it is important to investigate the potential teaching-related antecedents of these developmental changes.

As one potential antecedent of the development of student-perceived interest and teacher support, we examined how teacher-reported enthusiasm was related to changes in students' interest and student-perceived support. Thus, by including teacher-reported enthusiasm as having an influence on students' perceptions, we were able to examine the multiple perspectives of both teachers and students in order to gain a deeper understanding of the effects of socializers' beliefs regarding student interest. Furthermore, based on transactional models of socialization processes (Hamre & Pianta, 2006; Sameroff, 2009), we examined the bidirectional relationships between students' perceptions of their teacher's support and their mathematics interest. With regard to these assumptions, we tested the following hypotheses:

(1) We expected a decline in students' average mathematics interest and perceived teacher support in class from Grade 5 to 6 (Hypothesis 1a), and we assumed that the declines in the students' average perceived teacher support and mathematics interest would be positively related to each other and, thus, reinforce each other (Hypothesis 1b).
(2) We assumed that teacher-reported enthusiasm in Grade 5 would be positively and significantly related to changes in the students' average mathematics interest (Hypothesis 2a) and to changes in perceived teacher support in class from Grade 5 to 6 (Hypothesis 2b).
(3) We expected to find bidirectional relationships between the students' class-level mathematics interest and perceived teacher support. More specifically, we assumed that the initial level of mathematics interest in class would buffer the decrease in perceived teacher support (Hypothesis 3a) and vice versa (Hypothesis 3b).

The conceptual model is depicted in Fig. 1

2. Method

2.1. Sample and procedure

Data were collected as part of a large longitudinal educational assessment (Tradition and Innovation (TRAIN), see www.train.uni-tuebingen.de for further information) in Germany that focused on investigating the developmental pathways of students. The current study was based on a subsample (n = 1,000, 53.6% male) of the original sample from Grades 5 and 6 from Cohort 1 of the TRAIN study (N = 3160). We used the data from those 47 classes who did not experience a change in the classroom teacher from Grade 5 to 6, and their 42 classroom teachers who reported that they taught mathematics in these classrooms. Students were surveyed at the beginning of Grade 5 (Time 1) and Grade 6 (Time 2) and had a mean age of 11.14 years (SD = 0.57) at Time 1. Students came from three different types of schools: the *Hauptschule* track (i.e., the least academically demanding track; 50.6% of the sample in 26 classrooms), the *Realschule* track (i.e., the intermediate track; 10.4% of the sample in 4 classrooms), and the *Mittelschule* track (i.e., a combination of *Hauptschule* and *Realschule*; 37.8% of the sample in 17 classrooms). The mean number of students per class was 21.28. The teachers' years of experience ranged from 0 to 38 years (M = 19.97, SD = 12.55), and 70.7% of the participating teachers were female. The surveys were anonymized and filled out during regular classroom hours. The student participation rate for Time 1 was 81.8% (83.3%, 90.1%, and 74.9% for *Hauptschule, Realschule, and Mittelschule*, respectively). Participation rates were similar at Time 2. All the classroom teachers participated in the study.

2.2. Measures

The complete wording of all the items of the constructs that were included in the analyses are presented in Appendix C.

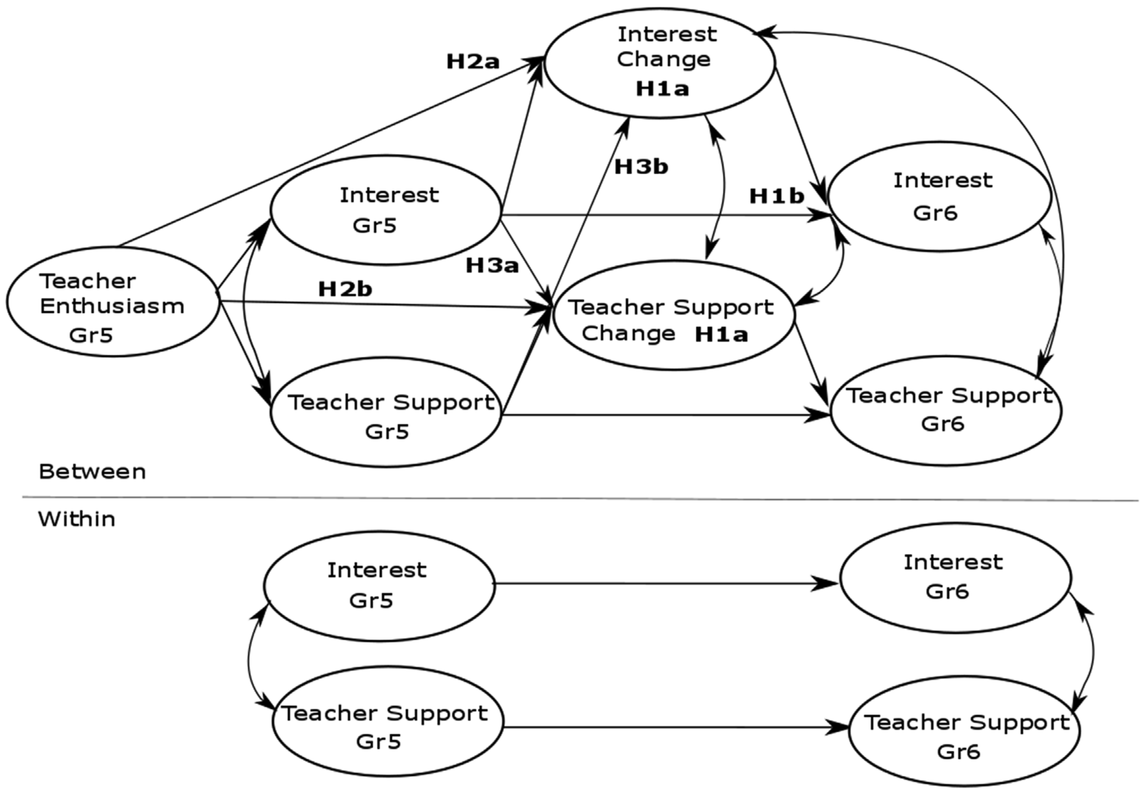

Fig. 1. Schematic statistical model of the final model (Table 4, Model 3).
Note. Cross-lagged paths at the student level were also tested but did not reach significance.

2.2.1. Interest in mathematics

Subject-specific interest in mathematics was assessed using student self-reports at Time 1 and Time 2. This was measured through three items using a four-point Likert-type scale (1 = *completely disagree* to 4 = *completely agree*). An established scale (Marsh et al., 2005), originally developed based on Krapp's (1992) interest theory, was adapted for the present context. For instance, an example item was, "Doing exercises in mathematics is fun for me." Internal consistency was satisfactory at both Times 1 and 2 (α = .66 and .74 at Grades 5 and 6, respectively).

2.2.2. Teacher support

Perceived teacher support was assessed using students' self-reports at Times 1 and 2. The scale consisted of seven items (e.g., "Our teacher supports us in our learning"; 1 = *completely disagree* to 4 = *completely agree*). The scale measures the teachers' active support and patience in fostering the students' learning. Its validity has been established in previous longitudinal assessments (Baumert et al., 2009). The internal consistency of the scale was good at both Times 1 and 2 (Grade 5: α = .89; Grade 6: α = .91).

2.2.3. Teacher-reported enthusiasm

Each teacher's enthusiasm for teaching was assessed via a teacher report at Time 1, using three items (e.g., "Teaching brings me joy") on a four-point Likert-type scale (1 = *not true at all* to 4 = *very true*). This scale has been used in previous longitudinal educational assessments (Baumert et al., 2009; Kunter et al., 2008). The internal consistency of the scale was good (α = .84).

2.2.4. Mathematics achievement

Mathematics achievement was assessed using the students' results in the last class exam in mathematics obtained from the school records. For the additional analyses that included class-level mathematics achievement, we aggregated mathematics achievement at the classroom level by creating a mean score of the students' achievement per classroom.

2.3. Statistical analyses

To test how the change in students' mathematics interest was associated with the change in student-perceived teacher support at the classroom level, we applied a multilevel latent change model (LCM) approach (LCM; McArdle, 2009; Steyer, Eid, & Schwenkmezger, 1997). As described in the statistical literature (McArdle, 2009, p. 583), in order to be able to model the latent change score (Δ), we added a set of fixed values (=1) on the specific parameters between a variable value at Time 1 and 2. The change score (Δ) is thereby explicitly defined. Furthermore, in order to identify the model, for each of the latent variables, the parameter between their latent change score and their level at Time 2 was set to 1 (McArdle, 2009). We conducted multilevel LCMs because students were nested in classrooms (Marsh et al., 2012). The multilevel data analysis approach allows for a corrected estimation of standard errors and regression coefficients in the models (Raudenbush & Bryk, 2002). The Mplus program version 7.0 was used for all analyses (Muthén & Muthén, 1998–2015).

In this study, multilevel LCMs were applied in order to investigate the interrelations between the change in students' interest and student-reported teacher support at the classroom level. Because we were interested in the development of students' mathematics interest and perceived teacher support at the classroom level, we modeled the change in these variables at the classroom level and only included stability paths of both latent constructs at the individual level. In this way, we applied a latent-manifest approach in which multiple manifest indicators (items) are used to measure student-level and classroom-level latent constructs. The Level 2 (classroom level) item indicators are manifest aggregations of the Level 1 (student level) item indicators. This approach does not control for sampling errors, which might be appropriate when Level 2 constructs are based on all possible Level 1

Table 1
Means and standard errors for the student-reported constructs at the classroom level based on latent change models with strong invariance restrictions.

Variable		M	SE	ICC_1	ICC_2
Interest	Initial level	3.61	0.03	.13	.64
	Change	−0.14***	0.02	.16	.71
Teacher Support	Initial level	3.21	0.04	.21	.85
	Change	−0.13***	0.04	.15	.78

Note. Latent means and standard errors were computed from unconditional change models, and strong measurement invariance restrictions across time and levels were kept in these models.
***$p < .001$.

units in each group (Marsh et al., 2009). In the current study, all students from participating classrooms also participated in the survey, which makes this approach appropriate for planned data analyses.

In the first step of our analysis, an unconditional multilevel LCM was separately estimated for each of the latent constructs. Measurement invariance across time is a precondition for latent change analyses (McArdle, 2009). Therefore, we tested for strong measurement invariance, that is, item loadings and intercepts were held invariant across time points (Byrne, 1989). To evaluate the invariance constraints, we calculated the change in the comparative fit index (ΔCFI) (Cheung & Rensvold, 2002; Vandenberg & Lance, 2000). The results showed strong measurement invariance across time and across levels of analysis for perceived teacher support and for mathematics interest. The results of measurement invariance testing are presented in Appendix A.

In the next step, we specified a multilevel LCM with measurement invariance restrictions that included the initial level and the change in both the students' mathematics interest and the student-perceived teacher support at the classroom level (Model 1). Subsequently, we used teacher-reported enthusiasm as the predictor of the initial level and the change in both variables (Model 2). In the last step, we tested bidirectional relationships between mathematics interest and student-perceived teacher support by specifying the initial level of mathematics interest as a predictor of the change in the perceived teacher support, and vice versa (Model 3). To control for the potential effects of different school types and the class-level achievement and, thus, to test for the robustness of our effects, we also included school type and achievement at the classroom level. The findings of these analyses are presented in Appendix B.

The percentage of missing values per variable was 21.2% (mathematics interest at Time 1), 23.6% (mathematics interest at Time 2), 21.1% (perceived mathematics teacher support at Time 1), and 24.4% (perceived mathematics teacher support at Time 2) for the manifest scales at the student level. The full information maximum likelihood (FIML) included all cases in the parameter estimation (Arbuckle, 1996).

The goodness of the model fit was evaluated using the following criteria (Tanaka, 1993): the Yuan-Bentler scaled χ^2 (YB χ^2, mean-adjusted test-statistic robust to non-normality), the Tucker and Lewis index (TLI), the CFI, and the root mean square error of approximation (RMSEA). Additionally, the standardized root mean residual (SRMR) values were also reported. TLI and CFI values greater than .95 (Hu & Bentler, 1999) and RMSEA values lower than .06 and SRMR ≤ .08 (Hu & Bentler, 1999) were accepted as indicators of a good model fit.

3. Results

3.1. Descriptive analyses

We tested whether the mean values of the key variables in the subsample differed significantly from those in the original sample using the Wald Chi-Squared Test with Bonferroni correction (the adjusted level of significance was $p = 0.013$). We then corrected for the nested structure of the data. There was no significant difference in the students' mathematics interest at Time 1 (original sample: $M = 3.11$, $SD = 0.75$; subsample: $M = 3.16$, $SD = 0.71$; Wald χ^2 (1) = 2.03, $p = 0.15$) and at Time 2 (original sample: $M = 2.89$, $SD = 0.77$; subsample: $M = 2.95$, $SD = 0.76$; Wald χ^2 (1) = 1.92, $p = 0.17$). There was also no significant difference in the student-reported teacher support at Time 1 (original sample: $M = 3.29$, $SD = 0.61$; subsample: $M = 3.30$, $SD = 0.65$; Wald χ^2 (1) = 0.01, $p = 0.99$) and at Time 2 (original sample: $M = 3.10$, $SD = 0.74$; subsample: $M = 3.17$, $SD = 0.72$; Wald χ^2 (1) = 1.07, $p = 0.31$).

Subsequently, we assessed the reliability of the aggregated student variables by computing the intraclass correlations (ICC) for mathematics interest and perceived teacher support (Raudenbush & Bryk, 2002). The ICC values were calculated for the 47 classrooms (average classroom size: 21.28) and are presented in Table 1. An ICC_1 value of greater than .05 shows that individual ratings are attributable to group membership (LeBreton & Senter, 2008). ICC_2 values above .70 indicate a high accuracy of class-mean ratings. The ICC_1 values indicate that 21% of the proportion of total variance of perceived teacher support and 13% of the variance of students' interest was attributable to students' belonging to the same classroom. In other words, a substantial amount of variance in perceived teacher support and student interest is explained by which class the students belong to. This indicates that students in the same classroom influence each other in terms of their interests and perceptions of teacher support. Consequently, the multilevel structure of the data with students being nested in classrooms cannot be ignored.

Table 1 also shows the means and standard errors of the latent variables that were derived from the unconditional multilevel LCM with strong measurement invariance restrictions. In line with Hypothesis 1a, the mean of the latent change variables indicates that both mathematics interest and perceived teacher support decrease significantly at the class level from Grade 5 to 6.

Table 2 shows the manifest intercorrelations that were computed in Mplus using FIML among all the constructs for both points of time and at both levels. The intercorrelation coefficients indicate a moderate stability of mathematics interest and student-perceived teacher support from Grade 5 to 6 at the student level. At the classroom level, the stability across time of mathematics interest was moderate and of student-perceived teacher support was high. At the student level, mathematics interest in Grades 5 and 6 was highly significant and positively correlated with student-reported mathematics teacher support in Grades 5 and 6. At the classroom level, student-reported mathematics interest in Grade 5 was significantly correlated with perceived teacher support at both time points, but was not significantly correlated with teacher-reported enthusiasm in Grade 5. Mathematics interest in Grade 6, however, was significantly associated with perceived teacher support in

Table 2
Manifest intercorrelations between the study variables.

Within	1	2	3	4	
1) Interest G5		.40***	.18***	.13**	
2) Interest G6			.17***	.29***	
3) Teacher Support G5				.41***	
4) Teacher Support G6					
Between	1	2	3	4	5
1) Interest G5		.39***	.25*	.25*	.10
2) Interest G6			.44**	.51***	.34***
3) Teacher Support G5				.75***	.24
4) Teacher Support G6					.30*
5) Teacher Enth G5					

Note. Standardized correlation coefficients are reported. G5 = Grade 5; G6 = Grade 6; Teacher Enth = Teacher-reported enthusiasm for teaching mathematics.
*$p < .05$; **$p < .01$; ***$p < .001$.

Table 3
Standardized coefficients from the multilevel latent change modeling.

	Model 1											
	Interest						Teacher Support					
	Level G6			Change			Level G6			Change		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Between												
Interest G5	.65	.18	< .001	–.01	.48	.98						
Teacher Support G5							.79	.06	< .001	–.09	.21	.66
Teacher Enth G5												
Within												
Interest G5	.48	.06	< .001									
Teacher Support G5							.46	.04	< .001			

Note. G5 = Grade 5; G6 = Grade 6; Teacher Enth = Teacher-reported enthusiasm for teaching mathematics.

Grades 5 and 6 and with teacher-reported enthusiasm in Grade 5. Only student-perceived teacher support in Grade 6—and not in Grade 5—was significantly associated with teacher-reported enthusiasm in Grade 5.

3.2. Latent change models

To test our hypotheses, we modeled a series of multilevel LCMs. We first specified a multilevel LCM with measurement invariance restrictions that included the initial level of and changes in both the students' mathematics interest and student-perceived teacher support at the classroom level and stability paths at the student level. The coefficients of this LCM are presented in Table 3 (Model 1). The model showed an acceptable fit to the empirical data: χ^2 = 686.97, *df* = 360, CFI = .94, TLI = 0.94, RMSEA = .03, $SRMR_{within}$ = .05, and $SRMR_{between}$ = .13. Because we were interested in the interrelations of level and the change in students' interest and teacher support at the classroom level, we modeled only stability paths at the student level (Fig. 1). At the student level, the students' mathematics interest in Grade 5 was significantly and positively related to their mathematics interest in Grade 6 (β = .48, SE = .06, $p < .001$). Student-perceived teacher support in Grade 5 was significantly and positively related to the student-perceived teacher support in Grade 6 (β = .46, SE = .04, $p < .001$; Table 3). The LCM at the classroom level showed that class-level mathematics interest in Grade 5 was not significantly related to the average change in the class-level mathematics interest (β = −.01, SE = .48, *p* = .98). Class-level perceived teacher support in Grade 5 was not significantly related to the average change in the class-level perceived teacher support (β = −.09, SE = .21, *p* = .66). Contrary to Hypothesis 1b, the latent correlations (Φ) in this model showed that changes in the students' mathematics interest were not significantly associated with changes in the student-perceived teacher support (Φ = .46, SE = .26, *p* = .07).

In the next step, we used teacher-reported enthusiasm as the predictor of the initial level of and the change in both variables. The coefficients of this LCM are presented in Table 4 and Fig. 2 (Model 2). The model showed an acceptable fit to the empirical data: χ^2 = 773.45, *df* = 416, CFI = .94, TLI = 0.94, RMSEA = .03, $SRMR_{within}$ = .05, $SRMR_{between}$ = .13. The results presented in Table 3 show that, in line with Hypothesis 2a, teacher-reported enthusiasm was significantly and positively related to the average change in students' mathematics interest at the classroom level (β = .41, SE = .20, *p* = .04). Contrary to Hypothesis 2b, teacher-reported enthusiasm was not significantly related to the average change in student-perceived teacher support (β = .25, SE = .19, *p* = .19). When the teachers reported higher levels of enthusiasm, there was less of a decrease in mathematics interest over time at the classroom level. Teacher-reported enthusiasm was not significantly related to the level of mathematics interest in Grade 5 (β = .18, SE = .21, *p* = .39) or to the level of average perceived teacher support in Grade 5 (β = .32, SE = .17, *p* = .07).

In the final step of the analyses, we tested the bidirectional relationships between mathematics interest and student-perceived teacher support. The coefficients of this LCM are presented in Table 5 and Fig. 2 (Model 3). The model showed an acceptable fit to the empirical data: χ^2 = 764.39, *df* = 414, CFI = .94, TLI = 0.94, RMSEA = .03, $SRMR_{within}$ = .05, $SRMR_{between}$ = .11. In line with Hypothesis 3a, the class average student-perceived teacher support in Grade 5 was significantly and positively related to the class average change in the students' mathematics interest (β = .46, SE = .15, *p* = .003). Contrary to Hypothesis 3b, the students' class average mathematics interest in Grade 5 was not significantly related to the average change in student-perceived teacher support (β = .09, SE = .17, *p* = .59; Table 4).

4. Discussion

This study aimed to examine the developmental change in students' mathematics interest and student-perceived teacher support at the classroom level as they transition from Grade 5 to Grade 6. Moreover, we analyzed the role of teacher-reported enthusiasm in changes in students' average mathematics interest and perceived teacher support from Grade 5 to 6. Finally, the study addressed the question of bidirectional relationships between students' class-level mathematics interest and perceived teacher support. The main findings of the study were that students' class-level mathematics interest and perceived teacher support significantly declined from Grade 5 to Grade 6. Teacher-reported enthusiasm buffered the decline in the students' class-level mathematics interest but not in the class-level perceived teacher support. Class-level perceived teacher support in Grade 5 was significantly and positively related to the change in student interest and, thus, buffered the decline. Class-level mathematics interest in Grade 5 however was not significantly related to the change in student-perceived teacher support at the classroom level.

4.1. Discussion of findings

In accordance with the stage-environment fit theory (Eccles & Roeser, 2009; Eccles et al., 1993), our expectations were partially confirmed, as the students' mathematics interest and perceived teacher support declined significantly (Hypothesis 1a). However, the decline in the students' class-level interest was independent of the decline in their class-level perception of teacher support (Hypothesis 1b). Our findings corroborate those of previous studies that have shown a decline in students' mathematics interest (Fredricks & Eccles, 2002; Watt, 2004) and in perceived teacher support after the

Table 4
Standardized coefficients from the multilevel latent change modeling.

Model 2																		
Interest										Teacher Support								
	Level G5			Level G6			Change			Level G5			Level G6			Change		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Between																		
Interest G5				.66	.15	< .001	–.15	.32	.65									
Teacher Support G5													.78	.06	< .001	–.15	.20	.44
Teacher Enth G5	.18	.21	.39				.41	.20	.04	.32	.18	.07				.25	.19	.20
Within																		
Interest G5				.48	.06	< .001												
Teacher Support G5													.46	.04	< .001			

Note. G5 = Grade 5; G6 = Grade 6; Teacher Enth = Teacher-reported enthusiasm for teaching mathematics.

transition to secondary school (De Wit et al., 2010; Furrer & Skinner, 2003; Reddy et al., 2003). Consequently, the results of this study indicate that the years after the transition to secondary school might be a critical developmental stage for students. The findings also indicate that the level of student-perceived teacher support as well as the level of interest at the classroom level in Grade 5 were only weakly related to the developmental change in class-level interest (Model 3). An explanation for these findings lies in the timing of our study. We focused on adolescents shortly after their transition from elementary to secondary school, when class-level interest and perceptions of teacher support might not yet be stable, since these are newly created classrooms taught by new teachers. Since the students had not known their teachers for a long period of time, they may have used other sources of information when forming their interests.

Our findings further showed that, as expected in Hypothesis 2a, teacher-reported enthusiasm in Grade 5 slowed the decline in the students' class-level mathematics interest from Grade 5 to 6. From an educational perspective, this finding emphasizes the importance of the teachers' affect in class, because enthusiastic teachers transmit their positive emotions to their students and, thus, impact their students' adaptive motivational development.

This finding corresponds with prior research on emotional transmission processes in classrooms (Frenzel et al., 2009; Keller et al., 2014). Interestingly, teacher-reported enthusiasm was not reflected in the developmental changes in the students' class-level perceptions of teacher support, which contradicted our expectations (Hypothesis 2b). This finding might be interpreted as a direct transmission of teacher enthusiasm to students' interest development. The effect was no longer significant when controlling for student-perceived class-level teacher support in Grade 5. Because teacher-reported enthusiasm in Grade 5 was not significantly related to class-level perceived teacher support in Grade 5, teacher support did not mediate the relationship between enthusiasm and interest (cf. Preacher & Hayes, 2008). The level of perceived teacher support in class—which might emerge because students talk to each other about their perceptions of the teacher's support—thus seems to be an independent and more important predictor for the level of interest in class than the teacher's enthusiasm.

The non-significant relationship between teacher-reported enthusiasm and student-perceived teacher support at the classroom level contradicts the findings of past research (Kunter et al., 2008, 2013). However, while previous studies examined classrooms at the end of

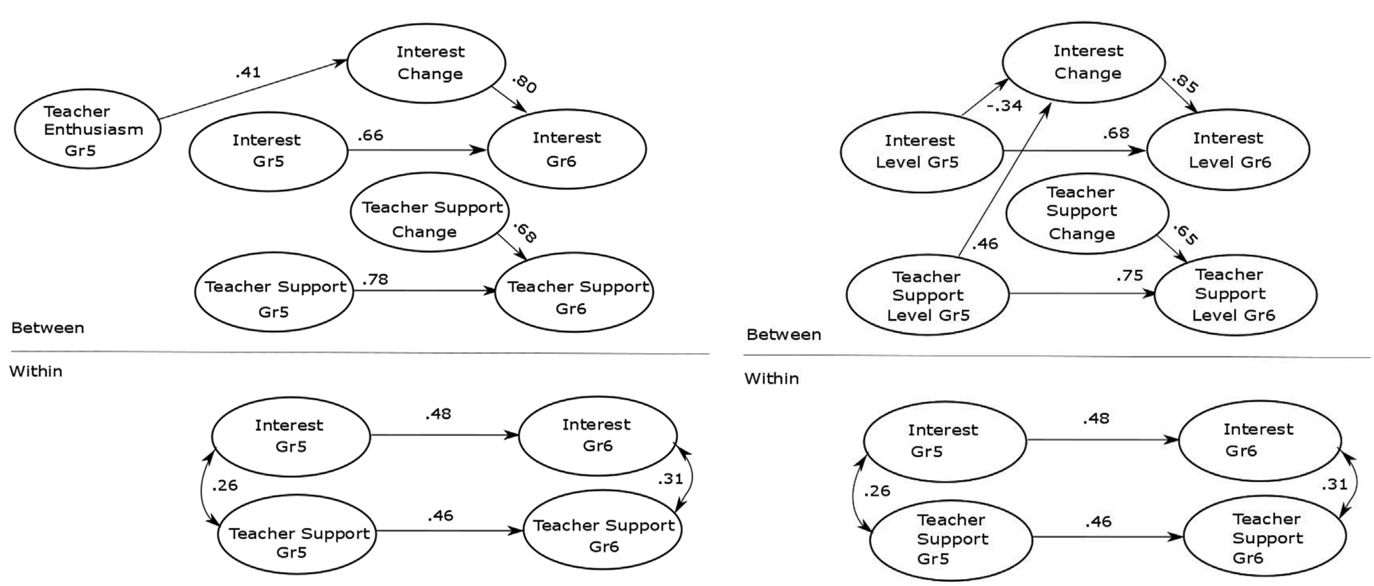

Fig. 2. Structural paths for the relations between teacher-reported teacher enthusiasm, mathematics interest, and student-perceived teacher support. Only statistically significant ($p < .05$) standardized coefficients are displayed. Model 2 (see also, Table 3) does not contain the bidirectional effects from the level of interest (teacher support) to the change of teacher-support (interest). Correlations were allowed but are not depicted for reasons of clarity. Model 3 (see also, Table 4) does contain the bidirectional paths. For reasons of clarity, statistical non-significant paths from the models are only presented in Tables 3 and 4. Partial scalar invariance restrictions across levels and time were retained.

Table 5
Standardized coefficients from the multilevel latent change modeling.

Model 3																		
Interest										Teacher Support								
	Level G5			Level G6			Change			Level G5			Level G6			Change		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
Between																		
Interest G5				.68	.12	< .001	–.34	.17	.04							.13	.18	.45
Teacher Support G5							.46	.15	.01				.75	.05	.001	–.09	.17	.60
Teacher Enth G5	.17	.20	.38				.26	.19	.17	.29	.17	.09				.22	.21	.29
Within																		
Interest G5				.48	.06	< .001												
Teacher Support G5													.46	.04	< .001			

Note. G5 = Grade 5; G6 = Grade 6; Teacher Enth = Teacher-reported enthusiasm for teaching mathematics.

secondary school, in this study, classrooms were assessed one year after the transition to secondary school, because of which the findings may differ. There may also be a lower agreement among the students in this study regarding the teachers' classroom practices and teaching style, because the students may still not be very familiar with each other. This assumption is reflected in the lower amount of shared variance in perceived teacher support in this study (Table 1) compared to previous studies (ICC ≥ .29 in Kunter et al., 2013; see also, Baumert et al., 2010).

Taken together, we assume that because we focused on longitudinal relationships between teacher-reported enthusiasm, students' class-level perceived teacher support, and students' interest one year after the transition to secondary school, the direct relationship between teacher enthusiasm and class-level interest may be more pronounced than the indirect mechanism through class-level perceptions of classroom practices in this developmental phase.

Based on the conceptual model of child-teacher relationships proposed by Hamre and Pianta (2006), we tested both class-driven and teacher-driven socialization processes in early adolescence. Our expectation of bi-directional relationships as presented in Hypothesis 3a was not confirmed as the intercept of class-level interest in Grade 5 was not significantly related to the change in class-level teacher support. Instead, evidence for uni-directional effects was provided as the intercept of student-perceived class-level teacher support in Grade 5 reduced the decline in the students' class-level mathematics interest (Hypothesis 3b). These findings are inconsistent with previous studies that showed both teacher- and youth-driven processes within the relationships between students' motivation and perceived teacher support (Hughes et al., 2008; Skinner & Belmont, 1993). Potential reasons for this inconsistency might be the level of analyses and the students' ages. Previous studies (Hughes et al., 2008; Skinner & Belmont, 1993) focused on the level of the individual student. Regarding class-level effects, prior findings have already showed teacher-driven effects with class-level teacher support being a predictor of the students' class-level enjoyment (Kunter et al., 2013). Our findings accordingly showed that classrooms that are characterized by overall high levels of perceived teacher support may witness a smaller decrease in the overall level of interest in class. Our findings did not, however, indicate class-driven processes. Although such effects can be assumed because students in classrooms influence each other, and high levels of shared interest may enhance supportive communication between the group and the teacher, shared perceived teacher support at the classroom level did not substantially contribute to a slower decline of class-level perceived teacher support.

This study extended previous studies that have typically only investigated how the perceived teacher support at the individual level affects the developmental change in students' interest (e.g., Frenzel et al., 2010; Wentzel, 1996). Our results showed that the level of student-perceived teacher support in class was weakly related to the developmental change in class-level interest. This finding may also be related to the measures used in the present study and emphasize the need to further elaborate measures of teacher support. Questions that need to be addressed are, for example, how specific teaching strategies support the learning processes of a group of students or of the individual student or both. One could assume, for example, that the promotion of verbal participation in class (in this study reflected in the item "Our teacher gives us the opportunity to present our opinions.") would enhance communication among students and thus, interest at the classroom level (Gillies, 2004). However, teaching strategies that relate to the learning progress of individual students (item "Our teacher is interested in the learning progress of each and every student.") might, in turn, be only weakly related to interest at the classroom level. Consequently, future research should aim to elaborate the construct 'teacher support' by identifying teacher support behaviors that are adaptive for the individual student, and teacher support behaviors that are adaptive for the whole class.

In terms of educational implications, our study highlights that teaching should focus on those instructional strategies that enhance the students' perceptions of high levels of teacher support in class. Such strategies include, for example, the teacher employing a non-controlling and appreciative style of communication that encourages classroom discourse; an adaptive learning speed that also includes a slower pace; and the provision of explanations that are adapted to learning processes in the classroom (see items of the scale "teacher support" in Appendix C). A theoretical contribution of this study to past research on supportive teacher-student relationships and student motivation is its focus on the classroom level. Teacher enthusiasm and classrooms that are characterized by a high level of behavioral support seem beneficial for the adaptive development of students' class-level interest shortly after the transition to secondary school.

4.2. Limitations

Several limitations need to be considered when interpreting the findings of this study. First, we examined the development of students' mathematics interest and perceptions of teacher support across one year after the transition to secondary school and not across a wider time span before and after the transition. Consequently, our interpretations are limited to a relatively short time period following a decisive contextual change in the students' academic careers. To gain a deeper understanding of the developmental processes during school transition, future research needs to investigate which individual and social factors are related to an adaptive academic development across school transitions (Lazarides, Viljaranta, Ranta, & Salmela-Aro, 2017).

The second limitation of this study is that it focused solely on the students' perspective when assessing the teachers' support. Although past research has shown that socializers' beliefs and behaviors need to be perceived by adolescents in order to be transmitted (Gniewosz & Noack, 2012), a strict examination of bidirectional relationships between students' motivation and teachers' behaviors would require actual teacher data (for further discussion see Lazarides, Rubach, & Ittel, 2017).

The third limitation of this study is that the analyses are based on the data of a longitudinal large-scale study that only focused on non-academic track school types (Hauptschule, Realschule, Mittelschule) in Germany. Becker and Neumann (2016) showed that students in high-achieving classrooms report a lower academic self-concept than equally able students in comparatively low-achieving classrooms after the transition from elementary school to the academic track in Germany. Because it is well known that students who attend academic track schools show higher achievement gains than students who attend other school types (Becker, Lüdtke, Trautwein, & Baumert, 2006), it might be assumed that negative contrast effects might be stronger in high-ability settings. Although this study did not focus on students' self-concepts, students' interest in mathematics may also be affected by the school context. The findings of Frenzel et al. (2010) showed that non-academic track membership coincided with a weaker linear decline in interest in Grade 7. This finding implies a more favorable interest trajectory for students attending non-academic track schools compared with students from academic track schools. However, Frenzel et al. (2010) also showed that students from non-academic track schools started out with slightly lower levels of mathematics interest in Grade 5. In our study, we focused on Grades 5 and 6. Because students in non-academic track schools seem to start with lower levels of interest than students in academic track schools, but their interest decreases less strongly, it may be of particular interest for research on learning and instruction to identify teacher and classroom characteristics that contribute substantially to the increase (or decline) of interest in non-academic school settings. The sampling of school types, however, remains a limitation of this study that needs to be considered when interpreting its findings.

Lastly, one final limitation of this study is its assessment of student-perceived teacher support, which refers to the students' perceptions of their classroom teachers' support. We only included those students in the analyses whose classroom teachers reported that they taught mathematics as classroom teachers. Furthermore, students in this study always referred to the same teacher as their teachers did not change over time. Additionally, student-perceived teacher support in this study was highly correlated with mathematics interest within and across the measurement points (Table 2). Therefore, it might be assumed that the measure of perceived teacher support that was used in this study can be used to test the hypothesized relationships. However, future studies with measures that refer only to mathematics teachers are needed to validate the findings of this study.

4.3. Conclusions

According to past research based on the stage-environment fit theory (Eccles & Roeser, 2009), our findings highlight that the period following the transition to secondary school is a critical developmental stage. In the year following the transition, the level of mathematics interest in classrooms and students' shared perceptions of teacher support both decline, and these declines occur independently of each other. To our knowledge, there have been no studies so far on the interrelation between teacher-reported enthusiasm and developmental changes in student-perceived teacher support. By investigating how teacher-reported enthusiasm is related to both the level of and the changes in student-perceived teacher support and interest, classroom factors that enhance an adaptive academic development across adolescence can be identified. It is therefore important to acknowledge that causal interpretations of the findings of this study need to be treated with caution, because other social and individual factors may also contribute to students' class-level interest (Eccles et al., 1983; Wigfield, Tonks, & Klauda, 2016). In this study, teachers' self-reported enthusiasm to teach and the students' shared perceptions of teacher support in the classroom in Grade 5 were identified as classroom factors that are related to a lower level of decline in classroom interest from Grade 5 to Grade 6. The practical implications of these findings for learning and schooling are that the importance of affective components of teaching, such as the teacher's enthusiasm, need to be reflected in teacher training. Furthermore, didactic and pedagogical strategies through which teachers can enhance the level of shared perceptions of teacher support in class need to be discussed and reflected throughout teachers' professional development and education programs. Our findings emphasize that classrooms that are characterized by a high level of perceived teacher support and by teachers who are enthusiastic about teaching are important grounds for adaptive motivational development.

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Appendix A

Measurement Invariance Tests for Interest and Teacher Support

Step	χ^2	*df*	CFI	ΔCFI	TLI	RMSEA	$SRMR_{within}$	$SRMR_{between}$
Interest								
1	42.930	14	.970	–	.935	.045	.019	.037
2	43.064	18	.974	.004	.956	.037	.020	.035
3	48.945	20	.970	–.004	.955	.038	.020	.043
4	49.367	22	.971	.001	.961	.035	.020	.039
Teacher Support								
1	325.238	152	.960	–	.952	.034	.015	.040
2	332.060	164	.961	.001	.957	.032	.015	.040
3	345.937	170	.959	–.002	.957	.032	.015	.040
4	347.825	175	.960	.001	.958	.031	.015	.040

Note. 1 = freely estimated; 2 = factor loadings invariant across time, all parameters freely estimated across levels; 3 = item intercepts invariant across time, all parameters freely estimated across levels; 4 = factor loadings invariant across levels.

Appendix B

Standardized coefficients from the multilevel latent change modeling including school type and achievement as covariates at the classroom level

Model 3a

	Interest						Teacher Support					
	Level G6			Change			Level G6			Change		
	β	(*SE*)	*p*	β	(*SE*)	*p*	β	(*SE*)	*p*	β	(*SE*)	*p*
Between (Classroom)												
Interest G5	.65	(.12)	< .001	−.46	(.21)	.02	.76	(.05)	< .001	.17	(.27)	.54
Teacher Support G5	.31	(.14)	.03							−.11	(.19)	.58
Teacher Enth G5	.18	(.21)	.39	.24	(.15)	.11	.30	(.18)	.10	.22	(.21)	.29
School RS				−.35	(.14)	.01				.09	(.19)	.64
School MS				−.17	(.01)	.02				.04	(.29)	.89
Achievement				−.12	(.20)	.54				−.09	(.27)	.75
Within (Student)	Level G6						Level G6					
Interest G5	.48	(.06)	< .001									
Teacher Support G5							.46	(.04)	< .001			

Note. G5 = Grade 5; G6 = Grade 6. Teacher Enth = Teacher-reported enthusiasm for teaching mathematics. School RS = Realschule, School MS = Mittelschule; Reference group of school type was lower academic track (Hauptschule).
Model fit χ^2 = 865.730, df = 486, CFI = .94, TLI = 0.93, RMSEA = .03, $SRMR_{within}$ = .02, $SRMR_{between}$ = .06.

Appendix C

Student-reported interest in mathematics	
Solving math problems is fun for me.	Matheaufgaben machen mir einfach Spaß.
It is important for me to be good at math.	Es ist mir wichtig, gut in Mathe zu sein.
I am willing to sacrifice my leisure time for mathematics.	Für Mathematik bin ich auch bereit, Freizeit zu opfern.
Student-reported teacher support	
How does your classroom teacher conduct him/herself in your classroom? Our classroom teacher[a] …	Wie verhält sich dein Klassenlehrer im Unterricht in eurer Klasse? Unser Klassenlehrer …
… is interested in the learning progress of each and every student.	… interessiert sich für den Lernfortschritt jedes einzelnen Schülers.
… provides additional support if we need it.	… unterstützt uns zusätzlich, wenn wir Hilfe brauchen.
… stays patient even when we proceed slowly.	… bleibt auch geduldig, wenn wir nur langsam vorankommen.
… supports us in our learning.	… unterstützt uns beim Lernen.
… explains everything until we understand it.	… erklärt etwas so lange, bis wir es verstehen.
… gives us the opportunity to present our opinions.	… gibt uns Gelegenheit, unsere Meinung zu sagen.
… encourages us to ask questions when we do not understand something.	… ermutigt uns zu fragen, wenn wir etwas nicht verstehen.
Teacher-reported enthusiasm to teach	
How much pleasure do you get from teaching your class[b]?	Wie viel Freude macht Ihnen das Unterrichten? Beziehen Sie sich hierbei bitte auf den Unterricht in der „Zielklasse".
I teach with great delight.	Ich unterrichte mit Begeisterung.
It is a joy for me to teach.	Es macht mir Freude, zu unterrichten.
Teaching something to the students is always fun for me.	Es macht mir immer wieder Spaß, den Schüler(inne)n etwas beizubringen.

[a] Only those students have been included whose classroom teachers taught mathematics as the classroom teachers.
[b] Here, "your class" refers to the class in which the teachers are classroom teachers.

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