Supplemental Material

Table A1

Descriptive statistics for the analysis sample (N = 1429)

	Number	Percent
Adolescent males	703	49.2
Middle School[a]	681	47.7
Seventh grade	227	16.0
Eight grade	450	31.5
High school[a]	748	52.3
Ninth grade	95	6.6
Tenth grade	318	22.3
Eleventh grade	234	16.4
Twelfth grade	97	6.8
Hispanics	964	67.5
Asian	216	15.1
Other ethnicity	249	17.5
English learners	505	35.3
Free or reduced lunch	915	64.0

Note. [a] missing information about the grades for high-and middle school students for each $n = 4$.

Table A2

Overview of all Used Items in the Student Questionnaire

		Ω		λwithin		λbetween	
		T1	T2	T1	T2	T1	T2
Interest in math	I enjoy the subject of math.	.945	.940	.881	.881	.998	.995
	I like math.			.906	.911	.971	.980
	I am fascinated by math.			.837	.806	.997	.993
	I enjoy doing math.			.923	.912	.999	1.00
	Math is exciting to me.			.846	.825	.945	.987
Negative affect in math	How often do you feel irritated in your math class?	.682	.709	.614	.659	.994	.988
	How often do you feel exhausted in your math class?			.609	.656	.995	.997
	How often do you feel bored in your math class?			.706	.691	.951	.861
Teachers' support for collaborative work	Our math teacher encourages us to help other students with their math work.	.795		.683		.972	
	Our teacher wants the students in this class to work well			.770		.948	
	together.			.679		.951	
	Our math teacher allows us to discuss our work with			.680		1.00	
	classmates.						
	Our math teacher encourages us to share ideas with one another in class.						
Teachers' emotional support	Our math teacher cares about how we feel.	.759		.713		.915	

	Our math teacher listens to what I have to say.		.800	.986
	Our math teacher considers students' feelings.		.745	.909
Teachers' cognitive support	Our math teacher makes sure that the work we do really makes us think.	.796	.598	.932
	In math class, when we give answers we have to show we understand.		.655	.858
	Our teacher asks us to explain how we got our answers in math.		.681	.841
	When we solve a problem in math, our teacher tells us to keep trying without giving up right away.		.719	.973

Table A3

Overview of all Used Items in the Teacher Questionnaire

Measures teachers' questionnaire		Ω	λbetween
Support for collaboration	Students work together on collaborative math activities.	.914	.635
	Students discuss their work with classmates.		.884
	Students share ideas with one another in class.		.934
	Students help their classmates with their math work.		.900
Emotional support	Teachers treat all students fairly.	.886	.780
	Teachers treat all students with respect.		.839
	Teachers listen to student ideas.		.918
	Teachers make students feel good about themselves.		.724
Cognitive support	Students explain how they got their answers in math.	.855	.928
	Students are encouraged to keep trying when searching for a possible solution to a math problem.		.688
	Students do math work that really makes them think.		.583
	When students give answers in math class, they have to show they understand.		.801

Table A4

Model Fit Indices of the Stepwise Procedure to Test Measurement Invariance Across Time and Level

	χ^2	*df*	*p*	*RMSEA*	*CFI*	*TLI*	$SRMR_{within}$	$SRMR_{between}$
Student interest value								
Configural measurement invariance	414.63	58	.00	.06	0.97	0.96	.02	.04
Metric measurement invariance	432.74	70	.00	.06	0.97	0.96	.02	.03
Scalar measurement invariance	444.45	75	.00	.06	0.97	0.97	.02	.03
Student negative affect								
Configural measurement invariance	33.63	10	.00	.04	0.99	0.97	.01	.08
Metric measurement invariance	41.37	16	.00	.03	0.99	0.98	.01	.09
Scalar measurement invariance	71.05	19	.00	.04	0.98	0.97	.01	.13

Note. Given our longitudinal design, measurement invariance of students' interest value and negative emotions across time (Time 1 to Time2) and across levels (student level and classroom level) were established by using criteria defined by Chen (2007). A change of ≥ -.01 in the comparative fit index (CFI), supplemented by a change of ≥ +.015 in root mean square error of approximation (RMSEA), can be interpreted as an indicator of a lack of invariance. Strong invariance, i.e., invariant factor loadings and intercepts, was confirmed for both scales with an adequate fit for students' interest value and negative affect in Time 1 and Time 2.

Supplement A5

Missing data. Given our interest in associations between students' perceived teacher behavior and teacher-reported behavior in their classes, we used only data from students for whom we have data from their math teachers at Time 1. To do this, we excluded the following cases: From 9,945 participating students at wave 4, it was possible to connect students' data with teachers' data for 2,664 students. Furthermore, only classes with the same teacher at Time 1 (fall term) and Time 2 (spring term) were chosen (N = 1,602 in 110 classes) to interpret longitudinal relations within a relatively stable classroom environment. We excluded classes with less than ten students per class to ensure accurate estimations at the classroom level. This resulted in the final sample of 1,429 students with teacher data.

Mean differences of all reported student variables were checked for students included in the study (N = 1,429) and excluded from the study (N = 8,516). Results show mean differences for students' interest value at Time 1 ($M_{1,429}$=2.58; $M_{8,516}$=2.71; t (9919) = 3.829, $p \leq .05$), perceived teacher support for collaboration ($M_{1,429}$=3.72; $M_{8,516}$=3.66; t (1969) = -2.041, $p \leq .05$), emotional support ($M_{1,429}$=3.46; $M_{8,516}$=3.57; t (9817) = 3.545, $p \leq .05$) and perceived cognitive support from math teachers ($M_{1,429}$=3.90; $M_{8,516}$=3.84; t (9778) = -2.569, $p \leq .05$) as well as students' competence level in math ($M_{1,429}$=323.16; $M_{8,516}$=332.88; t (9778) = -6.898, $p \leq .05$). Despite the significant mean differences, there is no coherent pattern, which would indicate systematic differences in our subsample from the disregarded cases. We examined whether there are systematic missing data for students' gender and students' ethnicity using the Pearson χ^2-Test. To check the null hypothesis, we used a more conservative significance level of $p < .20$. The analysis demonstrated no meaningful associations between the missing cases in the subsample and students' gender (χ^2 [1] = 0.83, $p > .20$) and the frequency of Hispanics in our subsample (χ^2 [1] = 0.89, $p > .20$). Little's missing completely at random test (MCAR) indicated no systematic missing of students' interest value (n = 10, 0.70%) and negative affect (n = 11, 0.78%) between both measurement time (χ^2 [10] = 13,705, p > .05).

Table A6

Descriptive statistics (means, standard deviations) and Intercorrelations between all used variables on the individual level

		1	2	3	4	5	6	7	8	9	10	11
1	Other ethnic groups[a]	-										
2	Asian[a]	-.19***	-									
3	Female	.00	-.06**	-								
4	CST.T0	.06	.32***	-.04*	-							
5	Coll.Sup.T1	-.10***	.07**	.07**	.09*	-						
6	Emo.Sup.T1	-.06*	.02	.05	.06	.68***	-					
7	Cog.Sup.T1	-.10***	.03	.05	.06	.66***	.63***	-				
8	Interest.T1	-.08**	.13***	-.07*	.21***	.28***	.32***	.27***	-			
9	Interest.T2	-.06	.11***	-.06*	.18***	.20***	.24***	.22***	.70***	-		
10	Neg.Aff.T1	.10***	-.07	.05	-.11***	-.35***	-.36***	-.31***	-.52***	-.39***	-	
11	Neg.Aff.T2	.08**	-.03	.04	-.11***	-.21***	-.21***	-.19***	-.37***	-.51***	.50***	
	M				330.00	3.72	3.47	3.90	2.58	2.57	3.04	3.17
	SD				1840.11	0.97	1.05	0.84	1.17	1.15	0.90	0.91
	ICC_1					.22	.19	.18	.14	.13	.13	.13
	ICC_2					.84	.81	.79	.74	.72	.73	.72

Note. ICC = interclass correlation coefficients; CST = California Standards Test in Mathematics; Coll.Supp = Support for collaboration; Emo.Supp = Emotional Support; Cog.Supp = Cognitive Support; Interest = Interest Value; Neg.Aff = Negative Affect; T1 = Time 1; T2 = Time2.

[a] reference group are Hispanic students. * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$.

Table A7

Descriptive statistics (means, standard deviations) and intercorrelations between all used variables on the classroom level

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	ELS.level	-												
2	a.CST.T0	-.43***	-											
3	Grade.level	-.55***	-.26**	-										
4	a.Coll.Sup.T1	.13	.34***	-.41***	-									
5	t.Coll.sup.T1	.09	.30***	-.45***	.60***	-								
6	a.Emo.Sup.T1	.03	.27**	-.24*	.81***	.38***	-							
7	t.emo.Sup.T1	.45***	-.38***	-.13	-.23**	-.22*	-.20*	-						
8	a.Cog.Sup.T1	.17	.30***	-.50**	.84***	.60***	.79***	-.09	-					
9	t.cog.sup.T1	-.02	.20	-.23*	.32***	.65***	.16*	.07	.43***	-				
10	a.Interest.T1	.16	.37***	-.45***	.53***	.46***	.53***	.02	.61***	.33***	-			
11	a.Interest.T2	.06	.29**	-.24*	.39***	.42***	.46***	-.05	.46***	.26**	.80***	-		
12	a.Neg.Aff.T1	-.18	-.25**	.44***	-.67***	-.52***	-.67***	.14	-.62***	-.30***	-.66***	-.52***	-	
13	a.Neg.Aff.T2	-.04	-.16	.13	-.50***	-.38***	-.51***	.30**	-.45***	-.17†	-.51***	-.69***	.64***	-
	M	-	327.03	-	3.69	4.35	3.46	3.96	3.88	4.23	2.58	2.54	3.03	3.16
	SD	-	39.83	-	0.52	0.59	0.51	0.61	0.39	0.51	0.47	0.44	0.35	0.35

Note. ELS = Percent of English Learners in Classrooms; CST = California Standards Test in Mathematics;; Coll.Supp = Support for collaboration; Emo.Supp = Emotional Support; Cog.Supp = Cognitive Support; Interest = Interest Value; Neg.Aff = Negative Affect; a = aggregated (students report); t = teachers report, * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Table A8

Results of the null model and the intraclass coefficients (ρ) *for interest value and negative affect*

		Estimate	S.E.	Est/S.E.	Sig
(1) Negative Affect (T2)					
Within		.76	0.03	24.79	.00
Intercept [u_{oj}]	Variance	.07	0.04	82.86	.00
		ρ = 0.07/(0.07+0.76)=0.08 [8.4%]			
(2) Negative Affect (T1/T2)					
Residual		.58	.03	19.23	.00
Intercept [u_{oj}]	Variance	.04	.01	3.39	.00
		ρ = 0.04/(0.04+0.58)=0.06 [6.3%]			
(3) Interest Value (T2)					
Within		1.21	.04	30.11	.00
Intercept [u_{oj}]	Variance	0.12	.03	4.61	.00
		ρ = 0.12/(0.12+1.21)=0.09 [9.0%]			
(4) Interest Value (T1/T2)					
Residual		0.68	.02	34.54	.00
Intercept [u_{oj}]	Variance	0.03	.01	2.81	.01
		ρ = 0.03/(0.03+0.68)=0.044 [4.4%]			

Note. Formular calculation the intraclass correlation (ρ): ρ = $\frac{\sigma_B^2}{\sigma_B^2+\sigma_W^2}$ (see Heck & Thomas, 2015)

Results

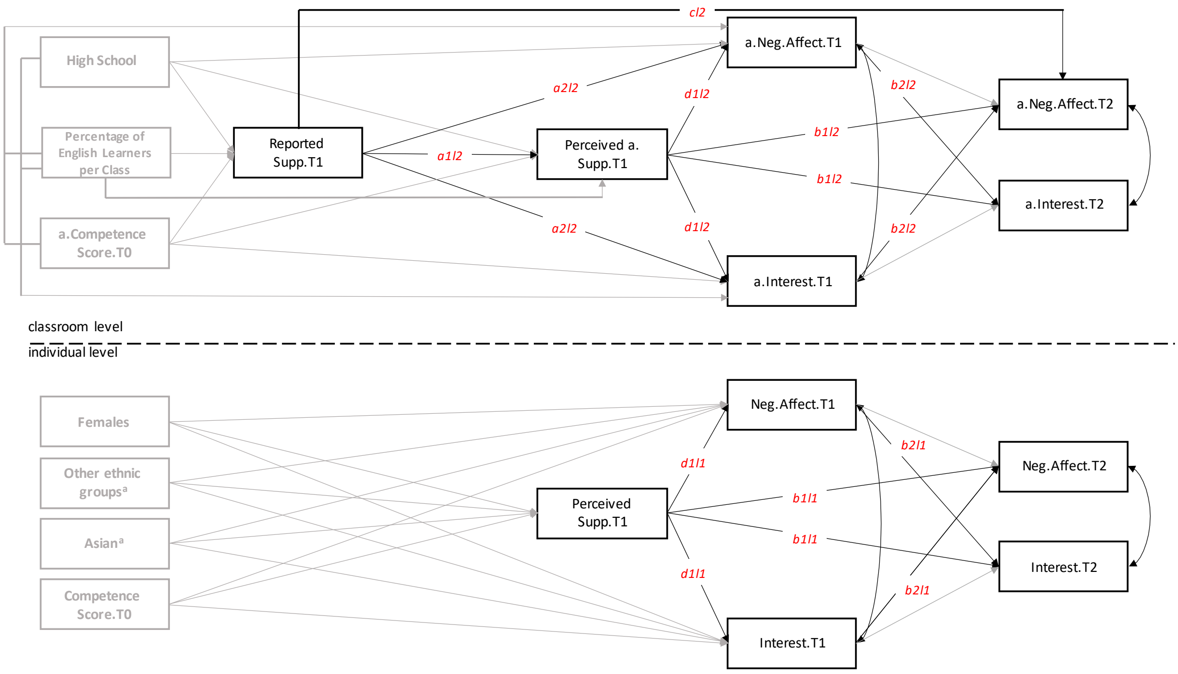
Negative Affect. 8.4% of the total variance in negative affect at Time 2 is associated with the class as opposed to individual. Including negative affect at Time 1 in the model, 17.6% of the total variation of negative affect at Time2 from the null model was explained. However, even after controlling for negative affect at Time 1, significant variation in negative affect at Time 2 exist across classes.

Interest value. 9.0% of the total variance in interest value at Time 2 is associated with the class as opposed to individual. Including interest value at Time 1 in the model, 41.4% of the total variation of interest value at Time2 from the null model was explained. However, even after controlling for interest value at Time 1, significant variation in interest value at Time 2 exist across classes.

Supplement A9

Figure A9.

Model that guided analysis of indirect effects



Syntax to test indirect effects:

<u>Examples</u> of specification of pathin our syntax

%between%

[…]

A_interest_T2 on reported_supp_T1 (**c**);

A_interest_T2 on A_negaffect_T1 (**b2l2**);

A_interest_T2 on perceived_supp_T1 (**b1l2**);

[…]

MODEL CONSTRAINT:

NEW(k l m o p q z1 z2 klm);

k=a1l2*d1l2* **b2l2**; !Indirect classlevel effect (2-2-2-2, 4 steps)

l=a1l2*d1l2*b2l1; !Crosslevel effect (2-2-2-1, 4 steps)

m=a1l2*d1l1*b2l1; !Crosslevel effect (2-1-1-1, 4 steps)

klm = k+l+m; !Overall indirect effect (4 steps)

o=a1l2*d1l2; !Indirect classlevel effect (2-2-2, 3 steps)

p=a1l2*d1l1; ! Crosslevel classlevel effect (2-2-1, 3 steps)

q=a1l2*d1l1+a1l2*d1l2; !Overall indirect effect (3 steps) z1= a1l2*b1l1+a1l2* **b2l2**+a2l2*b1l1+a2l2***b1l2**+k+l+m+**c**; !Total effect (4 steps)

z2= a1l2*d1l2+a1l2*d1l1+a2l2; !Total effect (3 steps)