Teacher–student relationship and academic achievement: a cross-lagged longitudinal study on three different age groups

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Abstract Although the relation between teacher–student relationship and academic achievement has been addressed in many studies, the reciprocal relations between these two constructs have not been explored sufficiently. The aim of the present study was to test three competing models that hypothesized directionality of influence in relations between teacher acceptance, student-perceived teacher support, and academic achievement. Eight hundred sixteen students from 3 different grade levels in Slovenian elementary and secondary schools, covering the age range from late childhood through early-to-middle adolescence, participated in the study at the beginning and at the end of the school year. Structural equation modeling was used. Different models of relations between teacher acceptance, student-perceived teacher support, and academic achievement were analyzed using the cross-lagged panel correlation technique. The results supported the hypothesized reciprocal model, indicating the relation between teacher acceptance and academic achievement in both directions. Student-perceived teacher personal support partially mediates the relation between teacher acceptance and achievement in both directions on the whole sample but not in specific age groups. Finally, we found some age-specific differences in the relations between teacher acceptance, teacher personal support, and achievement.

Keywords Teacher–student relationship · Teacher acceptance · Teacher support · Academic achievement · Structural equation modeling

Introduction

Two of the most important forms of social relations that students form and maintain in school are relations with peers and with teachers, and the former seem to be more consistently related to academic outcomes from childhood to adolescence (Murdock 1999; Ryan et al. 1994). Recent research clearly indicates intertwinement between social relations and academic outcomes in

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students' school adjustment (e.g., Furrer and Skinner 2003; Niehaus et al. 2012; Sakiz et al. 2012; Wentzel 1998). However, to date, the reciprocal relations have not been explored sufficiently; the question of whether teacher acceptance leads to students' achievement or whether students' achievement and other characteristics influence teacher acceptance was either rarely addressed (e.g., Hughes et al. 2008) or the research methodology failed to enable conclusions about reciprocal relations (e.g., Crano and Mellon 1978). In the present study, teacher acceptance was used as one aspect of teacher–student relationship. The aim of the present research was threefold: (1) to test three competing models that assume different directions of relations between teacher acceptance, student-perceived teacher support, and academic achievement; (2) to examine the mediating role of perceived teacher support in the relation between teacher acceptance and academic achievement; and (3) to examine whether the direction and the strength of the relation between the variables mentioned previously differ in three different age groups: late childhood, early adolescence, and middle adolescence.

Effect of teacher–student relationship on academic achievement

The vast majority of studies assume teacher–student relationships to be predictors of students' academic outcomes and, thus, measure the effects of these relationships on different academic measures. For example, Hamre and Pianta (2001) found an effect for teacher–student relationship conflict assessed in the first grade on achievement 7 years later, controlling for relevant baseline child characteristics. Research examining the role of relations with teachers in students' academic achievement variables originates extensively from the self-determination theory (SDT; Connell and Wellborn 1991; Deci and Ryan 2000). This theory is used as a theoretical framework that connects teacher–student interactions with students' engagement and, consequently, their achievement. Of special relevance for the purpose of this research is a mini-theory within SDT called Basic Needs Theory (Ryan and Deci 2002) that assumes three basic psychological needs: autonomy, competence, and relatedness. The social context can either support or thwart these needs, thereby positively or negatively affecting students' engagement. Thus, SDT emphasizes the need for relatedness as one of the basic psychological needs. According to this theory, teachers' involvement is crucial for satisfying the need for relatedness. This refers to the quality of interpersonal relations with students and is manifested through teachers having time for students, expressing positive feelings toward them, being flexible to their needs, etc. Some studies (e.g., Furrer and Skinner 2003; Skinner and Belmont 1993) suggest that teachers' involvement seems to be the strongest predictor of students' academic engagement among all of the other presumably important dimensions of teachers' behavior; the students of highly involved teachers perceive their teachers not only as involved but also as giving more structure and support to students' autonomy, independently of the teachers' actual behavior in these two dimensions. However, the recent meta-analysis from Stroet et al. (2013) does not fully support such conclusions. Based on a systematic review of the evidence on the effects of need supportive teaching on early adolescents' academic motivation and engagement, the authors conclude that, although evidence indicates positive relations of each of the three dimensions of need supportive teaching with students' motivation and engagement, the research of their unique importance is scarce and needs further investigation.

However, the association between students' need for relatedness and their academic outcomes is clearly documented. The sense of relatedness tapped by the measures of school climate and the quality of teacher–student relations, as well as the feelings of belonging, acceptance, importance, and interpersonal support, are related to important academic outcomes, including positive affect (Baker 1999; Birch and Ladd 1997; Skinner and Belmont 1993), effort and self-

efficacy (Sakiz et al. 2012), engagement (Furrer and Skinner 2003; Skinner and Belmont 1993; Wu et al. 2010), self-reported academic initiative (Danielsen et al. 2010), interest in school (Wentzel 1998), self-regulated learning (Ryan and Patrick 2001), and grades (Birch and Ladd 1997; Furrer and Skinner 2003; Niehaus et al. 2012; Roeser et al. 1996; Wu et al. 2010).

Effect of academic achievement on teacher–student relationship

Studies that investigated the relation between teacher–student relationships and academic achievement usually failed to test for the reciprocal effect of achievement on teacher–student relationships. However, some studies investigated the role of students' characteristics (including academic achievement) in the formation of teachers' preference for students. Teacher preference or acceptance is defined as the degree to which a teacher likes a specific student (Mercer and DeRosier 2010) and is usually expressed in teachers' differential interactions with students, although teachers may not be aware of this unequal treatment (Babad 1993). This reasoning assumes a directionality of influence that is opposite to the one mentioned previously: students' achievement is considered as predictor and teachers' perception is considered as outcome.

This model received some empirical support. Namely, students' academic achievement was found to contribute to teachers' perceptions of their students (Aluja-Fabregat et al. 1999) and teachers prefer students with higher achievements (Babad 1993; Davis 2006; Kuklinski and Weinstein 2000; Wentzel and Asher 1995).

The question of directionality of influence in the relation between teachers' expectations and students' achievement was addressed in the study of Crano and Mellon (1978). However, the cross-lagged correlation method used in their study does not allow causal interpretations, although the findings suggest that teachers' expectations cause students' academic achievement.

The mediating role of student perceptions

The relation between teachers' acceptance expressed in teachers' differential behavior toward students and their academic outcomes can operate directly without involving students' interpretative processes (Weinstein et al. 1987). However, the contributions of teachers' perceptions to changes in students' academic outcomes are probably mediated through students' perceptions of their teachers' support (Kuklinski and Weinstein 2001; Skinner et al. 2008; Weinstein et al. 1987). This mediation depends on two conditions: (1) the differences in teacher acceptance of students are expressed in the degree of teachers' supportive behavior and (2) students have the capacity to perceive the expressed level of teacher support. With regard to the first condition, Babad (1990) reported a discrepancy in students' and teachers' perception of teachers' emotional support for students regarding their achievement: students perceived that the high achievers receive more emotional support, whereas teachers reported being more supportive toward low achievers. Although both perspectives can be regarded as valid, this result could also imply the possibility that teachers are unaware of their differential behavior. Also, Kuklinski and Weinstein (2001) reported that teachers differ in their propensities to treat high and low achievers differently: in some classrooms, teachers' differential behavior is more salient than in others. The second condition, i.e., students' capacity to perceive teachers' differential treatment, depends on students' developmental level. However, Weinstein et al. (1987) reported that even first graders identify classroom differences in the degree of differential teacher treatment toward high and low achievers.

In SDT, the measures of self are predicted to be mediators between teacher behavior and students' academic behavior and outcomes, thus assuming that it is not teachers' behavior per se that influences students' motivation, but rather, how they perceive this behavior. Results of a recent meta-analysis by Stroet et al. (2013) revealed that students' perceptions of need supportive teaching are generally positively related to their motivation and engagement. However, in the small body of studies that used observations or teacher perceptions as a measure of need supportive teaching, much smaller associations or even no associations were found. This finding indicates that student perceptions have a larger impact on motivation and engagement than the actual teachers' behavior.

Teacher–student relationship and its relation to academic achievement in different grade levels

The nature of the teacher–student relationship and its meaning for students change over the school years. In transition to adolescence, there is a shift in students' orientation from relations with teachers to increased peer orientation (Lynch and Cicchetti 1997). Studies mostly report a decrease in the quality of teacher–student relationships (Chang et al. 2004; Lynch and Cicchetti 1997; Moritz Rudasill et al. 2010; O'Connor 2010) which may be attributed in part to changes in school context (more students in the class, higher school demands, and fewer opportunities for individual contact with teachers) and partly to an increase in students' need for autonomy (Chang et al. 2004). But despite this decrease, students' relations with teachers remain positively related to students' academic outcomes (Danielsen et al. 2010; Davidson et al. 2010; Niehaus et al. 2012).

Another aspect of age dependency in teacher–student relationships is the development of students' capacity to perceive the differential teacher behavior toward different students. Developmental changes in students' social cognition also imply an increased capacity to perceive the differential teacher treatment (Weinstein et al. 1987), thus assuming a moderating effect of students' age on the links between teacher acceptance, student-perceived teacher support, and achievement. However, research has mostly been focused on students at a single age, ignoring the age-related differences in the magnitude of the relation between teacher perceptions and achievement. One exception is the longitudinal study of Kuklinski and Weinstein (2001) which examined the mediating role of students' self-expectations with respect to indirect teacher expectancy effects on achievement from grades 1 to 5. They reported a significant increase in the direct effects of teacher expectations on children's self-expectations from first grade, when effects were nonsignificant, to fifth grade, but only in classrooms in which differential treatment was pronounced. They also found a significant decline in direct teacher expectancy effects on achievement from first to fifth grade, although the effect still remained significant in the fifth grade.

The current study

In the majority of studies mentioned previously, the teacher–student relationship was assumed to be a predictor and academic variables were seen as an outcome, thus hypothesizing that academic outcomes are influenced by relations with teachers. In this study, three alternative explanations of the relation between teacher–student relationships and students' academic outcomes are presented and explored. (1) Teacher acceptance of students influences students' academic outcomes. In this hypothetical model (M1), the causal relation is mediated by students' perceived personal support from their teachers. Mercer and DeRosier (2010) reported teacher acceptance to be a predictor of students' perceptions of teacher–

student relationship quality. Students' ability to recognize the quality of teachers' treatment is predicted to be crucial for the differences in students' academic achievement. (2) Teacher acceptance of students mostly reflects actual student performance, which implies the opposite causal direction, namely, the influence of students' academic performance on teachers' acceptance (M2). Research shows that students with higher academic motivation, achievement, and self-regulation and stronger identity as a student form better relations with their teachers (Babad 1993; Davis 2006; Wentzel and Asher 1995). Thus, it is possible that teachers just prefer students who are easier to work with and more rewarding for their effort. Also, for this relation, we tested whether it is mediated by students' perceptions of teacher support. (3) The third possible explanation is the reciprocal model (M3) which assumes that, independently of the initial direction of causality, the relation between teacher acceptance and students' academic outcomes becomes reciprocal, i.e., teachers form more positive relations with students that achieve better, which influences students' perceived support from their teacher, and this positive relation reinforces students' academic performance. This is the relation that Skinner et al. (2008) described as "dynamics": the internal and external causal feedback loops that serve to promote or undermine the quality of children's performance in school over time. Students who are engaged and perform better receive more teacher involvement than disaffected students, where teachers increasingly withdraw their support and/or become more controlling in time. In that way, the initial dynamics are amplified (Hughes et al. 2008; Skinner and Belmont 1993).

With regard to developmental changes in the teacher–student relationship (e.g., Chang et al. 2004; Moritz Rudasill et al. 2010), we were also interested in whether the relations between teacher acceptance, perceived teacher personal support, and academic achievement are contingent on students' age. Thus, the proposed models were tested using three different age groups: students in late childhood (fourth grade of elementary school), early adolescence (seventh grade of elementary school), and middle adolescence (second grade of secondary school).

Three hypotheses were tested:

1. Teacher acceptance and students' academic achievement are reciprocally related in all three age groups included in the study.
2. Student-perceived teacher support mediates the link between teacher acceptance and academic achievement.
3. The strength of the direct and mediated effect of teacher acceptance on academic achievement and the reversed direct and mediated effect of academic achievement on teacher acceptance are independent of students' age: these effects are constant in all three age groups (late childhood, early adolescence, and middle adolescence).

Method

Participants and procedure

Eight hundred sixteen students from 45 classrooms in 8 Slovenian elementary schools and 5 secondary schools from one urban district participated in the study. This included 302 fourth grade elementary school students (mean age at the time of the first measurement, 9.85 years; SD=0.45; 53.7 % male), 287 seventh grade elementary school students (mean age at the time of the first measurement, 12.94 years; SD=0.47; 54 % male), and 227 second grade high school students (mean age at the time of the first measurement, 15.98 years; SD=0.88; 50.7 % male). From the developmental point of view, participants covered the age range

from late childhood to early and middle adolescence. The data about the participants' ethnicity was not collected.[1]

All public elementary schools in one of the largest urban districts in Slovenia were approached, and those that agreed to participate were included in the study. Thus, all study-relevant schools were contacted. However, the choice of the study location was rather convenient in nature. In the sample of high school students, all forms of upper secondary school education were represented. Sampling was proportional, considering the data of the Ministry of Education and Sport about the enrolment structure of the upper secondary school programs.

Also, 45 class teachers from the classrooms included in the study assessed the preference they have for all the students in the classroom. No additional information about teachers' demographics was collected.

The number of all students in all classrooms included in the study was 1,165. However, only students who returned signed parental permission forms participated in the study. Due to absences on data collection days and movement to and from schools throughout the year, different numbers of students completed the surveys at each time point. Students were included in the analyses reported here if they had complete data on all variables included in the study at both data collection points. Patterns of missing data were analyzed by student gender and academic achievement. Independent sample t tests indicated no statistically significant gender and academic achievement differences between students with complete data and students who were dropped from the analyses at any of the collection points ($p<0.05$).

The data were collected at the beginning (September) and at the end (May) of the school year (8-month time lag). The questionnaire for students was administered collectively in the classrooms by the first author who was also available to assist students. Students were told they should reveal information about their relations with teachers. The time available to complete the questionnaire was unlimited. The majority of students completed the questionnaires in 5 to 10 min. Because of the longitudinal research design and the triangulation with teachers' assessments, the data collection was not anonymous (the students had to write their name and the first letter of their surname). However, complete confidentiality was guaranteed to them. During the classroom testing, teachers were asked to assess their acceptance of every student in the class and students' grade point average (GPA).

Slovenian school system

Compulsory basic education in Slovenia is organized into a single-structure (ISCED 1 and ISCED 2) 9-year basic school attended by pupils aged 6 to 15 years (Key Data on Education in Europe 2012). Upper secondary education takes 2 to 5 years (but mostly 4 years). Educational programs include vocational, professional, and general ("gimnazija") programs. Compulsory and upper secondary education is free (National System Overview on Education System in Europe 2011).

The National Curriculum Document, adopted by the National Council of Experts for General Education, comprises the general content of compulsory subjects and general objectives and knowledge standards that all pupils should achieve. Within this framework, schools and teachers specify the actual content of subjects; they choose their own teaching methods and have freedom to select textbooks and exercise books of their choice. Basic school activities

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[1] However, according to the document "Religious, linguistic and ethnic structure of the population of Slovenia" (Šircelj 2003), the biggest ethnic group in Slovenia are Slovenes (83.1 %). Others are Serbs (2.0 %), Croats (1.8 %), Bosniaks (1.1 %), and others/unspecified (12.0 %).

include the compulsory curriculum and the extracurricular activities. Attendance of the latter is optional (National System Overview on Education System in Europe 2011).

In elementary schools, the law stipulates a maximum of 28 pupils per class. The average actual class size in 2010/2011 was 19 pupils (ISCED 1 and ISCED 2) (National System Overview on Education System in Europe 2011). Students are allocated to a school on the basis of geographical criteria but parents may request an alternative one (Key Data on Education in Europe 2012). Students are organized in classes independently of their gender, ability level, or ethnic affiliation. From years 1 to 3, students are generally taught the majority of subjects by their class teachers. In the fourth year of elementary education, teaching and school subject responsibilities gradually become divided among teachers, although in the fourth and fifth grades, the class teacher still teaches the majority of subjects. During the whole elementary and secondary schooling period, a class teacher is assigned to every class. The class teacher teaches the students at least one subject (Key Data on Education in Europe 2012).

Because of the unitary school system, it is reasonable to regard the participating elementary school classes as demographically representative of other classes in the selected periods of schooling.

Measures

Teacher acceptance

An established (i.e., Chang et al. 2004; Wentzel 1993, 1994) single-item measure was used to assess teachers' preference for students in their classrooms. The class teachers received the following instruction: *Considering the numerous differences between the students, it is normal and human that the teacher does not like all students in the same way, although he/she behaves equally fairly to all of them. For all of the students in the class, please indicate how much you would like to have this student in your class again next year.* The ratings were made on a five-point scale (*1—not at all*; *5—very much*).

Perceived teacher personal support

Perceived support from teachers was measured by the Teacher Personal Support subscale of the Classroom Life Measure (Johnson et al. 1983). The scale was adapted into Slovenian for the purposes of this study. The four-item scale measures perceived personal support from the teachers (e.g., My teacher really cares about me) on the five-point scale ranging from never (1) to always (5). Students of the seventh grade and secondary school students were instructed to bear in mind the majority of teachers.

Academic achievement

The class teachers were asked to provide information about students' GPA in the previous school year (first measurement at the beginning of the school year) and in the current school year (second measurement at the end of the school year).

Plan of analyses

Similar to the vast majority of studies in the school context, our study included a three-level nested data structure with students nested in classrooms from different schools. As there

might be a large clustering effect for all three study outcomes (i.e., teachers' acceptance, teacher personal support, and academic achievement), multilevel structural modeling would be the preferred method to analyze our data. However, our research question per se does not involve multilevel relations. Based on this, we examined our research questions using the cross-lagged panel correlation (CLPC) technique (Cole and Maxwell 2003; Selig and Preacher 2009). This technique is particularly popular when testing causal processes between constructs, as it tests the effect between constructs over time when controlling for the stability of the construct. Several studies from the field of educational as well as developmental psychology have applied this technique (e.g., Brensilver et al. 2011; Mercer and DeRosier 2008). Structural equation modeling using Amos 18.0 (Arbuckle 2009) was applied to test several competing models for the relations between teacher acceptance, personal support, and academic achievement.

First, however, a measurement model of the perceived teacher personal support scale was examined. As data were collected from two measurement points, a test of measurement invariance was conducted (Little et al. 2007). In a second step, the CLPC technique was applied. First, the stability model (M0), including teacher acceptance, teacher personal support, and academic achievement and their temporal stabilities and cross-sectional correlations, were tested. More precisely, we specified the structural paths between each time 1 (T1) variable and its time 2 (T2) counterpart as well as the correlations between all T1 variables. No other longitudinal relationships were modeled. In the causal model (M1), which is an upgrade of M0, additional paths were added from T1 teacher acceptance to T2 teacher personal support and from T1 teacher personal support to T2 academic achievement. By following the recommendations of Cole and Maxwell (2003), the significance of the indirect paths was inspected in order to confirm the mediation of teacher personal support. In half-longitudinal designs, which was the case in our study, only partial mediation can be confirmed by a significant ab estimate (i.e., a=path from X in T1 to M in T2; b=path from M in T1 to Y in T2). The Sobel test has been used to determine the significance of the indirect effect. The significance of a direct effect c (i.e., direct path from X in T1 to Y in a potential third time point) cannot be determined. We, however, added a direct path from T1 teacher acceptance to T2 academic achievement because an empirical relation between X and Y is a necessary precondition for mediation. We also tested whether the causal order between our variables could exhibit another pattern, which is one of the main advantages of the CLPC technique. In the reversed causation model (M2), paths from T1 teacher personal support to T2 teacher acceptance and from T1 academic achievement to T2 teacher personal support were included in addition to the basic M0 model. A direct link between T1 academic achievement and T2 teacher acceptance was also included in the reversed causation model. Finally, a reciprocal model (M3), which included all paths from M1 and M2, was tested as well.

We also conducted a multigroup analysis to examine the model fit in three different age groups (late childhood—fourth grade elementary school, early adolescence—seventh grade elementary school, and middle adolescence—second grade high school). Thus, the moderating effect of age groups was examined beside the main effects of the variables on each other across time lags. After establishing the best-fitting model, an unconstrained model was compared to a fully constrained model where all structural paths were set to be equal across groups. In the case of a significant difference between models, a subsequent path-by-path analysis, with constraints on each structural path in the final model, would follow.

Model fit was assessed using the common chi-square (χ^2) statistic, the goodness-of-fit index (GFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). Values of GFI and CFI should be 0.90 and higher, whereas the RMSEA should be lower than 0.08 to indicate an acceptable fit (McDonald and Ho 2002). Differences between

nested models were tested using the χ^2 difference tests. A significant difference in χ^2 between two nested models was used as an indicator of superiority of one model over the other.

Results

Descriptive statistics and preliminary analyses

Means and standard deviations across age groups as well as analyses of variance (ANOVAs) and post hoc tests are shown in Table 1. Significant differences across age groups occurred in all three study variables at both time points. Post hoc comparisons showed that the late childhood group differed noticeably from the early adolescence and middle adolescence groups in terms of teacher acceptance (early adolescence only), teacher personal support, and academic achievement (at T1 and T2). The late childhood group scored highest on all three variables of interest. Descriptive statistics, correlations, and reliabilities of all study variables at both measurement points for the total sample are presented in Table 2. Correlations within and between time lags were in the excepted directions. Teacher acceptance at T1 and T2 was positively related to teacher personal support and academic achievement at T1 and T2. Teacher personal support and academic achievement were positively correlated at both measurement points and across T1 and T2 as well. All correlations were small to moderate in size with the highest observed between construct, the correlation being 0.44 for teacher acceptance and academic achievement (in T2). As

Table 1 Descriptive statistics and univariate ANOVAs across age groups

	Late childhood (4th grade elementary; $n=302$)		Early adolescence (7th grade elementary; $n=287$)		Middle adolescence (2nd grade high school; $n=227$)		F	df_1	df_2
	M	SD	M	SD	M	SD			
T1									
1. Teacher acceptance[a]	4.47	0.87	4.21	0.97	4.39	0.86	6.44**	2	813
2. Teacher personal support[b]	4.16	0.80	3.24	0.83	3.19	0.67	137.85***	2	536.90
3. Academic achievement[c]	4.40	0.81	4.11	0.89	3.30	0.75	136.57***	2	530.97
T2									
4. Teacher acceptance	4.42	0.82	4.23	0.94	4.28	0.82	3.92*	2	813
5. Teacher personal support	3.98	0.84	3.14	0.76	3.03	0.65	121.30***	2	538.03
6. Academic achievement	4.22	0.84	3.71	1.15	2.96	1.16	99.23***	2	492.66

As for all variables, except teacher acceptance (T1 and T2), where the assumption of homogeneity of variance was violated, Welch's F was used instead of the F ratio. Bonferroni and Dunnett's T3 post hoc tests were computed in cases of homogeneity and heterogeneity of variance, respectively

*$p<0.05$; **$p<0.01$; ***$p<0.001$

[a] Post hoc comparison showed the following significant differences: fourth grade>seventh grade (T1 and T2)

[b] Post hoc comparison showed the following significant differences: fourth grade>seventh grade, second grade (T1 and T2)

[c] Post hoc comparison showed the following significant differences: fourth grade>seventh grade>second grade (T1 and T2)

Table 2 Means, standard deviations, reliabilities, and correlations (total sample)

	M	SD	1	2	3	4	5	6
T1								
1. Teacher acceptance	4.36	0.91	–					
2. Teacher personal support[a]	3.57	0.90	0.13***	(0.84)				
3. Academic achievement	3.99	0.93	0.37***	0.24***	–			
T2								
4. Teacher acceptance	4.31	0.87	0.65***	0.18***	0.38***	–		
5. Teacher personal support	3.42	0.88	0.23***	0.62***	0.34***	0.28***	(0.75)	
6. Academic achievement	3.69	1.16	0.38***	0.28***	0.79***	0.44***	0.34***	–

All variables range from 1 to 5, with higher values reflecting a greater magnitude of the variable. Alpha reliability coefficients of teacher personal support are shown on the diagonal

*p<0.05; **p<0.01; ***p<0.001

[a] The measures were invariant across time points (difference between constrained and unconstrained model: $\Delta\chi^2 (3)=4.23$, p=ns). General model fit was very good ($\chi^2 (15)=22.52$; GFI=0.99; CFI=0.99; RMSEA=0.03)

shown in Table 2, the teacher personal support measure exhibited good reliability (0.84 and 0.75 at T1 and T2, respectively). Further support for the psychometric appropriateness of the measure offered a factorial invariance test where we found that the teacher personal support measure functioned the same way at both points.

Teacher–student relationship and academic achievement

As shown in Table 3, the stability model (M0) was marginally acceptable ($\chi^2(48)=221.89$). Academic achievement was most stable across time lags (standardized path coefficient [SPC]= 0.79, p<0.001). Teacher acceptance and personal support were also relatively stable between T1 and T2 (SPC=0.65, p<0.001 and SPC=0.75, p<0.001, respectively). The causal model (M1), however, was found to be superior to M0 ($\Delta\chi^2(3)=57.80$, p<0.001) and was acceptable overall. With respect to our research questions, the links between teacher acceptance in T1 and teacher personal support in T2 (SPC=0.11, p<0.001), as well as between teacher personal support in T1 and academic achievement in T2 (SPC=0.11, p<0.001), were found to be relevant. M1 also included the direct link between teacher acceptance in T1 and academic achievement in T2 which was significant (SPC=0.10, p<0.001). Furthermore, the reversed causation (M2) model fitted the data significantly better than M0 ($\Delta\chi^2(3)=71.23$, p<0.001) as well. In terms of other

Table 3 GFIs for competing models

Model	χ^2	df	GFI	CFI	RMSEA	$\Delta\chi^2$	Δdf
M0: Stability	221.89	48	0.96	0.95	0.07		
M1: Causality	164.09	45	0.97	0.97	0.06	M1–M0: 57.80***	3
M2: Reversed causation	150.66	45	0.97	0.97	0.05	M2–M0: 71.23***	3
M3: Reciprocal model	102.89	42	0.98	0.98	0.04	M3–M0: 119.00***	6
						M3–M1: 61.20***	3
						M3–M2: 47.77***	3

χ^2 chi-square statistic, df degrees of freedom, GFI goodness-of-fit index, CFI comparative fit index, RMSEA root mean square error of approximation, $\Delta\chi^2$ chi-square difference test

GFIs, M2 was satisfactory and even better than M1. As assumed, cross-lagged relationships from teacher personal support in T1 to teacher acceptance in T2 (SPC=0.09, $p<0.01$) as well as academic achievement in T1 and teacher personal support in T2 (SPC=0.18, $p<0.001$) were also found to be significant. The direct link between academic achievement in T1and teacher acceptance in T2 was significant as well (SPC=0.14, $p<0.001$). Finally, the reciprocal model (M3) exhibited very good fit to the data and was also superior to M0 ($\Delta\chi^2(6)$=119.00, $p<0.001$), M1 ($\Delta\chi^2(3)$=61.20, $p<0.001$), and M2 ($\Delta\chi^2(3)$=47.77, $p<0.001$). Figure 1 illustrates the reciprocal relationships of the study variables in T1 and T2. Teacher acceptance in T1 positively predicted personal support and academic achievement in T2. Additionally, teacher personal support in T1 positively predicted academic achievement in T2. In the reversed direction, academic achievement in T1 positively predicted teacher personal support and teacher acceptance in T2. In addition, teacher personal support in T1 was positively linked to teacher acceptance in T2. To summarize, the best fit to the relationships between teacher acceptance, personal support, and academic achievement in the total sample was the cross-lagged reciprocal model.

The mediating role of teacher personal support

In two-wave (half-longitudinal) designs, only partial mediation can be tested (Cole and Maxwell 2003). In the three models (M1, M2, and M3), the necessary precondition (i.e., a direct connection between predictor and outcomes) was fulfilled, as T1 teacher acceptance was significantly related to T2 academic achievement and vice versa. A further condition for
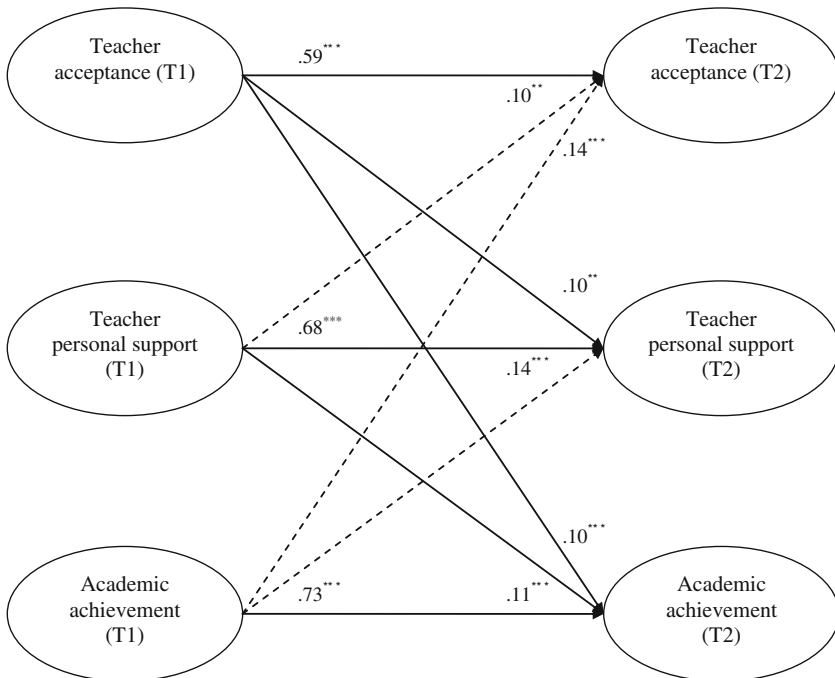

Fig. 1 SPC for the final (reciprocal) model. Only significant structural paths are shown. *Dashed lines* indicate the reversed causal direction. Error term coefficients and correlation coefficients are not shown for presentation clarity purposes

mediation to occur is a significant relation from the predictor to the mediator (path *a*) and from mediator to outcomes (path *b*). When looking at the results from the models M1, M2, and M3, in each case, the *a* and *b* paths were significant. Support for the partial mediation of teacher personal support between T1 teacher acceptance and T2 academic achievement also provided a significant indirect (*ab*) effect obtained by the Sobel test ($Z=3.00$; $p<0.01$). With respect to the reversed causal order, the (*ab*) path from academic achievement in T1 and teacher acceptance in T1 via personal support was significant as well ($Z=2.52$; $p<0.05$). Support for significant indirect effect in both directions was also found from the reciprocal model (Z—causation= 2.46; $p<0.05$ and Z—reversed causation=2.48; $p<0.05$). As other authors (Cole and Maxwell 2003; Taris and Kompier 2006) also suggested that the causal relations between predictors and mediators as well as mediators and outcomes should be tested in separate models, we double checked our mediation results by applying such a procedure. The results were invariant across both approaches. Therefore, we conclude that teacher personal support is a partial mediator of the acceptance–achievement link in both directions.

Differences between age groups

With respect to age group differences, we found a significant difference between the fully constrained and the unconstrained model ($\Delta\chi^2(30)=62.50$, $p<0.001$), thus indicating that our model is different across groups. More precisely, differences were found in the stability of academic achievement across groups. Higher stabilities were detected in late childhood and early adolescence ($\beta=0.77$, $p<0.001$ and $\beta=0.78$, $p<0.001$, respectively) than in middle adolescence ($\beta=0.50$, $p<0.001$). In addition, differences were also found in the relations between teacher acceptance, teacher personal support, and academic achievement. First, teacher acceptance in T1 was more strongly related to teacher personal support in T2 during late childhood ($\beta=0.25$, $p<0.001$) than in early and middle adolescence where this particular structural path was nonsignificant. Second, teacher personal support in T1 was more strongly related to teacher acceptance in T2 during early and middle adolescence ($\beta=0.21$, $p<0.001$ and $\beta=0.15$, $p<0.001$, respectively) than during late childhood where no such link was found. In addition, the most consistent cross-lagged reciprocal relationships between age groups were found between teacher acceptance in T1 and academic achievement in T2.

Interestingly, teacher personal support was not a partial mediator between acceptance and achievement in any of the causal directions when considering the preconditions for mediation (e.g., Cole and Maxwell 2003; Fairchild and McQuillin 2010). As shown in Table 4, in each of the groups, some of the necessary paths failed to reach significance.

Discussion

The main aim of this study was to explore the reciprocal effects between teacher acceptance, student-perceived teacher support, and academic achievement in different age groups. Three models with different directions of influence between constructs in two measurements (T1—beginning of the school year; T2—end of the school year) were tested using the CLPC technique. By testing these three models, we aimed to examine three possible assumptions: (1) teacher acceptance leads to achievement gains (M1); (2) students' academic achievement leads to teacher acceptance (M2); and (3) both pathways exist simultaneously (M3).

As shown in the "Results" section and Table 3, all three models exhibited an acceptable fit, with the reciprocal model that combines structural paths from causality and reversed causality models being superior to these two models. Perceived teacher personal support partially mediated

Table 4 Age group differences in SPCs of the final (reciprocal) model

	Late childhood (4th grade elementary)	Early adolescence (7th grade elementary)	Middle adolescence (2nd grade high school)	Differences between groups ($\Delta\chi^2$)
Teacher acceptance (T1)→teacher acceptance (T2)	0.62***	0.53***	0.57***	
Teacher personal support (T1)→teacher personal support (T2)	0.46***	0.64***	0.67***	
Academic achievement (T1)→academic achievement (T2)	0.77***	0.78***	0.50***	$\Delta\chi^2(2)=13.15$, $p<0.01$
Teacher acceptance (T1)→academic achievement (T2)	0.10**	0.11**	0.13*	
Teacher acceptance (T1)→teacher personal support (T2)	0.25***	0.10	−0.01	$\Delta\chi^2(2)=8.96$, $p<0.05$
Teacher personal support (T1)→academic achievement (T2)	0.02	0.11**	0.05	
Academic achievement (T1)→teacher personal support (T2)	0.13*	0.09	0.15	
Academic achievement (T1)→teacher acceptance (T2)	0.16***	0.24***	0.06	$\Delta\chi^2(2)=5.32$, $p<0.10$
Teacher personal support (T1)→teacher acceptance (T2)	0.01	0.21***	0.15*	$\Delta\chi^2(2)=7.02$, $p<0.05$

the link between teacher acceptance and academic achievement in both causal directions, which partly confirms our second hypothesis. Students that are more accepted by their teachers at the beginning of the school year seem to perceive more teacher personal support at the end of the school year (see also Mercer and DeRosier 2010); students with higher perceptions of teacher personal support at the beginning of the school year have better achievements at the end of the school year (see also Danielsen et al. 2010). The reverse direction was also established: students with higher academic achievement at the beginning of the school year reported higher levels of teacher personal support at the end of the school year; students with higher levels of teacher personal support at the beginning of the school year were more accepted by their teachers at the end of the school year. Beside these indirect effects, a direct relation between teacher acceptance and academic achievement also existed: students with higher teacher acceptance at the beginning of the school year had higher achievement at the end of the school year and students with higher achievement at the beginning of the school year were more accepted by their class teacher at the end of the school year. However, the strength of all the effects mentioned previously is small and of similar magnitude in all directions.

Despite the rather small effects, these results indicate that the relation between some aspects of the teacher–student relationship (i.e., teacher acceptance and student-perceived teacher support) and academic achievement adopts a form of reciprocal dynamics, described by Skinner et al. (2008) as "causal feedback loops that serve to promote or undermine the quality of children's performance in school over time." Regardless of the initial causal direction, the mutual influence between these constructs is amplified over time, with all the constructs reinforcing each other and, therefore, also reinforcing students' good/poor school adjustment (compare with Hughes et al. 2008; Skinner et al. 2008; Wentzel 2003).

The relation between teacher–student relationships and academic achievement could also be moderated and/or mediated by some other student-related nonacademic (e.g., students' intelligence, students' social behavior) and academic (e.g., engagement) variables that were not included in this study. Beside students' demographic characteristics like gender and ethnicity that are discussed later in the text, research indicates that teachers prefer students who are prosocial, responsible, and cooperative (Wentzel 1993) and that similar students' characteristics are also positively related to students' achievement (Casillas et al. 2012; Wentzel 1993). From the academic factors that can play the mediating role between the aspects of teacher–student relationships and academic achievement, the role of students' academic engagement is well documented. Students' engagement is predicted by their sense of relatedness with teachers (Furrer and Skinner 2003) and teacher support (Skinner et al. 2008) and mediates the relation between the teacher–student relationships and achievement, with a reciprocal causal relationship between engagement and achievement (Hughes et al. 2008). However, the primary aim of this study was the examination of the reciprocal effects between the teacher–student relationship and academic achievement without taking into account other potential factors mediating or otherwise influencing this relationship.

Differences between age groups

There are some differences in the relations between teacher acceptance, teacher personal support, and achievement with respect to age groups. The relation between teacher acceptance at the beginning of the school year and teacher personal support at the end of the school year was stronger in late childhood than in the two older age groups where this relation was nonsignificant. Because of the inequalities in the organizational contexts between age groups (one teacher teaching the majority of subjects only in the youngest

age group, wherein in all three groups, class teachers provided the teachers acceptance measure), any interpretation of this finding would be unjustified and too speculative.

In the reverse causal direction, a different tendency occurred: perceived teacher personal support at the beginning of the school year predicted teacher acceptance at the end of the school year only in both older age groups, i.e., students of early and middle adolescence. Thus, adolescents who perceived that their teachers cared for them at the beginning of the school year were better accepted by their class teachers at the end of the school year. This implies that the direction of the relation between teacher acceptance and student perception of teacher support is probably age-specific. In the youngest group, teacher acceptance predicted student-perceived teacher support, suggesting that students become aware of their teachers' (dis)like over time. Similar results were also reported by Mercer and DeRosier (2010). However, in adolescence, perceived support from the majority of teachers becomes a predictor of their class teacher acceptance. It can be speculated that this relation is mediated through students' behavior toward teachers: students who perceive that their teachers care for them behave in a friendlier manner toward them, which can cause changes in teachers' attitude toward these students. Such interpretation is consistent with the dyadic system model of teacher–student relationships, assuming that the feedback loops between students and teachers are determining the quality of their relations (Hamre and Pianta 2006). Again, it should be noted that these effects are small, indicating that other factors may also be implicated. Also, the methodology of this research does not allow conclusions about developmental trends; longitudinal data would be needed for such interpretations.

Although teacher personal support proved to be a partial mediator in the relation between teacher acceptance and achievement in the whole sample, this was not the case in any of the age groups where only a direct relation emerged. As predicted in our third hypothesis, the strength of this relation was similar in all three age groups (with the already mentioned exception of the nonsignificant relation between achievement in T1 and teacher acceptance in T2), suggesting that teacher–student relations also maintain their importance in understanding students' academic performance during the transition to adolescence (see also Danielsen et al. 2010; Davidson et al. 2010; Niehaus et al. 2012).

Limitations

The present study has several limitations that should be taken into account when interpreting and generalizing the results. The study was short-term longitudinal, across three age groups, so the differences between students of different age groups cannot be interpreted as developmental changes in relations between teacher–student relationships and academic achievement. Also, the mediating role of perceived teacher support was tested on the basis of two measurements, whereas three different measurement points should be provided for the full mediational design (Cole and Maxwell 2003). In addition, the stationarity assumption, which refers to the unchanging causal structure across time and is required to test full mediation, may not hold. However, two waves are the minimum requirement for testing mediation and represent a significant improvement over cross-sectional studies, as one is able to control for prior levels of the mediator and outcome.

The results of the present study should also be interpreted with caution, as the data had a nested structure (i.e., pupils in classes from different schools) which was not really addressed in the analyses. MLM was not applied, as we did not examine multilevel research questions. Controlling for clustering, however, is not ignorable but was omitted due to restrictions of the analysis software. In such cases, the estimation of standard error of means and beta

coefficients is usually downwardly biased (e.g., Trautwein et al. 2006). Readers should, therefore, note that potentially wrong conclusions have been reached because clustering was not controlled for.

Another obstacle for the interpretation of results is connected with some problematic aspects of the teacher acceptance assessment. First, the assessment of teacher acceptance in both older age groups was based on the assumption that the class teacher–student relation is a representative measure for the relations that students form with all the teachers that teach them, i.e., with teachers in generals. However, this is not necessarily the case. The assessment by two (or more) teachers would improve the reliability (and, thus, also validity) of the teacher acceptance measure in both older age groups. Second, the measure is prone to giving socially desirable responses. This tendency was probably partly reduced by the instructions but it could still affect the validity of the teacher acceptance measure. Third, on a minor note, teacher acceptance was measured using a single-item measure, which can be potentially problematic. However, there is ample evidence suggesting that single-item measures can be as valid and reliable as multi-item measures for assessing attitudes (e.g., Wanous et al. 1997) and even personality traits (Robins et al. 2001).

Implications and future research

This study contributes a small piece in the understanding of the relation between teacher–student relationships and achievement, providing some empirical support for the reciprocal nature of this relation. This finding has implications for school policymakers, teacher educators, teachers, and school psychologists. The reciprocal dynamics that were indicated, though not fully confirmed in this study, represent an important potential factor that contributes to the stability of students' school adjustment, with both constructs mutually reinforcing each other and leading to the amplification of the initial relation. This can represent a serious problem for students who start school academically at risk. To break these dynamics, the interventions provided to help at-risk students should focus on both social and academic factors of student school adjustment; otherwise, generalization of their effects is questionable. Also, establishing significant relations between teacher–student relations and academic achievement in both directions, our study implies the importance of teacher–student relations in students' academic performance, which is in accordance with the research theoretical foundations primarily originating from the SDT (Connell and Wellborn 1991; Deci and Ryan 2000). Teachers differ in their ability to provide personal support for students, and this differentiation is probably even larger in providing support for at-risk students whose behavior is less rewarding for teachers' efforts. Hargreaves (2000) reports that teachers feel rewarded when students show affection toward them and when they demonstrate that they enjoy their learning, which is a description of well-adjusted, academically engaged students. Therefore, teachers' ability to also establish and maintain warm and supportive relations with students with lower academic adjustment should be emphasized in teacher education and continuing professional development. Teachers' ability to regulate negative emotions toward students and express positive emotions that would not arise spontaneously represents a part of teachers' emotional work concept (Hargreaves 2000; Philipp and Schüpbach 2010). The ability to regulate and to mask negative emotions is crucial when working with students that teachers do not particularly like. Thus, it is important for teachers to develop the skills of managing and regulating the negative emotions toward students that can arise in their teaching practice. This can be assisted by the school psychologist who should provide an emotionally safe end nonevaluative context that enables teachers to express and reflect negative work-related or student-related emotions

(e.g., individual consultations, school supervision groups). We can assume that such practice would decrease the significant link between teacher acceptance and student-perceived teacher personal support found in this study; however, the effectiveness of such interventions should be empirically supported and could be the subject of future research. Teacher educators and school psychologists can also contribute to teachers' awareness of the influence they have on students' academic adjustment, not only in earlier grades but also in adolescents.

In this study, students' grades were used as a measure of their academic achievement; this measure was deliberately used as an aspect of student achievement that is more directly related to student motivation compared to standardized tests. However, the results would probably be different if a standardized test as a more objective measure of academic achievement was used (see, e.g., Pinxten et al. 2010). Further research might explore this question.

The role of students' gender was not addressed in this study; however, the relation between both aspects of teacher–student relationships and academic achievement could be moderated by students' gender. It is well documented that teachers form more supportive and less conflictive relations with girls, as assessed by teachers (Birch and Ladd 1998), students (Moritz Rudasill et al. 2010), and peers (Hughes et al. 2001). However, Furrer and Skinner (2003) reported that boys show stronger effects of teacher relatedness on their classroom engagement, indicating that the relation between relations with teachers and academic performance and its causal direction could be gender-specific. Future studies should, therefore, also focus on the role of gender and other demographic characteristics (e.g., ethnicity) in the nature of the relation between social and academic variables and its interaction with student age.

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Students' social relations in school context. Assessment of students' social relations. Teachers' professional development.

Most relevant publications in the field of Psychology of Education:

Košir, K., Pečjak, S. (2005). Sociometry as a method for investigating peer relationships: What does it actually measure? *Educational Research, 47*(1), 127–144.

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Most relevant publications in the field of Psychology of Education:

None.