Longitudinal relations between perceived autonomy and social support from teachers and students' self-regulated learning and achievement

Schuitema, J.; Peetsma, T.; van der Veen, I.

DOI
10.1016/j.lindif.2016.05.006

Publication date
2016

Document Version
Final published version

Published in
Learning and Individual Differences

Learning and Individual Differences 49 (2016) 32–45

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Longitudinal relations between perceived autonomy and social support from teachers and students' self-regulated learning and achievement

Jaap Schuitema *, Thea Peetsma, Ineke van der Veen

Research Institute Child Development and Education, University of Amsterdam, Nieuwe Achtergracht 127, 1018 WS, Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Received 31 May 2014
Received in revised form 29 January 2016
Accepted 16 May 2016

Keywords:
Self-regulated learning
Perceived teacher support
Reciprocal relations
Student motivation
Learning environment
Self-determination theory

ABSTRACT

Most research investigating the relation between perceived teacher support and self-regulated learning (SRL) is cross-sectional, and little is known about the direction of the effects. This longitudinal study investigated the direction of the effects between students' perceptions of autonomy support and social support from teacher on two behavioural aspects of SRL: delay of gratification and metacognitive strategy use. A second aim was to investigate the extent to which the effects of perceived teacher support on student achievement were mediated by SRL. Students ($N = 701$, age 12) completed questionnaires five times during their first 2 years in secondary education. Cross-lagged autoregressive models revealed small reciprocal effects in both directions between delay of gratification and perceived autonomy support. Metacognitive strategy use predicted perceived autonomy support and perceived social support from teachers predicted both aspects of SRL. The study revealed a small mediating effects from SRL between perceived teacher support and achievement.

1. Introduction

How can teachers promote student motivation and achievement in school? Self-determination theory (SDT; Deci & Ryan, 2000) maintains that learning environments that support students' basic psychological needs for autonomy, competence and relatedness facilitate students' self-regulated learning (SRL) and indirectly promote students' academic achievement. Teachers play an important role in providing a learning environment that supports students' basic needs to become motivated and engage in self-regulated learning (SRL). Many studies in the field of education have demonstrated that students' perceptions of their teachers' need supportive behaviour is related to students' motivation (Stroet, Opdenakker, & Minnaert, 2013). Most studies investigating teachers' support of students' basic needs have focused on perceived autonomy support (e.g. Assor, Kaplan, & Roth, 2002; Van Grinsven & Tillema, 2006). Teachers support students' need for autonomy when they create a learning environment in which students feel that they can act according to their own interests. Other studies have focused on the effects of students' perceptions of teachers' social support (i.e. expressing involvement and interest in students' wellbeing in school) on student motivation and performance in school (e.g., Skinner & Belmont, 1993; Van Ryzin, Gravely, & Roseth, 2009). Relatively few studies, however, have specifically focused on SRL and the relation with perceived teacher support (e.g. Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Van Grinsven & Tillema, 2006). Most of the studies investigating the effects of perceived teacher support on student motivation and performance in school are cross-sectional. However, reliance on a single measurement precludes conclusions about the causality of the relation. In line with SDT, it is usually assumed that perceived teacher support has a causal effect on students' SRL and, consequently, student achievement. However, there are indications that the relation is reciprocal and that students' SRL also has an effect on perceived teacher support (Skinner & Belmont, 1993). Longitudinal studies are necessary to shed more light on the relation between perceived teacher support, SRL and achievement. In particular, time-lagged effects in a longitudinal design can provide information about the direction of the effects. It is regrettable that there are almost no longitudinal studies on the relation between perceived teacher support and learning outcomes (Stroet et al., 2013). In this study, we investigated the longitudinal relations among perceived teacher support, SRL and achievement using cross-lagged autoregressive models estimated with the use of structural equation modelling (SEM). The first aim of this study was to provide more information on the direction of the effects between students' perceptions of their teachers' autonomy support and social support, on the one hand, and students' SRL, on the other. In addition, we investigated the extent to which the longitudinal effects of perceived teacher support on students' academic achievement in school were mediated by SRL.

2. Self-regulated learning

Several models of SRL have been proposed in educational research. Although each model accentuates different aspects of SRL, most models share certain basic assumptions (Boekaerts & Corno, 2005; Pintrich,

* Corresponding author.
E-mail address: j.a.schuitema@uva.nl (J. Schuitema).

http://dx.doi.org/10.1016/j.lindif.2016.05.006
1041-6080/

2004; Puustinen & Pulkkinen, 2001). Generally, SRL refers to the adaptation of thoughts, feelings and behaviour to affect learning and motivation. Self-regulated learners control their own learning processes and direct cognitive, behavioural and motivational processes to achieve self-set learning goals (Boekaerts & Cascallar, 2006; Pintrich, 2004). SRL has been found to be an important predictor for academic achievement in school (Pintrich & de Groot, 1990). Most models distinguish at least three phases in self-regulated learning (Puustinen & Pulkkinen, 2001). The first phase, the preparatory or forethought phase, precedes a performance phase in which students actually work on the learning task. In the final phase students evaluate and reflect on the learning process. Most models describe self-regulated learning as a cyclical process, i.e., attributions formed in the reflection phase may influence subsequent preparatory processes. SRL refers to the controlling of cognitive processes such as setting goals for learning, motivational processes such as motivational beliefs and the regulation of learning behaviour. In this study we focused on two aspects of SRL that are present in most models of SRL (Van der Veen & Peetsma, 2009) but have received less attention in relation to teacher support (see Stroet et al., 2013): Delay of gratification and the use of metacognitive strategies. Delay of gratification (Bembenutty & Karabenick, 2004) refers to the extent to which students are able to set aside distractions in favour of academic learning. Getting started and remaining engaged in a task require students to avoid other attractive alternatives. Students who are able to delay gratification are more likely to start and complete academic tasks. This aspect of SRL is closely related to concepts of behavioural engagement (e.g., Skinner, Kindermann, & Furrer, 2009). The second aspect of SRL on which this study is focused is the use of metacognitive strategies including planning, monitoring and evaluation of learning activities (Pintrich & De Groot, 1990; Zimmerman, 2000). For easy reference, in this article the term SRL was used to refer to these two aspects of SRL.

3. Autonomy support and social support from teachers

SDT assumes that people are by nature intrinsically motivated (Deci & Ryan, 2000). Satisfaction of people's basic psychological need for autonomy, competence and relatedness facilitates proactive and intrinsically motivated behaviour, whereas the frustration of these needs may lead to passivity and maladaptive behaviour (Vansteenkiste & Ryan, 2013). This means that the satisfaction of these basic needs becomes a necessary condition for students to become engaged learners and the support of students' basic needs in school is assumed to contribute to students' motivation and internally regulated learning behaviour. In this study we focus on students' perceptions of their teachers' supportive behaviour with regard to the their basic need for autonomy and relatedness. The need for autonomy refers to people's need to act in accordance with their sense of self. When people feel autonomous, they experience their behaviour as self-determined and consistent with their interests, values and their own personal goals. This experience of volition and a sense of internal locus of control is necessary for students to become motivated and engaged learners (Reeve, Nix, & Hamm, 2003). Without support of autonomy students' learning is assumed to lack personal interest, task involvement and self-initiative that are necessary for SRL (Reeve, 2009). Teachers can support students' autonomy by allowing them to act in accordance with their personal interests and values (Reeve, 2009). Autonomy support includes providing students with options and choices and creating space for self-initiative (Reeve & Jang, 2006). Within SDT, autonomy support is understood as more than providing freedom and choices. From the perspective of SDT, feeling autonomous is not necessarily the same as having self-control (Vansteenkiste et al., 2012). Teachers can also support students' sense of autonomy by explaining the meaning and relevance of the material to be learned. When students perceive learning for school as contributing to the realisation of their own personal goals and needs, they feel they act according to their own interests and values (Assor et al., 2002). Therefore, it is important for teachers to emphasise the relevance of learning tasks and to provide students with a rationale when choices are constrained (Assor et al., 2002). Teachers can also make learning tasks more relevant for students by helping students to connect what has to be learned with what they already know (Thoonen, Sleegers, Peetsma, & Oort, 2011).

Another important aspect of teacher support concerns teachers' involvement with students (Skinner & Belmont, 1993; Van Ryzin, 2011). Teachers' social support is important for students' need for relatedness (Deci & Ryan, 2000). SDT assumes that students' need to feel connected to others and to maintain caring relations with others. Teachers can support these needs by expressing their involvement and interest in students' wellbeing in school (Roorda, Koomen, Spilt, & Oort, 2011; Skinner & Belmont, 1993). Teachers' involvement in students can have substantial effect on students' motivational beliefs, such as feelings of competence and interest, and on students' emotions in school, such as enjoyment and anxiety (see Ahmed, Minnaert, Van der Werf & Kuyper, 2010). Social support from teachers can contribute to students' emotional security in school, which is considered to be a necessary condition for exploration of the environment (Roorda et al., 2011). Therefore, it is assumed that teachers' social support can have a positive effect on student motivation and SRL in school.

A large body of research has confirmed the positive relation between teachers' autonomy-supportive and social-supportive behaviour and students' motivation (for an overview of research in secondary education see Stroet et al., 2013). As we have mentioned before, most of these studies are cross-sectional and investigated this relation by examining students' perceptions of teacher support. A number of studies have found positive relations between SRL and perceived autonomy support. Sierens et al. (2009), for example, found that the regulation of cognition (i.e., the use of metacognitive strategies) was positively related to students' perceptions of the extent to which their teachers provided feedback and help in an autonomy-supportive way. In addition, Vansteenkiste et al. (2012) found that perceived autonomy support was positively related to students' learning behaviour, including the use of deep-level learning strategies and persistence during learning. The relation between perceived social support and SRL has also been documented in several studies. Research findings have shown that perceived social support was positively related to students' regulation of cognition (Patrick, Ryan, & Kaplan, 2007; Ryan & Patrick, 2001; Yin, Lee & Zhang, 2009). Other studies found a positive relation between perceived social support from teachers and effort regulation or behavioural engagement (e.g., Murdock & Miller, 2003).

In addition, teacher support has been associated with academic achievement. Autonomy support and social support have been found to improve students' academic performance. Roorda et al. (2011) found in a meta-analysis that positive student-teacher relations were related to achievement in school. This meta-analysis included mostly cross-sectional studies investigating student perceptions, but also some longitudinal studies and studies based on teacher perceptions and observations. Vansteenkiste, Simons, Soenens, & Lens, 2004 conducted three field experiments in which college students received instruction in either an autonomy-supportive or a controlling manner and found significant effects of autonomy-supportive instruction on academic achievement. It is assumed that the effect of teachers' autonomy support and social support on performance is mediated by student motivation and SRL. Vansteenkiste and colleagues indeed found that the effect of autonomy-supportive instruction on performance was mediated by the motivations of students. Likewise, a study by Van Ryzin (2011) in which a combined measure for emotional and behavioural engagement was used, showed that engagement mediated the effect of perceived autonomy support and social support on student achievement in school.

4. Causal direction of effects

As can be concluded from the brief discussion above, the relation between perceived autonomy support and social support and student learning behaviour is well documented. SDT maintains that it is need

supportive behaviour from teachers that has a causal effect on students' motivation and learning behaviour. In most of the studies investigating the relation between perceived teacher support, student learning behaviour and performance in school, the underlying assumption in line with SDT, is that teachers' supportive behaviour has a causal effect on student motivation and learning behaviour. However, it is also plausible to assume that students' behaviour in the classroom has an effect on the behaviour of teachers (Skinner & Belmont, 1993). Teachers may be inclined to respond differently to students who have a different initial level of SRL. Teachers may behave in a more autonomy-supportive way towards students who are highly able to regulate their learning, whereas teachers may feel the need to be more controlling towards students who are not able to regulate their learning. Similarly, when students are more motivated and put more effort into their learning, teachers may like those students more and may give them more social support. In addition, the majority of studies investigating teacher support rely on student questionnaires and, therefore, on students' perceptions of teacher support. Different students may perceive supportive behaviour of the same teacher differently (Opdenakker & Minnaert, 2011; Tapola & Niemivirta, 2008). For example, there is some evidence that self-confident students have more positive views of the learning environment than students who underestimate themselves (Seidel, Prenzel, Duit, Euler, Geiser et al., 2002, cited in Opdenakker & Minnaert, 2011). Students' ability to regulate their learning may also influence the way they perceive their teachers' behaviour.

Most studies that have investigated the relation between perceived teacher support and student learning in school have used a correlational cross-sectional design. Because cross-sectional designs rely on a single measurement and do not control for initial levels, they do not allow conclusions about the causality of the relation. The observed relation may be spurious—that is, the relation may be the result of a third variable that correlates with both perceived teacher support and student learning. In addition, a cross-sectional approach precludes inferences about the direction of the effects. Longitudinal research is needed to investigate the causal effects between perceived teacher support and student learning behaviour. In particular, time-lagged effects in longitudinal designs are useful to examine potential reciprocal causation between two variables (Finkel, 1995; Kenny, 1975; Rosel & Plewis, 2008). In addition, longitudinal studies can be used to investigate the stability of the relation between variables over time.

A few studies have investigated the longitudinal relations between perceived autonomy support, social support and student behavioural engagement. Skinner and Belmont (1993) found reciprocal relations between perceived teacher autonomy support and social support and student engagement using a two-wave cross-lagged design. Skinner, Furrer, Marchand, and Kindermann (2008) found that a combined measure of students' perceptions of autonomy support, social support and structure administered in the fall predicted improvements in student effort, attention, and persistence in the spring. Two studies (Van Ryzin, 2011; Van Ryzin et al., 2009) found that engagement (a combined measure of behavioural and emotional engagement) in the fall predicted teacher autonomy support and social support in the spring. Because behavioural engagement is closely related to the concept of self-regulated learning behaviour in this study, we expect that the relations between perceived teacher support and SRL are also reciprocal. To summarize, we can say that research has confirmed the assumed positive relation between perceived teacher support, SRL and achievement. However, less is known about the nature of these relations. To what extent is the effect of perceived teacher support on students' achievement mediated by SRL and what are the causal directions of these effects? Investigating the longitudinal relations between perceived teacher support, SRL and achievement may shed more light on these issues.

5. This study

The aim of this study was to advance our understanding of the longitudinal relations between students' perceptions of their teachers' autonomy support and social support, on the one hand, and SRL and achievement, on the other hand, in the first two years of secondary education. Two aspects of SRL were investigated in this study: delay of gratification and metacognitive strategy use. A five wave longitudinal design was implemented during a two-year period to investigate developments in students' delay of gratification, metacognitive strategy use, perceived teacher support and students' achievements. The first purpose of this approach was to assess the relation between perceived teacher support and the two aspects of SRL over time and to examine the causal direction of the effects between perceived teacher support and SRL. For these purposes, five-wave autoregressive cross-lagged models were estimated. Our first hypothesis was that the relation between SRL and perceived teacher support is reciprocal; therefore, we expected to find significant effects of perceived teacher support on SRL and of SRL on perceived teacher support. In addition, we investigated the longitudinal effects of perceived teacher support on student academic achievement in school and the extent to which these effects were mediated by SRL. Few studies have investigated the mediating effect of SRL in a longitudinal study. We hypothesized that perceived teacher support and SRL are both positively related to achievement and that SRL mediates the effect of perceived teacher support on academic achievement.

6. Method

6.1. Sample

We conducted a five-wave longitudinal study among 701 students from 13 Dutch schools. All students were in the first year of secondary education and were twelve years old on average at the beginning of the study. In the education system in the Netherlands, children of approximately twelve years of age leave primary school and progress to different levels of secondary education. The participating students in this study could be divided into three levels. The low-level group included 206 students from prevocational secondary education, the mid-level group included 189 students from lower general secondary education, and the high-level group consisted of 306 students from higher general secondary education or pre-university education. A sample of 362 boys (52%) and 339 girls (48%) participated in the study. Most of the students (86%) had a Dutch background or a non-Dutch Western background, and 101 (14%) students were from a non-Western ethnic minority group (mainly Moroccan, Turkish or Surinamese). Ethnic background was based on the father's country of birth. The criterion adopted for SES was the parents' highest level of education. A total of 26% of the students had a low SES (parents with a prevocational or lower general education), 29% had an average SES (parents with a vocational secondary education, higher general secondary education or pre-university education) and 25% had a high SES (parents with a higher education). The SES of 20% of the students was unknown to us. Not all students were present for every measurement: 441 (63%) students participated in all five measurements, whereas 20% of the students missed one occasion, 6% of the students missed two occasions, 7% missed three occasions, and 3% participated only once.

6.2. Measures

Self-report questionnaires were administered five times during the first 2 years in secondary education: at the beginning and halfway through the first year, and at the beginning, halfway point and end of the second year. All items were rated on a 5-point Likert-type scale from 1 (completely disagree) to 5 (completely agree). The items of the questionnaire are given in the Appendix.

6.2.1. Self-regulated learning

Two measures were used to investigate students' self-regulated learning behaviour. To assess students' ability to delay gratification,

Table 1
Means, standard deviations and observed relations between the study variables[a].

	M	sd	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Perc. autonomy support t1	3.21	0.62	–																					
2. Perc. autonomy support t2	3.16	0.67	0.45**	–																				
3. Perc. autonomy support t3	3.06	0.64	0.41**	0.50**	–																			
4. Perc. autonomy support t4	2.99	0.68	0.24**	0.36**	0.49**	–																		
5. Perc. autonomy support t5	3.03	0.69	0.31**	0.43**	0.53**	0.56**	–																	
6. Perc. social support t1	3.61	0.58	0.32**	0.26**	0.25**	0.19**	0.25**	–																
7. Perc. social suppor t2	3.65	0.68	0.25**	0.46**	0.25**	0.28**	0.27**	0.43**	–															
8. Perc. social suppor t3	3.66	0.69	0.23**	0.30**	0.47**	0.37**	0.37**	0.40**	0.52**	–														
9. Perc. social suppor t4	3.55	0.77	0.11**	0.21**	0.22**	0.46**	0.27**	0.26**	0.30**	0.34**	–													
10. Perc. social suppor t5	3.62	0.78	0.14**	0.30**	0.35**	0.42**	0.50**	0.36**	0.44**	0.58**	0.49**	–												
11. Delay of gratification T1	3.38	0.99	0.29**	0.13**	0.19**	0.08	0.13**	0.19**	0.16**	0.15**	0.05	0.03	–											
12. Delay of gratification T2	3.09	1.02	0.21**	0.22**	0.19**	0.15**	0.17**	0.18**	0.21**	0.16**	0.12**	0.10*	0.51**	–										
13. Delay of gratification T3	3.05	1.00	0.24**	0.18**	0.26**	0.15**	0.18**	0.15**	0.17**	0.23**	0.09*	0.18**	0.47**	0.61**	–									
14. Delay of gratification T4	2.99	0.97	0.16**	0.14**	0.19**	0.28**	0.20**	0.10*	0.14**	0.18**	0.16**	0.15**	0.35**	0.46**	0.58**	–								
15. Delay of gratification T5	2.97	0.97	0.11*	0.14**	0.20**	0.14**	0.23**	0.10*	0.08	0.17**	0.15**	0.23**	0.31**	0.46**	0.58**	0.50**	–							
16. Metacog. strat. use t1	2.92	0.81	0.49**	0.26**	0.29**	0.15**	0.25**	0.19**	0.12**	0.15**	0.05	0.06	0.49**	0.35**	0.33**	0.24**	0.21**	–						
17. Metacog. strat. use t2	2.93	0.81	0.31**	0.35**	0.25**	0.16**	0.21**	0.15**	0.18**	0.12**	0.07	0.09*	0.31**	0.50**	0.36**	0.28**	0.27**	0.53**	–					
18. Metacog. strat. use t3	2.90	0.83	0.24**	0.25**	0.35**	0.25**	0.25**	0.07	0.12**	0.17**	0.12**	0.16**	0.30**	0.37**	0.50**	0.36**	0.33**	0.51**	0.62**	–				
19. Metacog. strat. use t4	2.96	0.80	0.18**	0.16**	0.21**	0.40**	0.21**	0.11**	0.14**	0.16**	0.17**	0.15**	0.22**	0.27**	0.32**	0.49**	0.26**	0.36**	0.43**	0.54**	–			
20. Metacog. strat. use t5	3.01	0.83	0.26**	0.22**	0.29**	0.27**	0.39**	0.13**	0.12**	0.17**	0.20**	0.22**	0.22**	0.27**	0.35**	0.31**	0.49**	0.47**	0.51**	0.61**	0.52**	–		
21. GPA	6.52	0.75	0.05	0.05	0.04	0.04	0.10*	0.11**	0.18**	0.15**	0.10*	0.17**	0.18**	0.21**	0.28**	0.18**	0.16**	0.18**	0.16**	0.20**	0.15**	0.17**	–	
22. PEFT	533.20	10.03	0.04	0.01	−0.14**	−0.17**	−0.16**	−0.09*	0.06	−0.03	−0.02	−0.13**	0.09*	0.09*	0.08	0.05	0.05	0.09	0.17**	0.11**	0.11*	0.08	0.27**	–
23. Gender			0.01	0.04	−0.01	0.05	0.01	0.10**	0.15**	0.10*	0.09*	0.08*	0.04	0.07	0.01	0.02	0.01	0.15**	0.13**	0.12**	0.12**	0.18**	0.13**	0.05
24. Ethnic background			0.01	0.02	0.02	0.06	0.07	0.00	0.07	0.04	0.05	0.05	0.06	0.05	0.05	0.09*	0.11**	0.12**	0.08	0.06	0.07	0.09*	0.03	0.24**
25. School-level			0.11*	0.09	0.13**	0.08	0.11*	0.01	0.14	0.02	0.07	0.06	0.15**	0.14**	0.14**	0.10*	0.09	0.17**	0.24**	0.19**	0.14**	0.14**	0.21**	0.82**
26. SES			0.06	0.04	0.16**	0.12*	0.08	0.10	0.07	0.08	0.08	0.07	0.08	0.06	0.12*	0.07	0.03	0.11*	0.14**	0.14**	0.09	0.07	0.14**	0.32**

[a] Correlations are presented for relations between continuous variables. For relations involving categorical variables the table shows *eta*-coefficients.
* $p < 0.05$.
** $p < 0.01$.

Table 2
Fit indices for of the four versions of each model estimating the relationship between perceived teacher behaviour, SRL and GPA, controlling for Primary Education Final Test score, gender, SES, ethnic background and school-level.

Model	Fit indices					
Perceived autonomy support – delay of gratification	χ^2	v	CFI	RMSEA	90% CI RMSEA	AIC
No cross-lagged effects	67.58	26	0.99	0.05	0.03; 0.06	12,504.25
Cross-lagged effects from autonomy support to delay of gratification	60.68	25	0.99	0.05	0.03; 0.06	12,499.34
Cross-lagged effects from delay of gratification to autonomy support	58.23	25	0.99	0.04	0.03; 0.06	12,496.89
Cross-lagged effects in both directions*	52.36	24	0.99	0.04	0.03; 0.06	12,493.03
Perceived autonomy support – metacognitive strategy use	χ^2	v	CFI	RMSEA		
No cross-lagged effects	88.63	26	0.98	0.06	0.05; 0.07	10,956.89
Cross-lagged effects from autonomy support to metacognitive strategy use	81.91	25	0.98	0.06	0.04; 0.07	10,952.17
Cross-lagged effects from metacognitive strategy use to autonomy support	76.27	25	0.98	0.05	0.04; 0.07	10,946.54
Cross-lagged effects in both directions*	71.85	24	0.99	0.05	0.04; 0.07	10,944.12
Perceived social support – delay of gratification	χ^2	v	CFI	RMSEA		
No cross-lagged effects	72.59	26	0.98	0.05	0.04; 0.07	12,794.36
Cross-lagged effects from social support to delay of gratification*	60.95	25	0.99	0.05	0.03; 0.06	12,784.73
Cross-lagged effects from delay of gratification to social support	68.06	25	0.98	0.05	0.04; 0.06	12,791.83
Cross-lagged effects in both directions	57.15	24	0.99	0.04	0.03; 0.06	12,782.92
Perceived social support – metacognitive strategy use	χ^2	v	CFI	RMSEA		
No cross-lagged effects	79.88	26	0.98	0.05	0.04; 0.07	11,535.56
Cross-lagged effects from social support to metacognitive strategy use*	71.48	25	0.98	0.05	0.04; 0.07	11,529.16
Cross-lagged effects from metacognitive strategy use to social support	78.64	25	0.98	0.06	0.04; 0.07	11,536.32
Cross-lagged effects in both directions	70.52	24	0.98	0.05	0.04; 0.07	11,530.20

* Model with the best fit.

we used three items adapted by Van der Veen and Peetsma (2009) from the Academic Delay of Gratification Scale of Bembenutty and Karabenick (1998) (e.g., "I finish my school work before I meet with my friends to have fun"; average Cronbach's $\alpha = 0.84$). We assessed the use of metacognitive strategies using six items from Pintrich and De Groot (1990) and Pintrich (1991), measuring metacognitive activities such as planning and comprehension monitoring. The six items were translated and used in a study of Van der Veen and Peetsma (2009). An example of one of the items is "When I'm reading, I stop once in a while and go over what I have read" (average Cronbach's $\alpha = 0.80$). To examine the construct validity of the measures for SRL, we performed a confirmatory factor analysis using Mplus (Muthén & Muthén, 1998-2007). We compared models with one and two factors for each measurement occasion. A two-factor model gave the best fit on all five measurement occasions. Construct validity was further investigated by conducting a test of metric invariance. A longitudinal two-factor model was fitted to the data of the five measurement occasions. The factor loadings were held free across the two measurement occasions (configural model). Residuals of the corresponding items across time were allowed to correlate. This model was compared to a model in which the factor loadings were constrained to be equal across the five measurements (metric model). Because the chi-square difference test is influenced considerably by sample size, Cheung and Rensvold (2002) suggested using CFI differences smaller than 0.01 between the two models as a criterion for metric invariance. Both the configural model (χ^2 (810) = 1203.20, $p < 0.001$, RMSEA = 0.03, 90% confidence interval (CI) for RMSEA = [0.02; 0.03], CFI = 0.97) and the metric model (χ^2 (846) = 1247.68, $p < 0.001$, RMSEA = 0.03, 90% CI for RMSEA = [0.02; 0.03], CFI = 0.97) fitted the data well (Kline, 2005). In addition, the differences between the CFI values of the models were smaller than 0.01, and metric invariance was not rejected.

6.2.2. Perceived autonomy support and social support from teachers

We used items from three scales to measure student perceptions of their teachers' autonomy supportive behaviour. Four items were adapted from the short form of The Learning Climate Questionnaire (Williams & Deci, 1996). We selected only those four items that measure the degree to which teachers provide students with choices and options and take students' perceptions into account (e.g., "I feel that the teachers provide me choices and options"). Three items were used

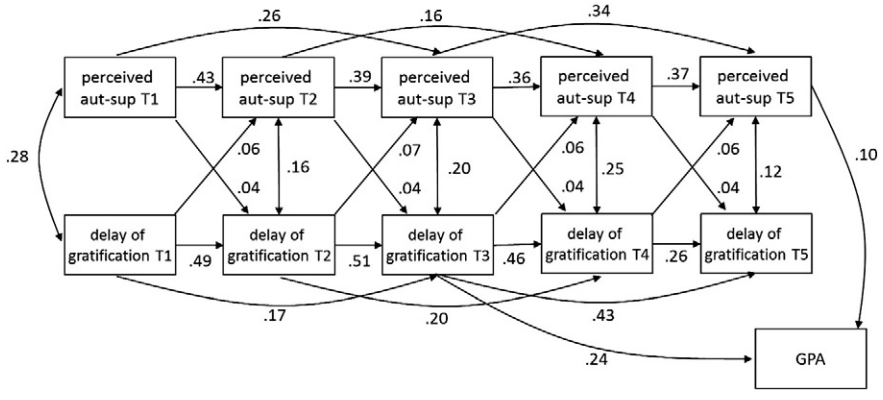

Fig. 1. Standardized estimates of the relations between the five measurements of perceived autonomy support and delay of gratification and GPA at the end of year two. In this model we controlled for Primary Educations Test score, school level, gender, SES and ethnic background. The control variables are not shown in this figure. See Table 3 for all path-coefficients.

Table 3
Path coefficients for the relations between perceived autonomy support, delay of gratification, GPA and control variables.

Variables	b	β	SE	Bootstrap 95% CI
Contemporaneous correlations				
Autonomy support T1 ↔ delay of gratification T1	0.16**	0.28	0.02	
Autonomy support T2 ↔ delay of gratification T1	0.08**	0.16	0.03	
Autonomy support T3 ↔ delay of gratification T1	0.08**	0.20	0.02	
Autonomy support T4 ↔ delay of gratification T1	0.11**	0.25	0.03	
Autonomy support T5 ↔ delay of gratification T1	0.05*	0.12	0.02	
Auto-regressive effects				
Autonomy support T1 → autonomy support T2	0.46**	0.43	0.04	
Autonomy support T1 → autonomy support T3	0.27**	0.26	0.04	
Autonomy support T2 → autonomy support T3	0.38**	0.39	0.04	
Autonomy support T2 → autonomy support T4	0.17**	0.16	0.04	
Autonomy support T3 → autonomy support T4	0.38**	0.36	0.06	
Autonomy support T3 → autonomy support T5	0.36**	0.34	0.06	
Autonomy support T4 → autonomy support T5	0.37**	0.37	0.06	
Delay of gratification T1 → delay of gratification T2	0.52**	0.49	0.04	
Delay of gratification T1 → delay of gratification T3	0.18**	0.17	0.05	
Delay of gratification T2 → delay of gratification T3	0.50**	0.51	0.04	
Delay of gratification T2 → delay of gratification T4	0.19**	0.20	0.04	
Delay of gratification T3 → delay of gratification T4	0.45**	0.46	0.05	
Delay of gratification T3 → delay of gratification T5	0.43**	0.43	0.05	
Delay of gratification T4 → delay of gratification T5	0.26**	0.26	0.05	
Cross-lagged effects				
Autonomy support T1 → delay of gratification T2	0.06*	0.04	0.03	
Autonomy support T2 → delay of gratification T3	0.06*	0.04	0.03	
Autonomy support T3 → delay of gratification T4	0.06*	0.04	0.03	
Autonomy support T4 → delay of gratification T5	0.06*	0.04	0.03	
delay of gratification T1 → autonomy support T2	0.04**	0.06	0.02	
delay of gratification T2 → autonomy support T3	0.04**	0.07	0.02	
delay of gratification T3 → autonomy support T4	0.04**	0.06	0.02	
delay of gratification T4 → autonomy support T5	0.04**	0.06	0.02	
GPA				
autonomy support T5 → GPA	0.11*	0.10	0.05	
delay of gratification T3 → GPA	0.18**	0.24	0.03	
Indirect effects***				
autT1 → dogT2 → dogT3 → GPA	0.01	0.00	0.00	0.001; 0.01
autT1 → autT2 → dogT3 → GPA	0.01	0.00	0.00	0.001; 0.01
autT1 → dogT2 → autT3 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → dogT2 –dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → autT3 → dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → dogT2 → autT3 → autT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → dogT2 → autT3 –dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → dogT2 → dogT3 –dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → dogT2 → dogT3 –autT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → autT2 → dogT3 → autT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → autT2 → dogT3 → dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT1 → autT2 → autT3 → dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT2 → dogT3 → GPA	0.00	0.00	0.00	0.000; 0.000
autT2 → dogT3 → autT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT2 → dogT3 → dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT2 → autT3 → dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
autT3 → dogT4 → autT5 → GPA	0.00	0.00	0.00	0.000; 0.000
Control variables				
PEFT → GPA	2.08**	0.28	0.49	
PEFT → autonomy support T4	−0.94*	−0.13	0.37	
PEFT → autonomy support T5	−0.60*	−0.09	0.30	
Ethnic background (non-Dutch) → delay of gratification T1	0.28*	0.10	0.13	
Ethnic background (non-Dutch) → delay of gratification T4	0.21*	0.07	0.10	
Gender (girls) → GPA	0.17**	0.11	0.06	
SES (reference = low)				
Average → GPA	−0.15**	−0.09	0.06	
Unknown → autonomy support T3	0.15*	0.09	0.06	
Average → delay of gratification T4	−0.15*	−0.07	0.06	
School level (reference = mid-level)				
High-level → autonomy support T1	0.12*	0.09	0.05	
High-level → autonomy support T3	−0.25**	−0.19	0.05	
High-level → delay of gratification T2	0.19*	0.09	0.08	
Low-level → delay of gratification T1	−0.35**	−0.17	0.10	

* $p < 0.05$.
** $p < 0.01$.
*** aut = autonomy support, dog = delay of gratification.

from the subscale 'relevance' from the Teacher as a Social Context questionnaire (TASC; Belmont, Skinner, Wellborn, & Connell, 1988) to measure students' perceptions of the emphasis given by teachers to the relevance of what is being learned (e.g., "The teachers talk about how I can use the things we learn in school"). The two other items of the of the subscale 'relevance' of the TASC overlapped in meaning with other

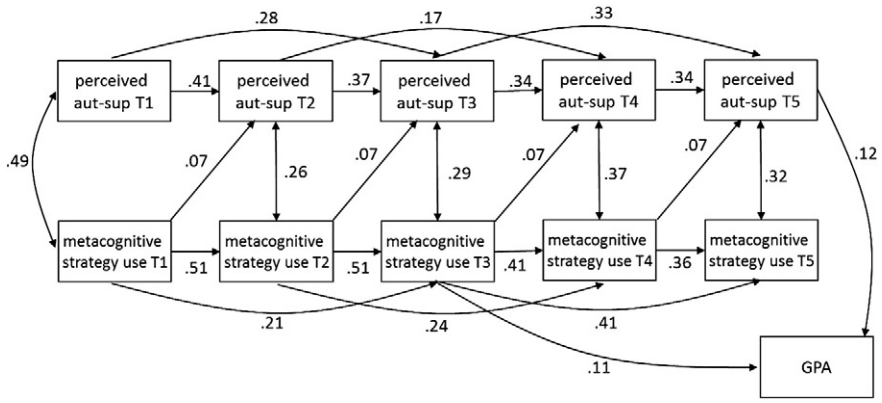

Fig. 2. Standardized estimates of the relations between the five measurements of perceived autonomy support and metacognitive strategy use and GPA at the end of year two. In this model we controlled for Primary Educations Test score, school level, gender, SES and ethnic background. The control variables are not shown in this figure. See Table 4 for all path-coefficients.

items in the scale and were therefor not included. Three items were adapted from the "connection to students' worlds" scale from Thoonen et al. (2011) to measure students' perceptions of the degree to which teachers tried to connect to what students already knew about a topic (e.g., "The teachers ask us what we already know about a topic").

Perceived teacher social support was measured using a four-item scale from Peetsma, Wagenaar, and de Kat (2001). One of the items was "My teachers are interested in me" (average Cronbach's α = 0.62). We conducted a confirmatory factor analysis, and several factor solutions were compared. A two-factor solution (with a factor for perceived autonomy support items and a factor for perceived social support items) fit the data well on all five measurement occasions. However, on two measurement occasions, a three-factor model had a better fit than a two-factor model. In this three-factor model, the items measuring 'options and choices' loaded on one factor, and the items measuring relevance and connection to students' worlds loaded on another factor. However, the correlation between these two latent factors was very high, ranging from 0.89 to 0.97. Because of this high correlation and because the behaviours measured in these two factors are usually regarded as one construct, we decided to combine all ten items into one scale measuring perceived autonomy support (average Cronbach's α = 0.85). We investigated the metric invariance of the two-factor model. The fit of the configural model (χ^2 (2160) = 3719.473, $p < 0.001$, RMSEA = 0.03, 90% CI for RMSEA = [0.03; 0.03], CFI = 0.89) and the metric model (χ^2 (2216) = 3850.065, $p < 0.001$, RMSEA = 0.03, 90% CI for RMSEA = [0.03; 0.03], CFI = 0.89) was reasonable. Although the CFI was relatively low, the RMSEA of both models indicated close fit. When comparing CFI values, we obtained a difference smaller than 0.01, indicating metric invariance.

6.2.3. Academic achievement

Student grades were gathered from their report cards at the end of year 2. Academic achievement was measured using the grade point average (GPA). To calculate the GPA we used the average of the final grades for Dutch (native language), English (foreign language), mathematics, history and social sciences. We did not include science (biology, physics and chemistry) because not all students studied these subjects. We could not obtain the report marks for 89 students (13%). To be able to control for initial levels of achievement at the start of secondary education, the scores from the Primary Education Final Test (PEFT) were collected from the school administration records. This is a standard test in The Netherlands measuring academic aptitude; children take this test in grade six, the last year of primary education. Not all primary schools conduct this test. As a result, 122 (17%) students in our study did not have a PEFT score.

6.3. Analyses

The development of students' perceived teacher support, SRL and academic achievement was investigated using five wave autoregressive cross-lagged path models with Mplus (Muthén & Muthén, 1998-2007). In this study we were interested to explore the direction of the causal effects between perceived teacher support and SRL. Autoregressive cross-lagged models are particularly useful to investigate the time lagged effects (Cole & Maxwell, 2003; Rosel & Plewis, 2008). Because the two aspects of SRL (i.e., delay of gratification and metacognitive strategy use) and the perceptions of teacher support were measured on the same occasions, the models enable the estimation of the causal relations between perceived teacher support and SRL, controlling for the autoregressive influence of each variable with itself over time (Finkel, 1995; Kenny, 1975; Rosel & Plewis, 2008). Because of the complexity of the models we estimated separate models for the two variables for perceived teacher support and the two measures of SRL. This resulted in four cross-lagged models. Each model included perceived autonomy support or social support, one of the two measures of SRL (delay of gratification or metacognitive strategy use) and GPA. Because of the large number of parameters in the model we used the observed scale means to model the perceptions of perceived teacher support and SRL. To be able to control for initial levels of achievement at the start of secondary education, the scores from the PEFT were included as a control variable. In addition, students' backgrounds may affect their perceptions of their teachers' supportive behaviour (see Opdenakker & Minnaert, 2011) and their SRL (Van der Veen & Peetsma, 2009). Therefore, we controlled for school level, gender, ethnic background and SES. Dummy variables for these variables were added as control variables. Because many students did not know their parents' education, we included a category 'unknown' for this variable. For clarity reasons, the control variables are not shown in the figures.

All 701 students were included in the analyses. The missing values were estimated using Full-Information Maximum Likelihood estimation (Little & Rubin, 1987). The FIML estimation is based on the assumption that missing values are missing at random (MAR), which assumes that missing values can be predicted from the available data. Removing all cases with missing values (listwise deletion) is based on the more strict assumption that the missing values are completely at random (MCAR). To evaluate the fit of the models, we used two indices in addition to the chi-square test (Browne & Cudeck, 1993), the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). An RMSEA of 0.08 or less indicates satisfactory fit in relation to the degrees of freedom, and an RMSEA value of 0.05 or less indicates a close fit of the model. The CFI values should be higher than 0.90, and values close to 1 indicate a very good fit. The Akaike Information Criterion (AIC) was

used to compare different models with the same degrees of freedom. Lower values indicate a better fit.

In each model GPA was regressed on perceived teacher support and SRL. GPA was obtained at the end of year 2. However, students' achievement at the end of the second year is actually a result of learning over the two years. Therefore, we could not make assumptions beforehand about which measurement occasion of perceived teacher support or SRL would predict GPA and we regressed GPA on all five measurement occasions of perceived teacher support and SRL.

The results showed that the cross-lagged models did not fit our data very well. To improve the fit of the models we included second order auto-regressive effects and contemporaneous correlations between the error terms of perceived teacher support and SRL at the same time point. Adding second order auto-regressive effects and contemporaneous correlations resulted in a close or satisfactory fit of the models (see Table 2).

In addition, we took three steps to further specify the cross-lagged models.

6.3.1. Step 1

First, we compared different models to examine the direction of the effects between perceived teacher support and SRL. The cross-lagged effects were constrained to be equal over measurement occasions. For each of the four models we compared four versions. (1) A model without cross-lagged effects; (2) a model in which only the cross-lagged effects from perceived teacher support to SRL were included; (3) a model in which only the cross-lagged effects from SRL to perceived teacher support were included and (4) a model that included both the cross-lagged effects from perceived teacher support to SRL and the effects from SRL to perceived teacher support. The fit of the models were compared using chi-square difference tests. To compare models with the same degrees of freedom we used the AICs.

6.3.2. Step 2

After we established which of the four versions resulted in the best fit, we constrained non-significant relations from the models to zero in a stepwise procedure to determine the most parsimonious model (see Kline, 2005).

6.3.3. Step 3

In the final step we estimated the models from which the non-significant relations were constrained to zero, while taking into account the nested structure of the data. Students who were in the same classroom have the same teachers and are more alike than students from other classes. Our longitudinal study, however, extended over two years in secondary education. While in some cases the classroom composition remained reasonably stable during the two years, in other cases classrooms were rearranged after the first year. Some of the students who were in the same classroom in the first year were in different classes in the second year and in some cases students who were in different classrooms in the first year were in the same classroom during the second year. Therefore, we made clusters of students who were together in the same classroom in year one and again in year two and consequently shared the same teachers in those two years. This resulted in 93 clusters. The models we started with in Step 1 included too many free parameters compared to the number of clusters to adjust for the nested structure of the data. However after we constrained the non-significant relations from the model in Step 2 to zero, it was possible to take the nested structure of the data into account. To obtain the final models in Step 3, we employed the TYPE = COMPLEX option in Mplus to adjust the standard errors for the nesting of students in clusters. Because there were only thirteen schools it was not possible to adjust the standard errors for the nesting of students within schools.

6.3.4. Investigating mediation

To investigate whether the effect of perceived teacher support was mediated by SRL we examined in each model the indirect effects of perceived teacher support on GPA at the end of the second year (see Cole & Maxwell, 2003). We examined all possible paths between any measurement occasion of teacher support to GPA through any measure SRL. Preacher and Hayes (2008) recommend bootstrapping for testing the significance of the indirect effects. Because bootstrapping is not available with TYPE = COMPLEX, we used bootstrapping (B = 5000) to obtain 95% confidence intervals without taking the nested structure of the data into account. We compared confidence intervals obtained with bootstrapping with the *z*-test of the ratio of the indirect effect to its standard error estimated using the TYPE = COMPLEX function. Mplus uses

Table 4
Path coefficients for the relations between perceived autonomy support, metacognitive strategy use and GPA and control variables.

Variables	b	β	SE
Contemporaneous correlations			
Autonomy support T1 ↔ metacognitive strategy use T1	0.23**	0.49	0.02
Autonomy support T2 ↔ metacognitive strategy use T1	0.11**	0.26	0.02
Autonomy support T3 ↔ metacognitive strategy use T1	0.10**	0.29	0.02
Autonomy support T4 ↔ metacognitive strategy use T1	0.14**	0.37	0.03
Autonomy support T5 ↔ metacognitive strategy use T1	0.10**	0.32	0.02
Auto-regressive effects			
Autonomy support T1 → autonomy support T2	0.44**	0.41	0.04
Autonomy support T1 → autonomy support T3	0.29**	0.28	0.04
Autonomy support T2 → autonomy support T3	0.36**	0.37	0.04
Autonomy support T2 → autonomy support T4	0.17**	0.17	0.04
Autonomy support T3 → autonomy support T4	0.35**	0.34	0.06
Autonomy support T3 → autonomy support T5	0.35**	0.33	0.06
Autonomy support T4 → autonomy support T5	0.38**	0.34	0.06
Metacognitive strategy use T1 → metacognitive strategy use T2	0.52**	0.51	0.04
Metacognitive strategy use T1 → metacognitive strategy use T3	0.22**	0.21	0.04
Metacognitive strategy use T2 → metacognitive strategy use T3	0.52**	0.51	0.05
Metacognitive strategy use T2 → metacognitive strategy use T4	0.24**	0.22	0.06
Metacognitive strategy use T3 → metacognitive strategy use T4	0.39**	0.41	0.05
Metacognitive strategy use T3 → metacognitive strategy use T5	0.41**	0.41	0.04
Metacognitive strategy use T4 → metacognitive strategy use T5	0.37**	0.36	0.05
Cross-lagged effects			
Metacognitive strategy use T1 → autonomy support T2	0.06**	07	0.02
Metacognitive strategy use T2 → autonomy support T3	0.06**	07	0.02
Metacognitive strategy use T3 → autonomy support T4	0.06**	07	0.02
Metacognitive strategy use T4 → autonomy support T5	0.06**	07	0.02
GPA			
Autonomy support T5 → GPA	0.14*	0.12	0.06
Metacognitive strategy use T3 → GPA	0.10*	0.11	0.05
Control variables			
PEFT → GPA	2.15**	0.28	0.52
PEFT → autonomy support T4	−0.92**	−0.14	0.33
PEFT → autonomy support T5	−0.61*	−0.09	0.29
Ethnic background (non-Dutch) → metacognitive strategy use T1	0.31**	0.14	0.07
Gender (girls) → GPA	0.15*	0.10	0.07
Gender (girls) → metacognitive strategy use T1	0.24**	0.15	0.07
Gender (girls) → metacognitive strategy use T5	0.19**	0.12	0.05
SES (reference = low)			
Average → GPA	−0.13*	−0.07	0.06
Unknown → autonomy support T3	0.13*	0.08	0.06
School level (reference = mid-level)			
High-level → autonomy support T1	0.12*	0.10	0.05
High-level → autonomy support T3	−0.27**	−0.21	0.05
High-level → metacognitive strategy use T1	0.28**	0.17	0.07
High-level → metacognitive strategy use T2	0.22**	0.13	0.06

* $p < 0.05$.
** $p < 0.01$.

the delta method to compute the standard errors of indirect effects (see MacKinnon, 2008).

7. Results

Means, standard deviations, and correlations between perceived teacher support and the two aspects of SRL (delay of gratification and metacognitive strategy use) are presented in Table 1. As expected, most of the correlations between students' perceptions of teacher support and SRL were significant. The correlations between perceived autonomy support and SRL were medium to large (Cohen, 1992) when measured at the same occasion (correlations ranged from $r = 0.23$ to $r = 0.49$). In general, the contemporaneous correlations between perceived social support and SRL were smaller than those of perceived autonomy support, ranging from $r = 0.17$ to $r = 0.23$. The cross-correlations between perceived teacher support and the two aspects SRL were smaller than the contemporaneous correlations (from $r = 0.03$ to $r = 0.29$). Most cross-correlations between perceived teacher support and SRL were significant. The correlations between SRL and academic achievement were small but significant (ranging from $r = 0.15$ to $r = 0.28$). There were also small significant correlations between perceived social support from teachers and academic achievement (from $r = 0.15$ to $r = 0.17$). However, in contrast to our expectations, most correlations between perceived autonomy support and academic achievement were not significant. We found only a small correlation between the GPA and the last measurement of perceived autonomy support ($r = 0.10$).

7.1. Perceived autonomy support - delay of gratification

To specify the cross-lagged models we first compared four versions of each model. Table 2 presents fit indices for each model. For perceived autonomy support and delay of gratification we found that the model with cross-lagged effects in both directions fitted the data best (χ^2 (24) = 56.52, CFI = 0.99, RMSEA = 0.04, 90% CI for RMSEA = [0.03; 0.06]). This model gave a significantly better fit than the model in which only the cross-lagged effects from autonomy support to delay of gratification were modelled ($\Delta\chi^2(1) = 8.32$, $p < 0.01$) and the model which included only the cross-lagged effects from delay of gratification to perceived autonomy support ($\Delta\chi^2(1) = 5.87$, $p < 0.05$). The fit was also significantly better than the fit of the model without cross-lagged effects ($\Delta\chi^2(2) = 15.22$, $p < 0.01$). To obtain the final model we constrained non-significant relations to zero and the nesting of the students within clusters was taken into account. The final model (Fig. 1) had a close fit to the data (χ^2 (107) = 127.91, CFI = 0.99, RMSEA = 0.02, 90% CI for RMSEA = [0.00; 0.03]). Table 3 presents all path coefficients of the model. There was a significant direct effect from delay of gratification on time 3 on GPA ($\beta = 0.24$, $p < 0.01$) and a significant direct effect form autonomy support on time 5 on GPA ($\beta = 0.10$, $p < 0.05$). The other direct effects from autonomy support and delay of gratification on GPA were not significant and removed in Step 2 of our analyses in a stepwise procedure.

Table 3 shows all possible paths between autonomy support to GPA through any measure of delay of gratification. Most of those paths were very close to zero. Confidence intervals obtained with bootstrapping indicated significant indirect effects. However, bootstrapping was done without taking the nested structure of the data into account. The *z*-test, with adjusted standard errors suggested that the indirect effects were not significant.

7.2. Perceived autonomy support and metacognitive strategy use

Comparing the different models including perceived autonomy support and metacognitive strategy use (see Table 2) revealed that the model that included cross-lagged effects in both directions fitted the data best (χ^2 (24) = 71.85, CFI = 0.99, RMSEA = 0.05, 90% CI for RMSEA = [0.03; 0.06]). Including cross-lagged effects in both directions resulted in a significantly better fit than the model that included only cross-lagged effects from autonomy support to metacognitive strategy use ($\Delta\chi^2(1) = 10.06$, $p < 0.01$). The model with cross-lagged effects in both directions also gave a significantly better fit than the model with cross-lagged effects from metacognitive strategy use to perceived autonomy support ($\Delta\chi^2(1) = 4.42$, $p < 0.05$) and a model without cross-lagged effects ($\Delta\chi^2(2) = 16.78$, $p < 0.01$). Fig. 2 and Table 4 present the relations in the final model in which the non-significant relations were removed and the error terms were adjusted for the nested structure of the data (χ^2 (108) = 160.02, CFI = 0.98, RMSEA = 0.03). The final model included small significant cross-lagged effects from metacognitive strategy use to perceived autonomy support ($\beta = 0.07$, $p < 0.01$). There was a significant direct effect from metacognitive strategy use on time 3 on GPA (($\beta = 0.14$, $p < 0.05$) and a significant direct effect from autonomy support on time 5 on GPA ($\beta = 0.10$, $p < 0.05$). The cross-lagged effects from perceived autonomy-support to metacognitive strategy were not significant and removed from the model. This also means that the model did not include any indirect paths from perceived autonomy-support to GPA via metacognitive strategy use.

7.3. Perceived social-support and delay of gratification

The model including perceived social-support and delay of gratification gave the best fit to the data when only the cross-lagged effects of perceived social support to delay of gratification were modelled (χ^2 (25) = 60.95 , CFI = 0.99, RMSEA = 0.05; CI for RMSEA = [0.03; 0.06]). This model gave a significantly better fit than a model with no cross-lagged effects ($\Delta\chi^2(1) = 11.64$, $p < 0.01$). In addition, the AIC of

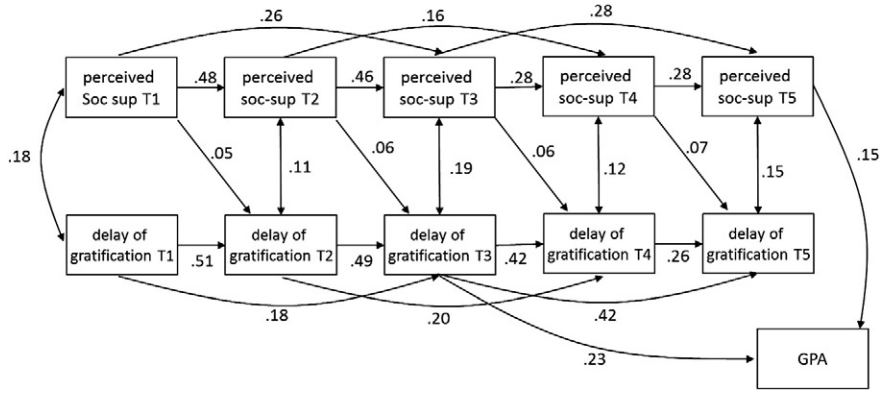

Fig. 3. Standardized estimates of the relations between the five measurements of perceived social-support and delay of gratification and GPA at the end of year two. In this model we controlled for Primary Educations Test score, school level, gender, SES and ethnic background. The control variables are not shown in this figure. See Table 5 for all path-coefficients.

Table 5
Path coefficients for the relations between perceived social support, delay of gratification and GPA and control variables.

Variables	b	β	SE	Bootstrap 95% CI
Contemporaneous correlations				
Social support T1 ↔ delay of gratification T1	0.10**	0.18	0.03	
Social support T2 ↔ delay of gratification T1	0.06*	0.11	0.03	
Social support T3 ↔ delay of gratification T1	0.08**	0.19	0.02	
Social support T4 ↔ delay of gratification T1	0.07*	0.12	0.03	
Social support T5 ↔ delay of gratification T1	0.07**	0.15	0.02	
Auto-regressive effects				
Social support T1 → social support T2	0.48**	0.48	0.05	
Social support T1 → social support T3	0.26**	0.26	0.05	
Social support T2 → social support T3	0.46**	0.43	0.05	
Social support T2 → social support T4	0.16**	0.16	0.05	
Social support T3 → social support T4	0.28**	0.28	0.06	
Social support T3 → social support T5	0.55**	0.28	0.04	
Social support T4 → social support T5	0.28**	0.28	0.04	
Delay of gratification T1 → delay of gratification T2	0.51**	0.51	0.04	
Delay of gratification T1 → delay of gratification T3	0.18**	0.18	0.05	
Delay of gratification T2 → delay of gratification T3	0.49**	0.49	0.05	
Delay of gratification T2 → delay of gratification T4	0.20**	0.20	0.04	
Delay of gratification T3 → delay of gratification T4	0.42**	0.42	0.05	
Delay of gratification T3 → delay of gratification T5	0.42**	0.42	0.05	
Delay of gratification T4 → delay of gratification T5	0.26**	0.26	0.05	
Cross-lagged effects				
Social support T1 → delay of gratification T2	0.09**	0.05	0.03	
Social support T2 → delay of gratification T3	0.09**	0.06	0.03	
Social support T3 → delay of gratification T4	0.09**	0.06	0.03	
Social support T4 → delay of gratification T5	0.09**	0.07	0.03	
GPA				
Social support T5 → GPA	0.15**	0.15	0.05	
Delay of gratification T3 → GPA	0.17**	0.23	0.03	
Indirect effects				
Social supportT1 → social supportT2 → delay of gratificationT3 → GPA	0.01**	0.01	0.00	0.003; 0.01
Social supportT1 → delay of gratificationT2 → delay of gratificationT3 → GPA	0.01**	0.01	0.00	0.003; 0.01
Social supportT2 → delay of gratificationT3 → GPA	0.02**	0.01	0.01	0.01; 0.03
Control variables				
PEFT → GPA	2.09**	0.28	0.49	
PEFT → social support T5	−1.47**	−0.19	0.47	
Ethnic background (non-Dutch) → social support T2	−0.14*	−0.08	0.07	
Ethnic background (non-Dutch) → delay of gratification T1	0.29*	0.11	0.14	
Ethnic background (non-Dutch) → delay of gratification T4	0.26*	0.09	0.10	
Gender (girls) → GPA	0.16**	0.10	0.06	
Gender (girls) → social support T2	0.14**	0.10	0.04	
SES (reference = low)				
Average → GPA	−0.15**	−0.09	0.06	
High → social support T1	−0.14**	−10	0.05	
High → social support T3	−0.12*	−0.08	0.06	
Average → social support T3	−0.14*	−0.09	0.06	
Average → delay of gratification T4	−0.15**	−0.07	0.03	
School level (reference = mid-level)				
High-level → social support T2	0.18**	0.13	0.06	
High-level → social support T5	0.18*	0.12	0.08	
High-level → delay of gratification T2	0.22**	0.11	0.08	
Low-level → delay of gratification T1	−0.34**	−0.16	0.10	

* $p < 0.05$.
** $p < 0.01$.

the model with paths from perceived social support to delay of gratification was lower than the model with cross-lagged effects from delay of gratification to perceived social support (ΔAIC = 7.10). The model with cross-lagged effects in both directions did not gave a significant better fit ($\Delta\chi^2(1) = 3.80$, $p = 0.05$). To obtain the final model we removed the non-significant relations and adjusted the error terms for nested data. The final model is presented in Fig. 3 and Table 5 (χ^2 (106) = 132.95, CFI = 0.99, RMSEA = 0.02, CI for RMSEA = [0.00; 0.03]). In the final model there were significant cross-lagged effects from perceived social support on delay of gratification (ranging from $\beta = 0.05$, $p < 0.01$ to $\beta = 0.06$ $p < 0.01$). There was a significant direct effect from perceived social support on time 5 on GPA ($\beta = 0.15$, $p < 0.01$) and a direct effect of delay of gratification on time 3 on GPA ($\beta = 0.17$, $p < 0.01$). There was also an indication that delay of gratification mediated the effect of perceived social support on GPA. There were small but significant indirect effects from perceived social support to GPA via delay of gratification (see Table 5). Both the *z*-test with adjusted standard errors and the CI obtained with bootstrapping suggested that the indirect effects were significant.

7.4. Perceived social-support and metacognitive strategy use

For perceived social-support and metacognitive strategy use, the model in which only the cross-lagged effects of perceived social support to metacognitive strategy use were modelled gave the best fit to the data (χ^2 (25) = 71.48, CFI = 0.98, RMSEA = 0.05). This model gave a significantly better fit than a model with no cross-lagged effects ($\Delta\chi^2(1) = 8.40$, $p < 0.01$) and the AIC of this model was lower than the model with cross-lagged effects from metacognitive strategy use to perceived social-support (ΔAIC = 7.16). Including cross-lagged effects in both directions did not significantly improve the model fit ($\Delta\chi^2(1) = 0.96$, $p = 0.33$). Fig. 4 and Table 6 present the final model in which the non-significant relations were removed and in which we adjusted for the nesting of the data (χ^2 (105) = 144.38, CFI = 0.98, RMSEA = 0.02, CI for RMSEA = [0.01; 0.03]). Just as in the other models, there was a significant direct effect from perceived social support on time 5 on GPA ($\beta = 0.18$, $p < 0.01$) and a direct effect of delay of gratification on time 3 on GPA ($\beta = 0.11$, $p < 0.01$). The cross-lagged effects in the model from perceived social support to metacognitive strategy use were significant (ranging from $\beta = 0.05$, $p < 0.01$ to $\beta = 0.06$, $p < 0.01$). There were positive indirect effects from perceived social support to GPA via metacognitive strategy use (Table 6). Bootstrapping indicated that these indirect effects were significant. However, de *z*-test with adjusted standard errors suggested that these effects were not significant.

8. Conclusions and discussion

Previous research has demonstrated a relation between perceived teacher support and students' learning behaviour (e.g., Sierens et al., 2009; Ryan & Patrick, 2001; Vansteenkiste et al., 2012; Yin et al., 2009). However, most studies investigating these relations have a cross-sectional correlational design; as a result, there is little knowledge about the causal directions of the relations between perceived teacher support, SRL and achievement. This study extends existing research by examining the longitudinal relations between perceived teacher support, two aspects of SRL and achievement during the first two years of secondary education. Five-wave autoregressive cross-lagged path models were used to estimate the direction of the effects between perceived autonomy support and social support from teachers and students' delay of gratification and metacognitive strategy use.

The results showed that perceived teacher support and SRL covaried over time. The contemporaneous correlations between perceived teacher support and SRL were small to medium throughout the first two years of secondary education. Using a longitudinal design, the study makes a stronger case for causal inferences between perceived teacher

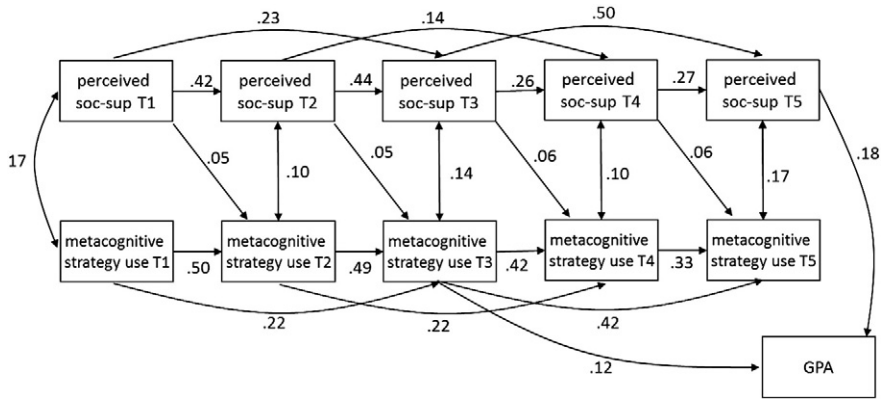

Fig. 4. Standardized estimates of the relations between the five measurements of perceived social-support and metacognitive strategy use and GPA at the end of year two. In this model we controlled for Primary Educations Test score, school level, gender, SES and ethnic background. The control variables are not shown in this figure. See Table 6 for all path-coefficients.

support and SRL than cross-sectional studies because it controls for initial levels. Controlling for initial levels makes it less likely that the observed correlations are spurious. However, contemporaneous correlations do not provide information about the directions of the effects.

We assumed that the relation between perceived teacher support and SRL was reciprocal. The results only partially confirmed this hypothesis. We found significant cross-lagged effects between perceived autonomy support and delay of gratification in both directions but not for metacognitive strategy use and perceived autonomy support. The result indicated that metacognitive strategy use predicted autonomy support and not the other way around. In addition, we found cross-lagged effects from perceived social support to SRL and not from SRL to perceived social support. In line with SDT, this study indicated that when students experience more social support from their teachers, they are more inclined to delay gratification and to use metacognitive strategies. Also in line with SDT we found that autonomy support was important for students' delay of gratification. The results are partially in agreement with the findings of other studies (Skinner & Belmont, 1993; Skinner et al., 2008; Van Ryzin, 2011) indicating longitudinal relations between students' perceptions of teacher support and student engagement. Although causality is still not strictly proven, the cross-lagged effects provide much stronger support for causality because of the time differences between the measurements.

Our study did not seem to support our assumption, based on the SDT, that autonomy support predicted students' metacognitive strategy use. In addition, the cross-lagged effects we found in this study were very small. A possible explanation for the weak link we found between perceived teacher support and SRL may be that there are other important factors that influence students' learning behaviour. Whereas the relation between perceived teacher support with student' intrinsic motivation may be more pronounced (e.g. Stroet et al., 2013), the relation with learning behaviour may be weaker because other factors may come into play when motivation for learning must be turned into action. For example, students need the knowledge and the skills to be able to regulate their learning and to use metacognitive strategies. In addition, school tasks should be made in a way that they allow students to regulate their own learning and stimulate them to use metacognitive strategies.

As we expected, our study revealed significant cross-lagged effects from SRL to perceived autonomy support. This may indicate that teachers adapt their autonomy-support to the self-regulated learning behaviour of the students. They may provide students who are able to regulate their learning with more autonomy-support and act more controlling towards students who are less able to regulate their learning. However it is also possible that students who are better able to regulate their learning perceive the same behaviour of teachers as more autonomy-supportive than students who regulate their learning less well.

In contrast to previous studies, the results indicate that there were no reciprocal effects from SRL to perceived social support. Our study seems to suggest that teachers do not adapt their social support to the SRL of students. However, it is also possible that there are actually two processes going on which are cancelling each other out (Skinner & Belmont, 1993). While some teachers may respond to students who are less motivated and less actively regulate their learning with less support, other teachers may try to compensate for a lack of motivated learning by increasing their social support.

In most models in our study, the contemporaneous correlations were larger than the observed cross-lagged effects. This result means that for most of the shared variance between perceived teacher support and SRL, the direction of the effect remains unclear. Further research is clearly needed to explain the shared variance between perceived teacher support and SRL. A possible approach to gain more insight into the dynamics of these relations would be to use a longitudinal design with shorter time intervals between the measurements than those in this study. Many authors have addressed the importance of choosing the right time interval for the measurements in longitudinal studies (Cole & Maxwell, 2003; Collins & Graham, 2002; Selig & Preacher, 2009). It is difficult to find the most appropriate time interval between measurements, and failing to do so may have an impact on the results. When the time interval between measurements is too short, there is no time for one variable to have an effect on the other. For example, when teachers give more autonomy support to students, it may take a while for students to adapt to these changes and alter their learning behaviour patterns. However, if the time intervals are too long, the effect of one variable to another may already have decayed or both variables may have changed significantly during the period between measurements and as a result the correlation of one variable with a previous measurement of an another variable becomes weak. Collins and Graham (2002) recommend using shorter time intervals to get more insight into how dynamic variables influence each other over time. Our suggestion for future research is therefore to use a longitudinal design with shorter time intervals between measurements. However, the questionnaires in our study are too long for students to use in a multiple-wave longitudinal design with very short time intervals. Short questionnaires must be developed for this purpose. In addition, other types of measurements (i.e., more qualitative measurements) may reveal more of the developmental processes in the relations among teacher support, learning behaviour and achievement.

Nevertheless, this study indicates that individual differences in SRL do not strongly depend on students' perception of the learning environment. A possible explanation might be that some SRL aspects are more of a rather stable personality trait and hard to influence. In this study the focus was on causality not on within-person effects. For future studies, it might be of interest to examine changes in perceived teacher

Table 6
Path coefficients for the relations between perceived social support, metacognitive strategy use and GPA and control variables.

Variables	*b*	*β*	*SE*	*bootstrap 95% CI*
Contemporaneous correlations				
Social support T1 ↔ metacognitive strategy use T1	0.07**	0.17	0.02	
Social support T2 ↔ metacognitive strategy use T1	0.04*	0.10	0.02	
Social support T3 ↔ metacognitive strategy use T1	0.05**	0.14	0.02	
Social support T4 ↔ metacognitive strategy use T1	0.05*	0.10	0.02	
Social support T5 ↔ metacognitive strategy use T1	0.06**	0.17	0.02	
Auto-regressive effects				
Social support T1 → social support T2	0.48**	0.42	0.05	
Social support T1 → social support T3	0.28**	0.23	0.05	
Social support T2 → social support T3	0.45**	0.44	0.05	
Social support T2 → social support T4	0.16**	0.14	0.05	
Social support T3 → social support T4	0.28**	0.26	0.06	
Social support T3 → social support T5	0.55**	0.50	0.04	
Social support T4 → social support T5	0.27**	0.27	0.04	
Metacognitive strategy use T1 → metacognitive strategy use T2	0.52**	0.50	0.04	
Metacognitive strategy use T1 → metacognitive strategy use T3	0.23**	0.22	0.05	
Metacognitive strategy use T2 → metacognitive strategy use T3	0.51**	0.49	0.05	
Metacognitive strategy use T2 → metacognitive strategy use T4	0.22**	0.22	0.06	
Metacognitive strategy use T3 → metacognitive strategy use T4	0.40**	0.42	0.04	
Metacognitive strategy use T3 → metacognitive strategy use T5	0.41**	0.42	0.04	
Metacognitive strategy use T4 → metacognitive strategy use T5	0.34**	0.33	0.05	
Cross-lagged effects				
Social support T1 → metacognitive strategy use T2	0.07**	0.05	0.02	
Social support T2 → metacognitive strategy use T3	0.07**	0.05	0.02	
Social support T3 → metacognitive strategy use T4	0.07**	0.06	0.02	
Social support T4 → metacognitive strategy use T5	0.07**	0.06	0.02	
GPA				
Social support T5 → GPA	0.18**	0.18	0.05	
Metacognitive strategy use T3 → GPA	0.11*	0.12	0.05	
Indirect effects time specific				
Social supportT1 → social supportT2 → metacognitive strategy useT3 → GPA	0.00	0.00	0.00	0.001–0.01
Social supportT1 → metacognitive strategy useT2 → metacognitive strategy useT3 → GPA	0.00	0.00	0.00	0.001–0.01
Social supportT2 → metacognitive strategy useT3 → GPA	0.01	0.01	0.00	0.002–0.01
Control variables				
PEFT → GPA	2.14**	0.28	0.51	
PEFT → social support T5	−1.43**	−0.19	0.47	
Ethnic background (non-Dutch) → social support T2	−0.15*	−0.08	0.06	
Ethnic background (non-Dutch) → metacognitive strategy use T1	0.34**	0.15	0.07	
Gender (girls) → GPA	0.13*	0.09	0.06	
Gender (girls) → social support T2	0.14**	0.10	0.04	
Gender (girls) → metacognitive strategy use T1	0.22**	0.14	0.07	
Gender (girls) → metacognitive strategy use T5	0.16**	0.10	0.05	
SES (reference = low)				
Average → GPA	−0.13*	−0.08	0.06	
High → social support T1	−0.14**	−0.11	0.05	
High → social support T3	−0.12*	−0.08	0.06	
Average → social support T3	−0.13*	−0.08	0.06	
School level (reference = mid-level)				
High-level → social support T2	0.18**	0.13	0.06	
High-level → social support T5	0.18*	0.11	0.08	
High-level → metacognitive strategy use T1	0.28**	0.18	0.07	
High-level → metacognitive strategy use T2	0.24**	0.15	0.06	

* $p < 0.05$.
** $p < 0.01$.

support and SRL using alternative approaches that can capture multivariate within person changes over time. See, for example, Curran, Howard, Bainter, Lane, and McGinley (2014) for a discussion on models that combine latent curve modelling with autoregressive structures or Ferrer and McArdle (2010) for a discussion on latent change models.

A second purpose of this study was to investigate the mediating effects of SRL between perceived teacher support and achievement. Unexpectedly, the study revealed rather small correlations between perceived teacher support and achievement. The effects of perceived autonomy support on achievement, in particular, appeared to be very small. In line with our hypothesis, we found that the effects of perceived social support on students' achievement was mediated by delay of gratification. No mediating effects between autonomy support and achievement were found from metacognitive strategy use. Our study yielded inconclusive results on the mediation of the effect of perceived autonomy support on achievement by delay of gratification and on the mediation between perceived social support and achievement by metacognitive strategy use. Significance of these last two relations depended on the statistical method used for analysis. However, whether these indirect relations were significant or not, it seemed that the effects of perceived teacher support and SRL on achievement were very small. It should be noted however, that in this study we focused on two specific aspects of SRL, future research that focuses on other aspects of SRL may find different results.

This study has a number of limitations that need to be addressed. First, students' perceptions of their teacher support were not specific to certain teachers or certain subjects but rather represented perceptions of an entire group of teachers. Although this is commonly used approach (see e.g. Hardre & Reeve, 2003; Murdock, Anderman, & Hodge, 2000; Murdock & Miller, 2003; Vansteenkiste et al., 2012), it is likely that

students' perceptions of teacher support vary between teachers and subjects. The reliance on general impressions may explain why the effects we found in this study were rather small. It is possible that students' perceptions of specific teachers in a particular class may be more strongly related to students' learning behaviour in that particular class.

It should also be taken into account that teachers may differ in the way they grade their students. Although research shows that teachers' grading of students is primarily based on achievement of students, in some cases other factors than achievement may also play a role (Randall & Engelhard, 2009).

Another limitation is that the study relied on student self-reports (except for the report cards information on GPA). Shared method variance could have increased the observed magnitude of the relations. In addition, because we only used student self-reports, we do not know the relation between SRL and the actual behaviour of teachers. It is plausible that students' perceptions of teacher support are most important for students' learning behaviour (Ames, 1992). However, a relevant question for educational practice is what teachers can do to motivate students. We assume that there is a relation between the perception of students and the actual behaviour of teachers; research has found low to moderate correlations between teachers' and students' perceptions of teacher behaviour (Hornstra, 2013; Kunter & Baumert, 2006). However, differences in the way students perceive their teachers' behaviour may be responsible for some of the findings in this study. It is possible that students' ability to regulate their learning has a different effect on the way students perceive autonomy support than social support and that these differences are responsible for the different results for autonomy support and social support. It is important for future research to disentangle students' perception of teacher support from actual teacher behaviour. Longitudinal research, including teacher reports and observations, may reveal different and complementary insights into the relation between the actual behaviour of teachers and students' learning behaviour. In addition to this, a more qualitative approach using teacher and student interviews may provide more insight into the processes behind changes in teacher support and how teacher behaviour is perceived by students.

Despite these limitations, this study contributes to our knowledge of the relations among perceived teacher support, SRL and achievement. The present study provides suggestions about the directions of the effects of perceived teacher support and SRL and provides modest support for the mediating effects of SRL between perceived teacher support and achievement. This study also shows that a great deal remains unknown with respect to the relations between perceived teacher support and achievement. One of the main questions for further research concerns the extent to which student perceptions of teacher support are coloured by their motivation towards school. This study confirms some of the implications of the self-determination theory for educational practice. Although further research is necessary, the present results indicate that the quality of teachers' personal relations with their students is not only positive for students' social and emotional wellbeing in school, but also important for students' learning behaviour and performance in school. Teacher support may influence the quality of the learning process and teachers do well by giving students space to employ their own initiatives, explaining the meaning and relevance of learning tasks and investing in caring and supportive relations with their students.

Appendix A. Appendix

A.1. Perceived autonomy-support

Providing choices and options and taking students perceptions into account (*The Learning Climate Questionnaire*: *William & Deci*, *1996*)

1. Teachers of this school encouraged me to ask questions
2. I feel that the teachers provide me choices and options.
3. The teachers try to understand how I see things before suggesting a new way to do things.
4. The teachers listen to how I would like to do things.

Relevance (*TASC*; *Belmont* et al., 1988)

5. My teachers encourage me to find out how schoolwork could be useful to me.
6. My teachers doesn't explain why what I do in school is important to me.
7. My teachers talk about how I can use the things we learn in school.

Connecting to students worlds (*Thoonen* et al., *2011*)

8. The teachers ask us what we already know about a subject.
9. When I have to learn something for school, Teachers first explain why it is important to learn.
10. My teachers explain that what we learn in school is also required outside school.

A.2. Perceived social-support

Social support from teachers (Peetsma et al., 2001)

1. My teachers pay attention to me
2. My teachers are not really interested in me
3. I can talk with my teachers about my personal problems
4. In the end, our teachers will let you down

A.3. Self-regulated learning

Delay of gratification (*Bembenutty & Karabenick*, *1998*

1. I finish my school work before I meet with my friends
2. I do my school work before I go out and have fun
3. I set aside enjoying activities till I have finished my school work

Metacognitive strategy use (*Pintrich*, *1991*; *Pintrich & De Groot*, *1990*)

4. Before I begin studying I think about the things I will need to do to learn.
5. I ask myself questions to make sure I know the material I have been studying.
6. When I'm reading I stop once in a while and go over what I have read.
7. When reading I ask myself questions to concentrate better
8. When I don't understand something, I will try to understand it again sometime later.
9. When I study, I set goals for myself

References

Ahmed, Minnaert, der Werf, Van, & Kuyper, Ahmed (2010). Perceived social support and early adolescents' achievement: The mediational roles of motivational beliefs and emotions. *Journal of youth and adolescence*, *39*(1), 36–46.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, *84*, 261–271.

Assor, A., Kaplan, H., & Roth, G. (2002). Choice is good, but relevance is excellent: Autonomy enhancing and suppressing teacher behaviours predicting students' engagement in schoolwork. *British Journal of Educational Psychology*, *72*, 261–278.

Belmont, M., Skinner, E., Wellborn, J., & Connell, J. (1988). *Teacher as social context: A measure of student perceptions of teacher provision of involvement, structure, and autonomy support (Tech. Rep. No. 102)*. Rochester, NY: University of Rochester.

Bembenutty, H., & Karabenick, S. A. (1998). Delay of gratification. *Learning and Individual Differences*, *10*, 329–346.

Bembenutty, H., & Karabenick, S. A. (2004). Inherent association between academic delay of gratification, future time perspective, and self-regulated learning. *Educational Psychology Review*, *16*(1), 35–57.

Boekaerts, M., & Cascallar, E. (2006). How far have we moved toward the integration of theory and practice in self-regulation? *Educational Psychology Review*, *18*, 199–210.

Boekaerts, M., & Corno, L. (2005). Self-regulation in the classroom: A perspective on assessment and intervention. *Applied Psychology: An international review*, *54*(2), 199–231.
Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen, & J. S. Long (Eds.), *Testing structural equation models* (pp. 136–162). Newbury Park, CA: Sage.
Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, *9*(2), 233–255.
Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155.
Cole, D. A., & Maxwell, S. E. (2003). Testing mediational models with longitudinal data: questions and tips in the use of structural equation modeling. *Journal of Abnormal Psychology*, *112*(4), 558.
Collins, L. M., & Graham, J. W. (2002). The effect of the timing and spacing of observations in longitudinal studies of tobacco and other drug use: Temporal design considerations. *Drug and Alcohol Dependence*, *68*, 85–96.
Curran, P. J., Howard, A. L., Bainter, S. A., Lane, S. T., & McGinley, J. S. (2014). The separation of between-person and within-person components of individual change over time: A latent curve model with structured residuals. *Journal of Consulting and Clinical Psychology*, *82*(5), 879.
Deci, E. L., & Ryan, R. M. (2000). The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behaviour. *Psychological Inquiry*, *11*, 227–268.
Ferrer, E., & McArdle, J. J. (2010). Longitudinal modeling of developmental changes in psychological research. *Current Directions in Psychological Science*, *19*(3), 149–154.
Finkel, S. E. (1995). *Causal analysis with panel data.* Thousand Oaks, CA: Sage.
Hardre, P. L., & Reeve, J. (2003). A motivational model of rural students' intentions to persist in, versus drop out of, high school. *Journal of Educational Psychology*, *95*(2), 347.
Hornstra, T. E. (2013). Motivational developments in primary school: Group-specific differences in varying learning contexts. *Dissertation.* University of Amsterdam.
Kenny, D. A. (1975). Cross-lagged panel correlation: A test for spuriousness. *Psychological Bulletin*, *82*(6), 887.
Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York: Guilford Press.
Kunter, M., & Baumert, J. (2006). Who is the expert? Construct and criteria validity of student and teacher ratings of instruction. *Learning Environments Research*, *9*(3), 231–251.
Little, R. J. A., & Rubin, D. B. (1987). *Statistical analysis with missing data.* New York: Wiley.
MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis.* New York: Erlbaum.
Murdock, T. B., & Miller, A. (2003). Teachers as sources of middle school students' motivational identity: Variable-centered and person-centered analytic approaches. *The Elementary School Journal*, 383–399.
Murdock, T. B., Anderman, L. H., & Hodge, S. A. (2000). Middle-grade predictors of students' motivation and behavior in high school. *Journal of Adolescent Research*, *15*(3), 327–351.
Muthén, L. K., & Muthén, B. O. (1998-2007). *Mplus User's Guide* (5th ed.). Los Angeles, CA: Muthén & Muthén.
Opdenakker, M. C., & Minnaert, A. (2011). Relationship between learning environment characteristics and academic engagement 1. *Psychological Reports*, *109*(1), 259–284.
Patrick, H., Ryan, A. M., & Kaplan, A. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology*, *99*(1), 83–98.
Peetsma, T. T. D., Wagenaar, E., & de Kat, E. (2001). School motivation, future time perspective and well-being of high school students in segregated and integrated schools in the Netherlands and the role of ethnic self-description. In J. K. Koppen, I. Lunt, & C. Wulf (Eds.), *Education in Europe, cultures, values, institutions in transition. Vol. 14.* (pp. 54–74). Münster, New York: Waxmann.
Pintrich, P. R. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ).*
Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review*, *16*, 385–407.
Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33–40.
Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891.
Puustinen, M., & Pulkkinen, L. (2001). Models of self-regulated learning: A review. *Scandinavian Journal of Educational Research*, *45*(3), 269–286.
Randall, J., & Engelhard, G. (2009). Examining teacher grades using Rasch measurement theory. *Journal of Educational Measurement*, *46*(1), 1–18.
Reeve, J. (2009). Why teachers adopt a controlling motivating style toward students and how they can become more autonomy supportive. *Educational Psychologist*, *44*(3), 159–175.
Reeve, J., & Jang, H. (2006). What teachers say and do to support students' autonomy during a learning activity. *Journal of Educational Psychology*, *98*, 209–218.
Reeve, J., Nix, G., & Hamm, D. (2003). Testing models of the experience of self-determination in intrinsic motivation and the conundrum of choice. *Journal of Educational Psychology*, *95*(2), 375–392.
Roorda, D. L., Koomen, H. M., Spilt, J. L., & Oort, F. J. (2011). The influence of affective teacher–student relationships on students' school engagement and achievement a meta-analytic approach. *Review of Educational Research*, *81*(4), 493–529.
Rosel, J., & Plewis, I. (2008). Longitudinal data analysis with structural equations methodology. *Methodology*, *4*(1), 37–50.
Ryan, A. M., & Patrick, H. (2001). The classroom social environment and changes in adolescents' motivation and engagement during middle school. *American Educational Research Journal*, *38*(2), 437–460.
Selig, J. P., & Preacher, K. J. (2009). Mediation models for longitudinal data in developmental research. *Research in Human Development*, *6*(2–3), 144–164.
Sierens, E., Vansteenkiste, M., Goossens, L., Soenens, B., & Dochy, F. (2009). The synergistic relationship of perceived autonomy-support and structure in the prediction of self-regulated learning. *British Journal of Educational Psychology*, *79*, 57–68.
Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology*, *85*(4), 571.
Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A motivational perspective on engagement and disaffection conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational and Psychological Measurement*, *69*(3), 493–525.
Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology*, *100*(4), 765.
Stroet, K., Opdenakker, M. C., & Minnaert, A. (2013). Effects of need supportive teaching on early adolescents' motivation and engagement: A review of the literature. *Educational Research Review*, *9*, 65–87.
Tapola, A., & Niemivirta, M. (2008). The role of achievement goal orientations in students' perceptions of and preferences for classroom environment. *British Journal of Educational Psychology*, *78*(2), 291–312.
Thoonen, E., Sleegers, P., Peetsma, T., & Oort, F. (2011). Can teachers motivate students to learn? *Educational Studies*, *37*(3), 345–361.
Van der Veen, I., & Peetsma, T. T. D. (2009). The development in self –regulated learning behaviour of first-year students in the lowest level of secondary school in the Netherlands. *Learning and Individual Differences*, *19*, 34–46.
Van Grinsven, L., & Tillema, H. (2006). Learning opportunities to support student self-regulation: Comparing different instructional formats. *Educational Research*, *48*(1), 77–91.
Van Ryzin, M. J. (2011). Protective factors at school: Reciprocal effects among adolescents' perceptions of the school environment, engagement in learning, and hope. *Journal of Youth and Adolescence*, *40*(12), 1568–1580.
Van Ryzin, M. J., Gravely, A. A., & Roseth, C. J. (2009). Autonomy, belongingness, and engagement in school as contributors to adolescent psychological well-being. *Journal of Youth and Adolescence*, *38*(1), 1–12.
Vansteenkiste, M., & Ryan, R. M. (2013). On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. *Journal of Psychotherapy Integration*, *23*, 263–280.
Vansteenkiste, M., Sierens, E., Goossens, L., Soenens, B., Dochy, F., Mouratidis, A., et al. (2012). Identifying configurations of perceived teacher autonomy support and structure: Associations with self-regulated learning, motivation and problem behavior. *Learning and Instruction*, *22*(6), 431–439.
Vansteenkiste, M., Simons, J., Soenens, B., & Lens, W. (2004). How to become a persevering exerciser? Providing a clear, future intrinsic goal in an autonomy-supportive way. *Journal of Sport & Exercise Psychology*, *26*, 232–249.
Williams, G. C., & Deci, E. L. (1996). Internalization of biopsychosocial values by medical students: A test of self-determination theory. *Journal of Personality and Social Psychology*, *70*, 767–779.
Yin, H., Lee, J. C., & Zhang, Z. (2009). Examining Hong Kong students' motivational beliefs, strategy use and their relations with two relational factors in classrooms. *Educational Psychology*, *29*(6), 685–700.
Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). San Diego, CA: Academic Press.