Studying motivation in classrooms

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What motivates early adolescents for school? A longitudinal analysis of associations between observed need supportive teaching and various motivational constructs

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Abstract

For many early adolescent students, motivation for school declines after their transition toward secondary education. Increasingly, the decisive importance of teachers in shaping early adolescents' motivation is stressed; thus far, however, both longitudinal and observational studies on this topic have remained scarce. The present study aimed to investigate how early adolescents' interactions with their math teachers affected the development of their motivation for math. Following Self-Determination Theory, videotaped teacher-student interactions were coded in terms of their being supportive or thwarting of the three fundamental human needs for autonomy, competence, and relatedness; i.e. in terms of their providing autonomy support, structure, and involvement. To assess need supportive teaching, at four measurement occasions equally spread over the first year of secondary education video-analysis was conducted of, in total, 137 complete math lessons in 20 math classes (40% female teachers). To assess developments in motivation at each of the same four measurement occasions questionnaires were distributed to the 489 students (aged 12-13; 49.9% girls) of the 20 math classes. Multilevel analysis did not indicate associations of autonomy supportive teaching with any of the four motivational constructs that were incorporated in the study (autonomous motivation, controlled motivation, amotivation, and performance avoidance). For structure, associations in expected directions were found with autonomous motivation (positive) and amotivation (negative), but not with the other two motivational constructs. For teacher involvement, associations in the expected direction were found with all four motivational constructs. The findings are discussed in terms of their implications for research and educational practice.

Keywords
early adolescence
teacher-student interactions
motivation
self-determination theory

6.1 Introduction

Motivation is an important prerequisite for learning that has been shown predictive of, amongst others, school achievement (e.g. Richmond, 1990; Steinmayr & Spinath, 2009; Wigfield & Cambria, 2010), transfer of learning (Laine & Gegenfurtner, 2013), and persistence in learning over time (e.g. Richmond, 1990). For many early adolescent students, however, motivation for school declines after their transition towards secondary education (e.g. Anderman & Maehr, 1994; Gottfried, Fleming, & Gottfried, 2001; Peetsma, Hascher, Van der Veen, & Roede, 2005; Wigfield, Byrnes, & Eccles, 2006; Van der Werf, Opdenakker, & Kuyper, 2008), making this a particular urgent period for studying motivation and how it can be fostered. This decline is worrisome, especially, because it is in their early adolescence that children develop their identity at a rapid pace and shape their cognitive and emotional responses to school (Wigfield, Eccles, & Rodriguez, 1998). As more and more it is emphasised that social and situational factors can be of decisive importance in shaping students' motivation (Pintrich, 2004; Perry, Meyer, & Turner, 2006), in the present study we focused on the question how early adolescents' motivation for math can be fostered in their math classrooms. Because in these classrooms the teachers have a central position, specifically, we aimed to relate characteristics of teacher-student interactions to various motivational constructs.

An encompassing theoretical framework for linking teacher-student interactions with students' motivation is Self-Determination Theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2000). According to SDT three fundamental human needs exist –i.e. needs for autonomy, competence, and relatedness– support or thwart for which affects students' motivation. A wide array of research is already available indicating positive associations between the degree to which early adolescents perceive their teachers as need supportive and their motivation (see Chapter 3 for a review). Among prior SDT-research, two features render the present study unique. First, we focused on observed instead of student perceived need supportive teaching to enhance ecological validity and help bridge the gap between educational theory and practice. Second, we measured the development over the course of a school year of both need supportive teaching and student motivation to further understanding of how teacher-student interactions affect the development over time of various motivational constructs. We choose to focus on math classrooms as math is a key-subject in the curriculum and as, in the Netherlands, lessons can be compared relatively well as differences in terms of subject-content between schools are small.

Below, we continue by a discussion of need supportive teaching as defined from the perspective of Self-Determination Theory (6.2.1), we discuss various motivational constructs and their

relationship with students' learning (6.2.2), and we provide an overview of empirical evidence on effects of need supportive teaching on early adolescents' motivation (6.2.3).

6.2 Theoretical background

6.2.1 Need supportive teaching

'What motivates early adolescent students for school?' A first interpretation of this question relates to social and situational factors that shape motivation. Next to, amongst others, early adolescents' home environments and peer groups, research shows that it matters what happens in students' classrooms (Vedder-Weiss & Fortus, 2011; Opdenakker, Maulana, & Den Brok, 2012; Chapter 2). A prominent theoretical framework in current educational research is SDT. As we mentioned in the introduction, in these classrooms teachers can foster their students' motivation by supporting their students' fundamental needs for autonomy, competence, and relatedness. The need for autonomy finds its origin in people's desire to be causal agents and to experience volition. For students to experience autonomy in their learning, it is crucial that they consider their actions as personally valuable and interesting. The need for competence refers to the innate striving people have to exercise and elaborate their interests and to seek challenges, while at the same time feeling effective in doing so (White, 1959). Finally, the need for relatedness concerns the desire to form and maintain strong and stable interpersonal relationships, to connect with and be accepted by others, and to belong (Baumeister & Leary, 1995; Bowlby, 1979; Harlow, 1958; Ryan, 1995). The need for relatedness can be satisfied within interpersonal relationships or through feelings of belongingness to social groups.

A need supportive teaching style might imply beliefs about the nature of student motivation, but it is not a prescribed set of techniques and strategies (Reeve, 2006). In the SDT-literature, three dimensions of practices of need supportive teaching have been described that complement each other in their effect on students' general level of need satisfaction (Connell & Wellborn, 1991). When interpreting teacher-student interactions in terms of these dimensions, this should be done in context, as a statement cannot be detached from the situation in which it has been uttered (e.g. Malinowski, 1930). The first dimension of need supportive teaching is autonomy support what includes adopting students' perspectives and providing explanatory rationales when choice is constraint, versus autonomy thwart what incorporates the assertion of power to overcome students' complaints or display of impatience for students to produce the right answer. The second dimension is provision of structure, including communication of clear and consistent

guidelines and expectations and providing of step-by-step directions and constructive feedback versus chaos, including providing contradictory expectations, not being available when students have questions, and discouraging them. The third dimension is involvement versus disaffection or rejection, referring to the distinction between showing as opposed to not showing interest in the individual students, understanding of what is of importance for them, and availability to offer support.

6.2.2 Motivational constructs and their associations with students' learning

A second interpretation of the question 'what motivates early adolescent students for school' relates to the factors that give impetus to action or lack thereof. SDT discerns between motivation that is autonomous, i.e. regulated by personal interest or valuing of the task at hand and motivation that is controlled, i.e. regulated by feelings of pressure by others or obligation to perform a task. In addition, SDT distinguishes amotivation, i.e. the state of lacking intention to act. According to SDT, need supportive teaching would be expected to have positive effects on students' autonomous motivation and negative effects on their controlled motivation and amotivation.

The decline in early adolescents' motivation has been shown to be induced by declines in (elements of) autonomous motivation particularly (Gottfried et al., 2001; Otis, Grouzet, & Pelletier, 2005; Corpus, McClintic-Gilbert, & Hayenga, 2009; Opdenakker et al., 2012). Autonomous motivation is considered pivotal to students' learning as it has been linked with, amongst others, creativity (Amabile, 1996), adaptive coping strategies (Boggiano, 1998; Ryan & Connell, 1989), deep conceptual learning strategies (Meece, Blumenfeld, & Hoyle, 1988) and academic achievement (Gottfried, 1985; Boggiano, 1998; Spinath, Spinath, Harlaar, & Plomin, 2006). Controlled motivation, in contrast, has been associated with negative outcomes such as negative emotions (Dowson & McInerney, 2001; Harter, 1992; Ryan & Connell, 1989), maladaptive coping strategies (Boggiano, 1998; Ryan & Connell, 1989), and poor academic achievement (Lepper, Corpus, & Iyengar, 2005) although positive associations with self-regulation (Miller, Greene, Montalvo, Ravindran, & Nichols, 1996) and adjustment to secondary education (Otis et al., 2005) were found as well.

Another motivational construct that has consistently been shown a good predictor of students' engagement in learning in general and learning math in particular is performance avoidance. Need supportive teaching would be expected to have a negative effect on performance avoidance as it refers to students' avoidance of situations where others will notice their shortcomings. Performance avoidance is closely associated with test anxiety (Elliot & McGregor, 1999) and has

predominantly been found negatively related to students' achievement (e.g. Elliot & Murayama, 2008) and transfer of training (see Laine & Gegenfurtner, 2013 for a meta-analysis).

Below, we continue by providing an overview of prior research on effects of need supportive teaching as defined in SDT and early adolescents' motivation, thereby paying special attention to the motivational constructs described above.

6.2.3 Need supportive teaching and early adolescents' motivation: An overview of prior research

A large body of research is available that links student-perceived need supportive teaching and early adolescents' motivation in correlational studies. These studies showed positive associations of need supportive teaching (Katz, Kaplan, & Gueta, 2010) and of autonomy supportive teaching (Chirkov & Ryan, 2001; Vallerand, Fortier, & Guay, 1997; Hardré & Reeve, 2003; Shih, 2008; 2009; Tucker et al., 2002) with students' autonomous motivation. In addition, in one study a negative association with controlled motivation was found (Chirkov & Ryan, 2001), while in another study, contrary to expectations, a positive association was found (Shih, 2008). For (measures closely related to) teacher involvement positive associations were found with autonomous motivation (Ryan, Stiller, & Lynch, 1994; Maulana, Opdenakker, den Brok, & Bosker, 2011), and no associations with controlled motivation (Maulana et al., 2011). Finally, in one study autonomy support, structure, and involvement each appeared uniquely associated with students' autonomous motivation (Tucker et al., 2002).

Thus far, most SDT-studies among early adolescents have relied on student perceptions (Chapter 3). Increasingly, however, the importance of conducting observational research in classrooms is emphasised to enhance ecological validity of findings and to help bridge the gap between educational theory and practice (Perry et al., 2006; Stefanou, Perencevich, DiCintio, & Turner, 2004). The few studies that did use observational measures typically related observed autonomy support and student engagement, finding positive associations (Stefanou et al., 2004; Jang, Reeve, & Deci, 2010). Further, a teacher training on autonomy support was found to generate positive effects on observed autonomy support and levels of the latter appeared predictive of changes in engagement between the pre-measure and the post-measures that took place 4 weeks and 9 weeks after the intervention (Reeve, Jang, Carrell, Jeon, & Barch, 2004). In addition, while in one study associations between observed structure and observed engagement but not student perceived engagement were found (Jang et al., 2010), in another study the development of observed need supportive teaching over time was shown negatively related to the development of controlled motivation but not autonomous motivation (Maulana, Opdenakker, Stroet, & Bosker,

2013).

Next to studies relying on observational measures of need supportive teaching, longitudinal SDT-studies among early adolescents have remained scarce (see Chapter 3). Such research is crucial, however, for furthering understanding of how the development of students' motivation is associated with their teachers being need supportive. Next to the studies by Reeve et al. (2004) on observed autonomy support and Maulana et al. (2013) on observed involvement described above, we could trace three longitudinal studies using student perceptions. These studies showed need supportive teaching in fall associated with changes in engagement between fall and spring (Skinner, Furrer, Marchand, & Kindermann, 2008), while no associations were found of structure in fall with changes in motivation between fall and spring (Pintrich, Roeser, & de Groot, 1994). Finally, (a measure closely related to) involvement in winter was found positively associated with changes in student motivation between fall and spring (Lapointe, Legault, & Batiste, 2005).

In conclusion, together these studies do further our understanding of associations among early adolescents of need supportive teaching with various motivational constructs. At the same time, they point towards gaps in the available empirical evidence supporting SDT. Next to longitudinal studies and research relying on observations instead of student perceptions being scarce, they point toward a lack of studies linking the dimension of structure with autonomous motivation and of studies focusing on amotivation or performance avoidance in general.

6.2.4 Present investigation

The present study concerned the relationship between math teachers' levels of need supportive teaching and the development over time of their students' motivation for math (in four waves). We focused on students in their first year after the transition toward secondary education. For measuring need supportive teaching, we used an observational measure that distinguished between the three dimensions of autonomy support versus thwart, structure versus chaos, and involvement versus disaffection. We choose to focus on math because this is considered a key-subject in the curriculum and because, in the Netherlands, for math differences in terms of subject-content between schools are small as a large majority of schools use one of two popular textbooks ("Getal en Ruimte[1]" (60%) and "Moderne Wiskunde[1]" (30%); Noordhoff publishers, personal communication, January 2, 2014).

Following recommendations by Snijders and Bosker (2012), we included as predictors both the math teachers' average levels of need supportive teaching over measurement occasions and their deviations of these levels per measurement occasion. For both, we hypothesised positive

[1] Groningen, the Netherlands: Noordhoff Publishers

associations of each of the three dimensions of need supportive teaching with developments of autonomous motivation for math and negative associations with developments of controlled motivation, amotivation, and performance avoidance for math.

6.3 Method

6.3.1 Participants

The data collection consisted of four waves, with at each wave 489 students participating. These 489 students (49.9 % girls) were divided over 20 classes, with class-sizes ranging from 17 to 31 students, in 10 schools, with 2 classes per school. In total 16 teachers in math (6 of which female, teaching in 40% of the classes) were involved; the reason for this total being less than 20 is that in some cases a teacher taught in two of the participating classes. The 20 classes all were grade 7, which in the Netherlands is the first year after the transition toward secondary education. Students attending this grade are aged 12-13. Further, all classes were at the prevocational level of Dutch secondary education ('vmbo') and worked in accord with a variety of diverse educational approaches. All classes used one of the two textbooks that are prominent in Dutch education (see 'Present Investigation'). In the Dutch educational system, the prevocational level is the lowest track of the three mainstream tracks, and is attended by more than half of the students (Dutch Inspectorate of Education, 2012). Heads of school departments decided upon participation in the study in consultation with their teams. Prior to the start of the study parent(s)/guardian(s) of the students had received information letters informing them that, at any time, they could decide not to grant permission for taheir child (to continue) participating in the study. The parent(s)/ guardian(s) of 1 student decided not to grant permission for the questionnaire-part of the study.

6.3.2 Measures

Need supportive teaching. The first wave of the data collection took place around 11 weeks after the start of the school year 2010-2011, while the other 3 waves were evenly spread over the rest of the school year. At each measurement occasion, in each of the 20 classes, at least 1 and whenever considered desirable (e.g. when we were not sure the first lesson we videotaped was a typical lesson) 2 lesson(s) in math were (was) videotaped. As in the end in 57 of 80 cases we videotaped 2 instead of 1 lesson this yielded a total of 137 (80 + 57) videotaped lessons. The videos were shot by four cameramen: Three trained university students and the first author. Classrooms were equipped with 2 cameras: 1 'fixed' camera that faced the class, and 1 'action' camera that

was operated by a cameraman at the back of the class. The 'action' camera was directed at the teacher, or, when the teacher was talking to an individual or small group of students, at the on-going teacher-student(s) interaction. Teachers were equipped with a small wireless microphone, so that all teacher-student interactions would be audible on the videotapes; including softly spoken interactions with individual or small groups of students. The cameramen tried to limit interference to an absolute minimum, so the teacher and the class could proceed with their lesson as usual. It was made clear to both the teachers and the students that the interest of the study was in normal classroom communication, and it was emphasised that all material would be processed anonymously.

The videotaped lessons were coded using an existing rating sheet assessing need supportive teaching from the perspective of SDT. This rating sheet was used and validated previously in schools for prevocational education (Chapter 4) and is presented in the Appendix of this dissertation. In the development of this rating sheet existing rating sheets were considered (i.e. Reeve et al., 2004 (autonomy support); Wiebenga, 2008 (need supportive teaching); Maulana et al., 2012 (involvement)), and an extensive review was conducted of available SDT-literature on practices of need support and thwart within teacher-student interactions (e.g. Ryan, 1982; Belmont, Skinner, Wellborn, & Connell, 1992; Deci & Ryan, 1994; Deci, Ryan, & Williams, 1996; Assor, Kaplan, & Roth, 2002; Alfi, Katz, & Assor, 2004; Stefanou et al, 2004; Katz & Assor, 2006; Reeve, 2006; Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008; Jang et al., 2010; Vansteenkiste, Niemiec, & Soenens , 2010).

Teacher-student interactions were classified as either not being relevant in terms of need supportive teaching or as providing students with one or more of its dimensions (autonomy support versus autonomy thwart, structure versus chaos, and/or involvement versus disaffection or reject). If a teacher-student interaction could not be coded (e.g. because it was inaudible), then a "no code" was used; in practice this did not occur. Teacher-student interactions were interpreted in context and from what we considered the perspective of the student(s). All our codes were linked to the complete video fragments they related to, so we could adequately map both frequency of occurrence and duration. For the dimensions of autonomy support versus autonomy thwart and structure versus chaos we considered durations of teacher-student interactions to most properly indicate its expressions. For example, as longer provision of step-by-step directions seemed indicative of higher levels of structure or as the more time teachers took to provide respect by listening carefully to students, the higher levels of autonomy support appeared. For the dimension of involvement versus disaffection, however, for two reasons we considered frequency the most appropriate indication of its expression. First, because more than is the case for the other

two dimensions, utterances seemed to provide involvement or disaffection rather independent of their duration. Second, because we found expressions of involvement and disaffection often to be manifest in part of a teacher-student interactions only, so that a focus on durations would somewhat mask the data. All coding was conducted by the first author. To determine reliability of final coding, we used four videos to calculate Cohen's kappa yielding values between .78 and .85 what indicates good to very good agreement.

Student motivation. Next to the collection of video-material, questionnaires were administered at each wave to measure students' motivation for math, thereby focusing on four motivational constructs, i.e. autonomous motivation, controlled motivation, amotivation, and performance avoidance. These questionnaires were administered during regular lessons by the students' mentors. On each measurement occasion, the mentors received a letter containing standardized instructions to guide the students through the questionnaires. The mentors were instructed not to check the students' answers and to make clear that all of the data would be processed anonymously. All items had five response categories, ranging from completely disagree (1) to completely agree (5), and were in Dutch, students' school language.

Autonomous motivation for math was assessed using an adapted and shortened version of the intrinsic and identified motivation subscales of the Ryan and Connell (1989) self-regulation questionnaire. The subscales were made course-specific and consisted of 8 items: E.g.: "I work on math because I enjoy it", "I work on math because I want to learn new things". In the current study, the scales had Cronbach's alphas ranging for the five measurement occasions from .88 to .92, indicating high internal consistencies.

Controlled motivation for math was assessed using an adapted and shortened version of the introjected and extrinsic motivation subscales of the Ryan and Connell (1989) self-regulation questionnaire. The subscales were made course-specific and consisted of 8 items. E.g.: "I work on math because I want others to think I am smart", "I work on math because I have to". Cronbach's alphas ranged from .77 to .83 indicating high internal consistencies.

Amotivation for math was assessed using an adapted and shortened version of the amotivation subscale of the Vallerand, Blais, Brière, and Pelletier (1989) academic motivation scale. The subscale was made course-specific and consisted of 3 items. E.g.: "I don't know why I work on math. Sometimes I feel I am wasting my time". Cronbach's alphas ranged from .80 to .86 for the four measurement occasions, indicating high internal consistencies.

Performance avoidance refers to situations where students are afraid that others will notice their shortcomings and was assessed using the 6-item subscale 'Self-Defeating Ego-Orientation' of the 'Goal Orientation Questionnaire' of Seegers, van Putten, and de Brabander (2002). E.g.: "I feel

embarrassed when I have to ask for help during math lessons". The Cronbach's alphas ranged from .86 to .95, indicating high internal consistencies.

6.3.3 Analytical approach

The coded teacher-student interactions were used to calculate the percentages of lesson-time teachers spent on providing autonomy support, autonomy thwart, structure, and/or chaos, and the frequencies per hour teachers expressed their involvement or disaffection. For determining the net levels of autonomy support and structure per class, per measurement occasion durations of autonomy thwart respectively chaos were subtracted from durations of autonomy support respectively structure. For determining the net levels of involvement, per class, per measurement occasion frequencies for disaffection were subtracted from frequencies for involvement.

For the purpose of answering our research questions, we used Hierarchical Linear Modelling (HLM), thereby following a multilevel approach to take into account the longitudinal and hierarchical structure in the data. Students with missing data on one or more measurement occasions were included in the analyses. In HLM, missing data are unproblematic, provided that all students have measures on at least one occasion and that data are missing at random. The former of these two conditions was met; for the purpose of checking whether the latter condition was met as well we performed an additional analysis (see 'missing data analysis'). Occasionally, students had missed items, assumedly at random. The scores to these items were always imputed with the mean of the scale.

First, series of unconditional models were used to estimate the proportion of variance within students, among students, and between classes (Table 2).

Second, comparison models were estimated that included the effects of 'time' and 'gender' (boys functioned as reference group) on motivational constructs (not presented). In these models, the linear effect of 'time' was always included as fixed effect; random slopes of 'time' for classes and polynomials to the second degree were added in turn when this significantly increased the fit of the model. The significance of the increase in fit was determined by means of χ^2 tests with 2 degrees of freedom for the random slope of 'time' (variance random slope and covariance random intercept and random slope), and 1 degree of freedom for the fixed effect of '$(time)^2$'.

Third, in turn each of the three dimensions of need supportive teaching was added to the model (Models 1, 2, and 3 of Table 3). In these models as predictors were included both the teachers' average levels of need supportive teaching over the four measurement occasions and the deviations of these average levels per measurement occasions. The significance of the increase of fit of these series of models relative to the comparison models was determined by means of a χ^2

test with 2 degrees of freedom. An (fictitious) example of how β-coefficients in models 1, 2, and 3 should be interpreted is that a β-coefficient of 1 for 'autonomy support (average)' for autonomous motivation would mean that an increase of 1 in the net average level of autonomy support is associated with an increase of 1-point on the 5-point scale of autonomous motivation.

6.4 Results

6.4.1 Missing data analysis

The vast majority of missing data in the measures of student motivation in the present study consisted in 8 of the 20 classes missing one measurement occasion for pragmatic reasons (e.g. miscommunication between mentors). These missed occasions could not be caught up due to the longitudinal nature of the study and the tightly scheduled measurement occasions. The first measurement occasion was missed by 2 classes, the third by 4 classes, and the fourth by 2 classes; classes never missed more than 1 measurement occasion.

In addition, missing data consisted of some students within classes missing one or more measurement occasion(s). In 12 of the 20 classes more than 15% of the students had not filled in the questionnaire at one or more of the measurement occasions. As we considered this type of missing data a potential threat to the assumption of missingness at random in HLM, for each measurement occasion we verified that the students with missing data had not scored differently from the other students on a premeasure of motivation for math administered at the beginning of the school year. Data on this premeasure were nearly complete. Whenever we found significant differences, we checked if these remained when comparing students within schools only. These comparisons typically did not reveal differences between students with and without missing data; except for 1 school for the fifth measurement occasion. Although this finding yields a violation of the assumption of missingness at random, the impact will be small as the assumption appeared violated for the fifth measurement occasion and for one school only

6.4.2 Associations of need supportive teaching with the development of students' motivation over time

The results as presented in Table 1 and in Figure 1 showed somewhat declining trends for all four motivational constructs. For the three dimensions of need supportive teaching, for autonomy support and involvement declining trends are visible while for structure the general trend appears rising.

Table 1 Means (M), Standard Deviations (SD), and Subsample without missing data (n) for the dimensions of need supportive teaching and motivational constructs for all four measurement occasions

	t1		t2		t3		t4	
	M (SD)	**n**	**M (SD)**	**n**	**M (SD)**	**n**	**M (SD)**	**n**
Need supportive teaching								
Autonomy support	.07 (1.1)	20	-.16 (1.3)	20	-.33 (.92)	20	-.54 (1.1)	20
Structure	.81 (1.0)	20	.86 (1.2)	20	.89 (1.2)	20	.97 (1.1)	20
Involvement	.32 (.77)	20	.12 (1.1)	20	-.01 (.63)	20	-.19 (.73)	20
Motivational constructs								
Autonomous motivation	3.44 (.90)	308	3.27 (.91)	406	3.09 (.85)	328	3.18 (.78)	365
Controlled motivation	2.42 (.81)	305	2.36 (.74)	406	2.49 (.76)	328	2.53 (.77)	365
Amotivation	1.99 (.98)	306	2.13 (.99)	406	2.37 (.97)	328	2.33 (.98)	365
Performance avoidance	1.83 (.86)	302	1.83 (.84)	390	1.92 (.88)	327	2.02 (.93)	358

Table 2 Distribution of the total variance over the class, student, and occasion level

Variable	**Autonomy support**	**Structure**	**Involvement**	**Autonomous motivation**	**Controlled motivation**	**Amotivation**	**Performance avoidance**
Class	57.6%	65.1%	50.5%	9.3%	4.8%	10.6%	14.3%
Student				48.8%	47.4%	42.5%	43.1%
Occasion	42.4%	34.9%	49.5%	41.8%	47.8%	46.9%	42.6%

The results as presented in Table 2 showed that for autonomy support, structure, and involvement (well) over half of the variance was attributable to class level, while for all three dimensions substantial proportions of variance appeared attributable to the occasion level as well. Further, although for all four motivational constructs most variance was attributable to student and occasion level, meaningful differences between classes were apparent as well. For autonomous motivation, amotivation, and, in particular, performance avoidance substantial parts of the variance were attributable to the class level. For controlled motivation a smaller but still meaningful part of the variance was attributable to the class level.

The results as presented in Table 3 showed that for autonomous motivation, amotivation, and performance avoidance a linear effect with a random slope at the class level was sufficient for modelling the effect of 'time', whereas for controlled motivation adding a polynomial to the second degree significantly increased the fit of the model. No effects were found of gender on autonomous motivation. For controlled motivation, amotivation, and performance avoidance negative effects of gender were found, indicating lower scores on these three motivational constructs for girls t

Table 3 Results from the HLM analyses predicting the development over time of four motivational outcomes by autonomy support, structure, and involvement

Variable	Autonomous motivation						Controlled motivation					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE	β	SE	β	SE	b	SE
Fixed effects												
Intercept	3.60	.12	3.38	.12	3.56	.11	2.61	.12	2.68	.13	2.64	.12
Time	-.12*	.03	-.11*	.03	-.12*	.03	-.15^	.09	-.15	.09	-.15^	.09
$(Time)^2$							.04*	.02			.04*	.02
Gender	-.12	.07	-.12	.07	-.12	.07	-.16*	.06	-.16	.07	-.16*	.06
Autonomy support (average)	.09	.08					-.04	.05				
Autonomy support (deviation)	-.03	.02					.01	.02				
Structure (average)			.21*	.06					-.07	.05		
Structure (deviation)			-.03	.02					-.00	.02		
Involvement (average)					.25*	.10					-.18*	.06
Involvement (deviation)					-.03	.03					-.02	.03
Random effects												
Class level												
Var. intercept	.18	.08	.18	.08	.15	.07	.07	.04	.07	.04	.06	.03
Var. slope Time	.01	.01	.01	.01	.01	.01	.01	.00	.01	.00	.01	.00
Var. Slope $(Time)^2$												
Cov. Intercept x slope Time	-.04	.02	-.04	.02	-.03	.02	-.02	.01	-.02	.01	.-02	.01
Cov. Intercept x slope $(Time)^2$												
Cov. Time x $(Time)^2$												
Individual level												
Var. intercept	.38	.03	.38	.03	.38	.03	.27	.03	.27	.03	.27	.03
Occasion level												
Var. intercept	.29	.01	.29	.01	.29	.01	.27	.01	.26	.01	.26	.01
Decrease deviance	2		12*		6^		1		2		8*	

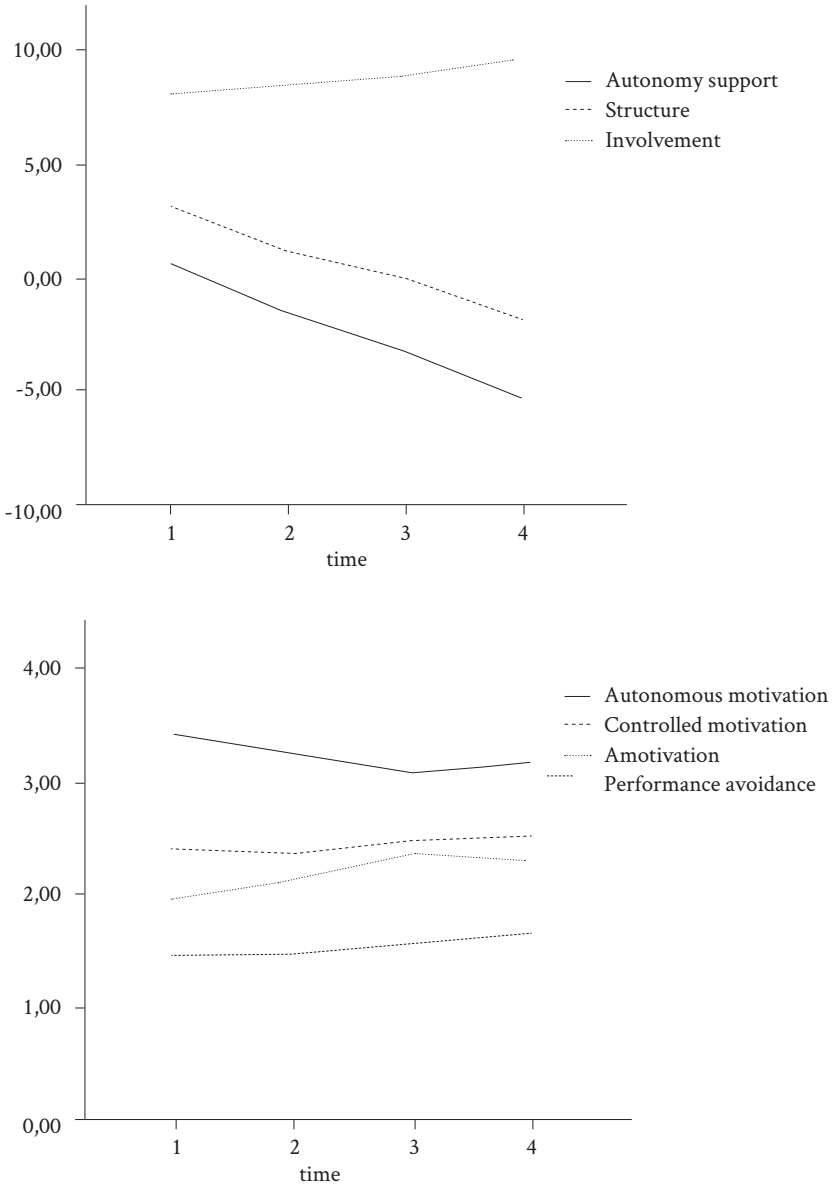
Note: * p<.05. ^p<.10 (Due to rounding of b and SE exact p-values cannot be deduced from the Table).

Table 3 continued

Variable	Amotivation						Performance avoidance					
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Fixed effects												
Intercept	1.97	.11	2.17	.13	2.02	.10	1.88	.10	1.89	.12	1.88	.09
Time	.14*	.03	.13*	.03	.14*	.03	.04	.03	.05	.03	.04	.03
$(Time)^2$												
Gender	-.29*	.07	-.29*	.07	-.28*	.07	-.19*	.06	-.19*	.06	-.19*	.06
Autonomy support (average)	-.13	.09					.01	.09				
Autonomy support (deviation)	.02	.03					-.02	.03				
Structure (average)			-.19*	.08					-.03	.08		
Structure (deviation)			.03	.03					-.01	.03		
Involvement (average)					-.39*	.10					-.21^	.11
Involvement (deviation)					.01	.04					-.03	.03
Random effects												
Class level												
Var. intercept	.14	.07	.15	.07	.08	.05	.11	.05	.11	.05	.08	.04
Var. slope Time	.01	.00	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
Var. Slope $(Time)^2$												
Cov. Intercept x slope Time	-.02	.02	-.03	.02	-.02	.01	-.02	.02	-.02	.01	-.02	.01
Cov. Intercept x slope $(Time)^2$												
Cov. Time x $(Time)^2$												
Individual level												
Var. intercept	.41	.04	.41	.04	.41	.04	.33	.03	.33	.03	.33	.03
Occasion level												
Var. intercept	.43	.02	.43	.02	.43	.02	.31	.01	.31	.01	.31	.01
Decrease deviance	2		6^		12*		1		0		4	

Note: * p<.05. ^p<.10 (Due to rounding of b and SE exact p-values cannot be deduced from the Table).

Figure 1



than for boys.

Further, the results as presented in Table 3 showed to what degree the development of students' motivation over time appeared associated with levels of need supportive teaching. For *autonomous motivation*, associations were found neither with average levels of autonomy support nor with deviations of these levels. Positive associations were found with average levels of structure (β=.21), but not with deviations of these levels. Finally, positive associations were found with average levels of involvement (β=.25), but not with deviations of these levels.

For *controlled motivation*, associations were found neither with average levels of autonomy support or structure nor with deviations of these levels. Further, negative associations were found

with average levels of involvement (β=-.18), but not with deviations of these levels.

For *amotivation*, associations were found neither with average levels of autonomy support nor with deviations of these levels. Negative associations were found with average levels of structure (β=.-19), but not with deviations of these levels. Finally, negative associations were found with average levels of involvement (β=-.39), but not with deviations of these levels.

For *performance avoidance*, associations were found neither with average levels of autonomy support or structure nor with deviations of these levels. Finally, negative associations were found with average levels of involvement (β=-.21; approaching significance), but not with deviations of these levels.

6.5 Discussion

In the present study, we investigated how the development over time of early adolescents' motivation for math was associated with their math teacher being need supportive. Following Self-Determination Theory (SDT), we defined need supportive teaching in terms of support for the fundamental human needs for autonomy, competence, and relatedness. The results of this study notably advance research on motivational classroom practices as two features rendered it unique. The first is that whereas most research on effects on student motivation of teaching practices has relied on students' perceptions of these practices (Perry et al., 2006), we used an observational measure. Although research on student perceptions is important for investigating the premises underlying educational theory, ultimately, to enhance ecological validity and for translating theory to practice observational research is necessary that is conducted in classrooms. The second discerning feature of this study was its longitudinal nature, incorporating both measures on the development over the course of the school year of need supportive teaching and of student motivation. Whereas the decline in early adolescents' motivation is well-documented, research has scarcely been focused on identifying factors that affect the development of early adolescents' motivation over time.

For the various motivational constructs we incorporated the results revealed distinct patterns. We found positive associations of teachers' provision of structure and of teacher involvement, but not of autonomy support, with the development over time of students' autonomous motivation. Further, the results showed negative associations of teacher involvement and not of the other two dimensions of need supportive teaching with the development of controlled motivation (the first of three motivational constructs having a negative connotation). We found negative

associations of provision of structure and teacher involvement, but not of autonomy support with the development of amotivation. Finally, we found negative associations of teacher involvement (approaching significance) and not of the other two dimensions with the development of performance avoidance. In the analyses, for each dimension of need supportive teaching we included two conceptualisations. First, teachers' average levels of need support over the school year (1 measure per teacher) were included. Second, for each of four measurement points teachers' deviations of their individual average levels (4 measures per teacher) were included. In the results described above, all reported positive and negative associations concerned the teachers' average levels of need supportive teaching; we did not find any associations of deviations of these levels with students' motivation.

The results have implications both for educational research and practice. First, they advance support for SDT among early adolescents by partly corroborating prior research relying on student perceptions. Because teaching practices can only affect students via their psychological responses to these practices (Deci, 1975), an often conveyed argument to refrain from using observations is that this would not yield the same strength of effects as relying on student perceptions would. The results of this study show, however, that observed need supportive teaching can be associated with early adolescents' motivation directly. Thereby, our findings substantiate the idea that SDT can be applied to define and observe characteristics of need supportive teaching, what is an essential prerequisite for SDT-interventions to be effective.

Second, although our findings do corroborate prior evidence in support of SDT, they do so neither for all dimensions of need supportive teaching nor for all motivational constructs. A striking finding in this regard is that for none of the motivational constructs we found associations with autonomy support. This is surprising, particularly, as others have found observed autonomy support associated with (observed) engagement. Different from our study, these studies used observational measures of engagement (Reeve et al., 2004; Stefanou et al., 2004; Jang et al., 2010) and/or brief questionnaires that concerned engagement in the observed lessons and were administered immediately after these lessons (Jang et al., 2010). A possible interpretation of these differences in findings would be that although autonomy supportive teaching does have an immediate effect on students' engagement in the task(s) at hand, this effect is short-term only and does not result in changes in their levels of motivation. Future research is necessary to sort this out. In addition, more research would be recommended on further defining autonomy supportive teaching practices and linking these to early adolescents' motivation.

For teachers' provision of structure, we found associations with development over time of some motivational constructs (autonomous motivation and amotivation), but not with others.

Although prior SDT-research has typically not related provision of structure to any of these four motivational constructs and the only observational study that was conducted showed mixed results (Jang et al., 2010), our findings do indicate that provision of structure can indeed motivate students for math. Future research is necessary to sort out differences between motivational constructs.

Teacher involvement appeared the dimension of need supportive teaching most strongly associated with the development over time of all four motivational constructs. Interestingly, even for performance avoidance associations with teacher involvement appeared stronger than associations with structure; despite this construct being closely related to students' feelings of competence, which is the need most closely associated with the dimension of structure. It could be speculated that for early adolescents not to feel the urge to avoid situations where their shortcomings will be noticed, it is of particular importance to feel accepted in their classrooms by teachers who are involved; for example by demonstrating affection, encouraging empathy, and being responsive to emotional distress. In conclusion, these findings indicate the importance of teacher trainings directed at enhancing their involvement with their students.

Third, our findings extend prior SDT-research by showing how need supportive teaching is associated with the development of early adolescents' motivation over time. An unexpected and intriguing finding that is consistent over the four motivational constructs is that associations were apparent of the teachers' average levels of need supportive teaching but not of their deviations of these levels with student motivation. In other words, students appeared more motivated when they were taught by a teacher who—on average, over the course of the school year—showed higher levels of need support. However, students' motivation as measured at a specific time-point was not associated with their teachers at that time-point being more or less need supportive than usual. Among plausible explanations is that although need supportive teaching does have a positive impact on students' motivation, this impact is not immediate. A possible cause for such a delay of effects could be that teachers changing their practices to become more need supportive has a negative side-effect resulting of change, whether positive or negative, causing unpredictability. Another possible explanation would be that positive effects of need supportive teaching depend on students being prepared to act upon the opportunities their teachers provide them with. For example, it could be that for provision of structure in the sense of a teacher providing step-by-step directions to have a positive effect on students' motivation students need to prepare their questions accordingly. It could even be that some students who expect a straightforward answer and, instead, appear expected to share their own thoughts on the solution respond by disappointment or anxiousness instead of enhanced motivation. Both these explanations relate to the notion that

students' role beliefs are hard to change because students do not have a clear conceptualization of their own needs and aspirations regarding their own learning (Boekaerts & Niemivirta, 2000).

Future research is necessary to further investigate the circumstances in which teachers becoming more need supportive does or does not foster students' motivation. For this aim, amongst others, longitudinal intervention research would be recommended to distinguish between immediate and long-term effects (such as Reeve et al., 2004 for autonomy support; Minnaert, Boekaerts, de Brabander, 2007 in vocational education). In line with the plausible explanations we suggested above, it could be crucial for teachers to properly introduce any changes in their practices (see also Sturm & Bogner, 2008). Further, long-term implementation of SDT-interventions could be beneficial; e.g. by making these school-based.

In addition, for future research it would be recommended to determine generalizability of findings beyond this study's target group of students just starting secondary education. A target-group specific plausible explanation for findings would, for example, be that whereas at first establishing good teacher-student relationships is critical, it is later on only that having autonomy support starts to gain weight. This interpretation would be in line with Minnaert, Boekaerts, de Brabander, & Opdenakker (2011) who showed relatedness to best predict students' situational interest at the start of a six month project, while later on in the project the importance of autonomy increased.

Several limitations of the present study can be thought of. The first of these relates to our use of an observational measure of need supportive teaching. Because in SDT need supportive teaching is not considered to exist in a prescribed set of techniques and strategies (Reeve, 2006) but should always be interpreted in context, the rating sheet we used had to entail a high degree of interpretation by the coders. Although we tried to counter this limitation by performing several steps to assure a degree of objectivity (e.g. elaborate discussions of video-fragments), the subjectivity of our coding sheets remains a limitation that is inherent to studying need supportive teaching in classrooms. For the future, it would be of interest to conduct more research into the question what need supportive teaching entails in the daily practice of early adolescents' classrooms, amongst others by conducting more research on links between observed need supportive teaching, early adolescent students' perceptions of teaching practices, and their motivation.

A second potential limitation is that the teachers and students who participated in our study might have changed their behaviour because of the video cameras that were present in their classrooms. Although we did emphasize the fact that all video-material would be processed anonymously, it might still have been the case that both teachers and students behaved differently than they would have normally. From our regular conversations with the teachers we did,

however, not get this impression as they regularly indicated to have forgotten about the cameras and told us that the students acted the same as they did when no cameras were present, at least after the first parts of the first lessons that we videotaped.

Despite these limitations, our findings advance SDT-research and provide insights of value for answering the question 'what motivates early adolescent students for school'? As our findings have a high level of ecological validity, some of these findings can be translated to educational practice directly. Particularly, our results indicate that teacher involvement and provision of structure have the potential to lessen the decline in early adolescents' motivation for school.