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Title: Adolescents' Academic Emotions and Academic Achievement Across the Transition to Lower Secondary School : The Role of Learning Difficulties

Year: 2021

Version: Accepted version (Final draft)

Please cite the original version:

Sainio, P., Eklund, K., Hirvonen, R., Ahonen, T., & Kiuru, N. (2021). Adolescents' Academic Emotions and Academic Achievement Across the Transition to Lower Secondary School : The Role of Learning Difficulties. Scandinavian Journal of Educational Research, 65(3), 385-403. https://doi.org/10.1080/00313831.2019.1705900

Abstract

This study examined the role of learning difficulties in academic emotions and achievement across the transition to lower secondary school among 848 Finnish adolescents. Reading difficulties (RD) and math difficulties (MD) were identified based on test scores in Grade 6 and 7. Students with difficulties were identified as having resolving, emerging, or persistent RD/MD. Students rated their academic emotions and information on students' academic achievement was acquired from school registers. The results showed that a decline in academic emotions and achievement was typical among all students across the transition. Resolving, emerging, or persistent types of RD/MD were also meaningfully reflected in the development of academic emotions across the transition. Generally, the results showed that RD/MD students had a higher proclivity to experience more negative academic emotions than their peers, and they lagged behind their peers in achievement across the transition.

Keywords: learning difficulties, academic emotions, academic achievement, school transition

Introduction

The transition from primary school to lower secondary school constitutes a time of major changes in classroom environments, and school workload demands. Although most students have positive expectations regarding the new school environment, the transition is also often experienced as stressful, and students have several transition-related concerns beforehand (Rice, Frederickson, & Seymour, 2011; Zeedyk et al., 2003). On average, it has been shown that adolescents' learning motivation, subjective wellbeing, and academic performance tend to decrease during the transition to lower secondary school (Coelho, Marchante, & Jimerson, 2017; Eccles & Roeser, 2011).

Students with learning difficulties may find the school transition even more stressful than their peers do, due to additional struggles related to learning (Anderson, Jacobs, Schramm, & Splittgerber, 2000; West, Sweeting, & Young, 2010). These struggles may present as fewer positive and more negative academic emotions (Lackaye, Margalit, Ziv, and Ziman, 2006; Rosenstreich, Feldman, Davidson, Maza, and Margalit, 2015; Sainio, Eklund, Ahonen, & Kiuru, 2019). However, there is a lack of studies examining the role of learning difficulties in students' academic emotions across the transition to lower secondary school, even though academic emotions are known to relate closely to learning environment and achievement (Pekrun, 2006). Thus, it can be presumed that students' academic emotions change across the transition generally and also specifically for students with learning difficulties.

It has been shown that learning difficulties are rather persistent (Andersson, 2010; Eklund et al., 2015; Landerl & Wimmer, 2008; Mazzocco et al., 2013). However, there is also evidence of different developmental paths that can be recognized as resolving or late-emerging learning difficulties (Catts, Compton, Tombling, & Bridges, 2012; Torppa, Eklund, van Bergen, &

Lyytinen, 2015). In the present study, we identified students with learning difficulties before and after the school transition and examined whether there were changes in academic emotions and achievement across the transition concerning all students, and whether there were changes specifically related to students with learning difficulties.

Learning difficulties across educational transitions

In the present study, we focused on students with either reading difficulties (RD) or math difficulties (MD), as reading and mathematics are fundamental academic skills in basic education (Opetushallitus, 2016). Learning difficulties have been shown to compromise students' academic achievement remarkably (e.g., Smart et al., 2001; Wise et al., 2008). In our study, RD and MD were defined by using a lenient cut-off score (being in the 16th percentile, at least -1 SD below the age mean) in group-assessed reading and arithmetic fluency tasks. Therefore, we chose to use the concept of *learning difficulties* in this study instead of *learning disability* which refers to a diagnosed and severe condition of dyslexia or dyscalculia (Landerl, Fussenegger, Moll, & Willburger, 2009).

RD in transparent orthographies (like Finnish) is typically characterized by slow reading, especially after the early school grades (e.g., de Jong & van der Leij, 2003; Landerl & Wimmer, 2008). Early identified RD has been shown to compromise students' learning relatively persistently, at least until Grade 8 (age 14) (e.g., Eklund et al., 2015; Landerl & Wimmer, 2008), although small subgroups with resolving difficulties have also been found (Torppa, Eklund, van Bergen, & Lyytinen, 2015). However, RD may also emerge at later grades, when reading development is mainly characterized by increased reading fluency (e.g., Catts, Compton, Tombling, & Bridges, 2012; Torppa et al., 2015).

MD has been shown to be rather persistent (Andersson, 2010), and students with MD in early school years typically have a lower math achievement in later school years when compared to their peers (Judge & Watson, 2011; Mazzocco et al., 2013). Furthermore, the differences between MD students and students without difficulties tend to increase as the grades progress (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004). Unlike with reading difficulties, there is hardly any evidence about resolving or late-emerging MD whereas there is some evidence of students whose low math achievement appears temporary during one school year only, being not visible the next year (Geary, 2011; Stock et al., 2010).

Cognitive factors related to the different developmental reading groups (no deficit, late-emerging, resolving, and persistent disability) have been examined in a few studies (Catts et al., 2012; Torppa et al., 2015). Likewise, various cognitive deficits are known to be in the background of MD at different ages (Bartelet et al., 2014; Kuhn, 2015). No attention, however, has been given to the differences between RD/MD groups in academic emotions, although there is evidence that students regularly experience academic emotions in learning, class, and test situations (Pekrun, 2006). Moreover, academic emotions are known to be domain-specifically related to different school subjects (e.g., Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Frenzel, Pekrun, & Goetz, 2007). Thus, one of the aims of this study was to find out whether students with resolving, emerging, or persistent RD/MD differ from their peers in academic emotions and achievement during the transition to lower secondary school.

Academic emotions in educational transitions

Academic emotions are fundamental to students' learning and achievement in school, since positive emotions can lead to higher achievement, while negative emotions have been associated with lower learning outcomes (e.g., Ahmed, van der Werf, Kuyper, & Minnaert, 2013; Pekrun et

al., 2011; Sainio et al., 2019; Suárez-Pellicioni et al., 2016). According to Pekrun's (2006) *control-value theory of achievement emotions,* academic emotions (such as enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom) are emotions that arise in various situations of learning, attending classes, and taking tests. Pekrun (2006) states that experienced academic emotions are a result of students' appraisals of their subjective control over the learning or achievement situation and the subjective value student associates to learning or achievement, e. g. enjoyment can be assumed to relate to learning situations which are regarded to be fairly well managed and which are valuated positively. Thus, students can experience state-like academic emotions in certain situations (e.g., test anxiety) or students can habitually experience specific academic emotions (e.g. math anxiety). In this study we considered academic emotions as trait-like emotions which associate relatively constantly to adolescents' learning and achievement in literacy or math domain during the school year.

Although the role of academic emotions in students' learning outcomes has been shown to be crucial (Ahmed et al., 2013; Pekrun et al., 2011; Suárez-Pellicioni et al., 2016), as far as we know, no prior studies have examined development of students' academic emotions during educational transitions. As exceptions, there are a few studies examining academic emotions among students of different ages, but the outcomes of previous research on the stability of academic emotions are contradictory (see e. g. Goetz et al., 2007; Raccanello, Brondino, and Bernardi, 2013). Contrary to previous studies, we followed the same students longitudinally across the transition to lower secondary school and examined the related changes in students' academic emotions.

The role of learning difficulties in academic emotions and achievement during educational transitions

Negative changes in adolescents' academic outcomes during the transition to lower secondary school (Anderson et al., 2000; Eccles & Roeser, 2011; Ryan, Shim, & Makara, 2013; West et al., 2010) have not been associated with the transition itself, but rather with the new learning environment that challenges adolescents' adaptation and may have negative consequences on students' learning-related motivation and emotions (Eccles et al., 1993; Salmela-Aro, Kiuru, & Nurmi, 2008). In their stage-environment fit theory, Eccles and Midgley (1989) argue that the lower secondary school environment does not fit adolescents' developmental needs, such as autonomy, competence, and relatedness. Instead, lower secondary school means more competition, higher achievement expectations, and less support in the teacher-student relationship. Hence, transition-related changes in the learning environment, together with the changing developmental needs of adolescents generally, challenge students' learning and motivation across the transition (e.g., Eccles et al., 1993; Eccles & Roeser, 2011; Salmela-Aro et al., 2008).

Moreover, it seems that students with learning difficulties specifically are at risk of experiencing cumulative stressors during school transitions since they struggle with their studies and have low academic achievement (e. g. Andersson, 2010; Holopainen et al., 2017; West et al., 2010). Furthermore, students with learning difficulties tend to have more negative emotional experiences in learning situations (Lackaye et al., 2006; Rosenstreich et al., 2015). As academic emotions are closely related to students' achievement, as well as to motivational aspects in learning (Pekrun, Hall, Goetz, Perry, 2014), it can be assumed that students with learning difficulties are likely to be more prone to the negative consequences of the school transition.

Research questions and hypotheses

The aim of the current research was to answer the following two questions:

(1) Do adolescents' domain-specific academic emotions (i.e., enjoyment, hope, pride, anxiety, anger, shame, hopelessness, and boredom) and achievement in literacy and mathematics change across the transition to lower secondary school (i.e. over four time points from Grade 6 fall to Grade 7 spring)?

Hypothesis 1. As academic emotions have shown to be domain-specific (Goetz et al., 2006), we studied literacy- and math-related emotions separately. School transitions are known to be stressful for many adolescents, which may be reflected as a decrease in students' learning motivation, academic performance, and overall wellbeing (Eccles et al., 1993; Rice et al., 2011; Salmela-Aro et al., 2008; Zeedyk et al., 2003). Hence, we assumed that the level of students' positive emotions would decrease, and the level of negative emotions increase from Grade 6 spring to Grade 7 fall and spring. In addition, we expected that academic achievement would temporarily decline during the transition, i. e. from Grade 6 spring to Grade 7 fall (see also Hakkarainen et al., 2013; Holopainen et al., 2017).

(2) Are adolescents' learning difficulties (i.e., RD or MD) associated with the levels and changes of domain-specific academic emotions and academic achievement in literacy and mathematics across the transition to lower secondary school?

Hypothesis 2. Previous research has shown that students with learning difficulties tend to experience fewer positive and more negative academic emotions (Lackaye et al., 2006; Rosenstreich et al., 2015) and they have lower academic achievement (e.g., Andersson, 2010; Holopainen et al., 2017; Smart et al., 2001) when compared to students with no

learning difficulties. Thus, we expected students with no RD/MD to differ in academic emotions and achievement from students with RD/MD. We assumed that having RD/MD would be associated with lower academic achievement and fewer positive and more negative academic emotions across the transition to lower secondary school. Furthermore, we expected RD/MD groups with different developmental paths of difficulties (resolving, emerging, and persistent) to differ from each other in academic emotions and achievement. More specifically, we expected students with persistent RD/MD to have fewer positive and more negative academic emotions and lower academic achievement than their peers. We also expected that students with emerging RD/MD would be particularly prone to more negative and fewer positive academic emotions and an abrupt decline in achievement across the transition, due to newly experienced struggles in studies.

In all the analyses, we controlled for the effects of gender, students' difficulties in the other academic domain, class differences, depressive symptoms, and pubertal timing. Gender was controlled because it has been shown that girls tend to have MD more often than boys, whereas boys have RD more often than girls (Landerl & Moll, 2010). As there are students that have comorbid RD and MD (e. g., Landerl et al., 2009), we controlled for students' difficulties in the other academic domain. Furthermore, we controlled for class differences as students' academic emotions have been shown to differ also on a classroom level (Frenzel et al., 2007). We controlled for depressive symptoms as poor school transition has been shown to relate to adolescents' vulnerability to depressive symptoms (West et al., 2010). Also, there is evidence that learning difficulties are a risk factor for mental health problems (Lindén-Boström & Persson, 2015). In addition, pubertal timing was controlled for as it varies between individuals and is related to other developmental trajectories in adolescence (Crosnoe & Johnson, 2011).

Method

Participants and procedure

The present study is part of the broader longitudinal study that follows a community sample of Finnish students across the transition from primary school to lower secondary school. The sample of this study consisted of 848 (457 girls, 54%) adolescents who were examined twice before (Grade 6, fall and spring) and twice after (Grade 7, fall and spring) the transition to lower secondary school. The adolescents were recruited from one large town and one middle-sized town in central Finland. Both towns also included semi-rural areas with smaller schools (for more details about the sample and its recruitment, see Hirvonen, Väänänen, Aunola, Ahonen, & Kiuru, 2018; Mauno, Hirvonen, & Kiuru, 2018). A total of 841 adolescents participated in the study in grade 6 fall, and 836 adolescents participated in grade 6 spring. In grade 7 fall there were 802 participants and in grade 7 spring there were 793 participants. Nine percent of adolescents completed the questionnaires only once, twice or three times out of four time points. In other words, complete data across four time points was available for over 90% of adolescents.

To evaluate the role of missing data in the sample, we compared adolescents who had complete data across the four time points (n = 770) to those adolescents who had missing data at least in one out of four measurement points (n = 78). The results revealed no differences between adolescents with and without complete data in regard to demographic characteristics. However, adolescents who had complete data across the four time points had better academic achievement (d=0.68) and they reported more positive and less negative academic emotions particularly before the transition (d=0.35) than adolescents who had missing data in at least one of the four waves.

The participants' age at the beginning of the study ranged from 11 to 13 years (mean = 12.3 years; *SD = 4.36*). The students came from 30 different schools and 57 different classes (mean class size = 21.10; *SD* = 4.66). The participants' mother tongue was Finnish in 95% of cases. Most participants lived with both parents in one household (*N* = 621; 75%) or alternated between their mother and father (*N* = 96; 12%). Sixty-one (7.2%) of the participants lived only with their mother and 1% only with their father. Four percent of the mothers and 8% of the fathers reported no vocational education after comprehensive school; 30% of the mothers and 42% of the fathers, completed vocational upper secondary school; 40% of the mothers and 29% of the fathers, completed vocational post-secondary college; and 26% of the mothers and 21% of the fathers, had a Master's degree or higher.

The students' data was collected during normal school days. All the tests and questionnaires were administered by trained testers. The students' reading and math skills were tested in Grade 6 fall (late September to early November 2014) and in Grade 7 spring (March to April 2016). In addition, the students filled out questionnaires concerning their academic emotions at four times: in Grade 6 fall (2014) and spring (2015) and in Grade 7 fall (2015) and spring (2016). Furthermore, the students' school achievement in literacy and in mathematics was acquired from school registers at the four times mentioned above.

Measures

Reading fluency (Grade 6 fall and Grade 7 spring). Reading fluency skills were measured with three tests, both in Grade 6 fall and in Grade 7 spring. Word decoding was assessed by two tests: Word Identification and Spelling Errors (Holopainen, Kairaluoma, Nevala, & Aho, 2004). In turn, sentence-level reading fluency was assessed with the Salzburg Reading Fluency Test (Landerl, Wimmer, & Moser, 1997; translated into Finnish by Sini Huemer).

In the first decoding task, the Spelling Errors test, the students were instructed to search for spelling errors in 100 words. The time limit for the whole task was three minutes and 30 seconds. Each word included one error (an incorrect, extra, or missing letter) that the students had to mark by drawing an upright line (for example, *carot = car|ot*). The students received one point for each correct line (maximum score 100). According to the manual (Holopainen et al., 2004), the test–retest reliability of this task has been .83 – .86.

The second decoding task, the Word Identification test, contained 25 word chains, each with four different words written without spaces between the words (e.g., *tailorbilberryreadyhorse*). The students were instructed to draw an upright line between the end and beginning of each identified word as fast and accurately as they could (e.g., *tailor|bilberry|ready|horse*). The students received one point for each correctly drawn line within the time limit of one minute and 30 seconds (maximum 100 points). According to the manual (Holopainen et al., 2004), the test–retest reliability of this task has been high (.70–.84).

Thirdly, in the short version of the Salzburg Reading Fluency Test, the students were asked to read 36 sentences one by one and mark whether the meaning of each sentence was true or false. The Salzburg test is constructed in such a way that the sentences are easy to understand, in order to capture reading fluency rather than reading comprehension. A time limit of one minute and 30 seconds was used, instead of the 3.5 minutes used in the original test, since this test featured only 36 of the 69 sentences from the original test. The test was shortened by removing the 33 first sentences belonging to the original test in order to fit in all necessary test and questionnaires within the given class periods. Moreover, by choosing the longest sentences of the original test, we aimed to ensure good enough variability in the measure. The students received one point for each correct answer, and the maximum possible score was thus 36. According to

the test manual, the reliability of the original Salzburg Reading Fluency Test has been .95 for second-grade students and .87 for eighth-grade students (Das Salzburger Lese-Screening 2–9).

Next, we standardized the students' scores in all three reading tests, after which we calculated an arithmetic mean across the students' scores in the three tests. The Cronbach's alpha reliability for the scale was .87 in Grade 6 fall and .89 in Grade 7 spring.

Using this scale score, the students were first classified into two groups, both in Grade 6 and Grade 7 as follows: 0 = no RD (n = 647) and 1 = with RD (n = 146). Students scoring below the 16th percentile (approximately one standard deviation below the mean of the whole sample) were considered to have RD. Next, the RD group was further divided into three subgroups (see Table 1) based on the stability of their difficulties: 1 = difficulties only in Grade 6 (resolving RD, n = 33), 2 = difficulties only in Grade 7 (emerging RD, n = 24), and 3 = difficulties both in Grade 6 and in Grade 7 (persistent RD, n = 89).

Arithmetic fluency (Grade 6 fall and Grade 7 spring). Math skills were assessed with the Basic Arithmetic Test (Aunola & Räsänen, 2007) both in Grade 6 fall and in Grade 7 spring. The test contains tasks of addition, subtraction, multiplication, and division. The students were asked to do mental calculations and write their answers on the test paper. The test has 28 tasks (e.g., 527 + 31 = ?; 15 – ? = 9; 12 x 28 = ?), starting with easier tasks and getting more difficult throughout. The time limit for completing the test was three minutes. Students received one point for each correct answer, the maximum possible score thus being 28. The Cronbach's alpha reliability for the scale was .82 in Grade 6 fall and .85 in Grade 7 spring.

Using their standardized score on the scale, the students were first classified into two groups, both in Grade 6 and Grade 7 as follows: 0 = no MD (n = 597) and 1 = with MD (n = 179). Students scoring below the 16th percentile (approximately one standard deviation below the

mean of the whole sample) were considered to have MD. Next, the MD group was divided into three subgroups (see Table 1) based on the stability of their difficulties: 1 = difficulties only in Grade 6 (resolving MD, n = 63), 2 = difficulties only in Grade 7 (emerging MD, n = 42), and 3 = difficulties both in Grade 6 and in Grade 7 (persistent MD, n = 74). There were a few borderline cases among students with MD at one time that were also near the cut-off at the other time. These students were considered to have persistent MD.

In Grade 6 fall, based on the cut-offs described above (see Table 1), a total of 44% of students who were identified as having either RD or MD were students with comorbid RD and MD. Likewise, in Grade 7 spring, a total of 40% of students with either RD or MD were identified as having both RD and MD. As comorbidity of RD and MD was common, we set MD as a covariate in literacy-related analyses and RD as a covariate in math-related analyses.

Table 1. *Standardized means in reading and arithmetic fluency for groups based on stabilities of reading difficulties (RD) and math difficulties (MD) across the transition from primary school to lower secondary school*

	RD				MD			
	n	%	Reading fluency		n	%	Arithmetic fluency	
			Grade 6 fall	Grade 7 spring			Grade 6 fall	Grade 7 spring
No difficulties	647	81%	0.38	0.37	597	77%	0.42	0.39
Resolving difficulties	33	4%	-1.13	-0.62	63	8%	-1.25	-0.29
Emerging difficulties	24	3%	-0.57	-1.20	42	5%	-0.26	-1.43
Persistent difficulties	89	12%	-1.44	-1.48	74	10%	-1.60	-1.65
All	793	100%			776	100%		

Academic emotions (Grade 6 fall and spring and Grade 7 fall and spring). Students' academic emotions concerning literacy and mathematics were measured with the Finnish version of the Achievement Emotions Questionnaire (AEQ; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011), which was adapted for school age students. The students rated their academic emotions (enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom) regarding learning, attending classes, and test situations on a five-point Likert-type scale (1 = *I disagree;* 5 = *I agree*) separately in literacy and math context. The academic emotions; enjoyment (e.g., *I enjoy acquiring new knowledge*), hope (e.g., *I have an optimistic view toward studying*), pride (e.g., *I am proud of my capacity*), anger (e.g., *Studying makes me irritated*), anxiety (e.g., *I get tense and nervous while studying*), shame (e.g., *I get embarrassed*), and hopelessness (e.g., *I feel hopeless when I think about studying*) were measured with three questions each. As an exception, boredom (e.g., *I get bored*) was measured with two questions.

We used confirmatory factor analysis to assess factorial validity and time invariance of academic emotions separately for literacy and mathematics. In these models, factor loadings of the same items were constrained to be equal across time to ensure invariance of the measurement across time. If required for model fit, some autocovariances of residuals of the same items were estimated. The measurement models, assuming measurement invariance across time, fit the data well: RMSEAs = 0.00 to 0.06, CFIs = 0.95 to 1.00, and SRMRs = 0.01 to 0.06. The standardized estimates of factor loadings for the key constructs were high (i.e., none of the factor loadings were lower than .40). The fact that the models fit the data well with high factor loadings suggests good construct validity and item reliability.

The Cronbach's alpha reliabilities for the emotions in literacy and mathematics at the four points in time ranged as follows: in enjoyment, from .72 to .78; in hope, from .76 to .80; in pride,

from .79 to .84; in anger, from .57 to .72; in anxiety, from .62 to .72; in shame, from .68 to .79; in hopelessness, from .76 to .84; and in boredom, from .76 to .80.

Literacy and math achievement (Grade 6 fall and spring and Grade 7 fall and spring). Information on the students' academic achievement in literacy and mathematics was acquired from school registers. In Finnish schools, the grades range from five to ten, with five being the lowest accepted grade and ten the highest.

Control measures. The students' gender (1 = girl; 2 = boy) and pubertal status (mean score of the Finnish version (Dick, Rose, Pulkkinen, & Kaprio, 2001; Mustanski, Viken, Kaprio, Pulkkinen, & Rose, 2004) of the five-item Pubertal Development Scale (PDS, α = .73, Petersen et al., 1988) were set as control variables in all the analyses. In addition, the level of depressive symptoms (mean score of ten questions of the Depression Scale (DEPS, α = .91; Salokangas et al., 1995)., difficulties in the other school subject (0 = no difficulties; 1 = difficulties), and school class identification number were used as control variables in all the analyses.

Analysis strategy

Our aim was to first investigate to what extent adolescents' domain-specific academic emotions (i.e., enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom) and academic achievement in literacy and mathematics change across the transition from primary school to lower secondary school, and secondly, to what extent adolescents' learning difficulties (i.e., RD or MD) predict the levels and changes of domain-specific academic emotions and academic achievement across the transition. These research questions were analyzed using repeated MANCOVAs (general linear model). The analyses were run separately in the literacy and math domains. In the models for literacy, literacy-related emotions (hope, enjoyment, pride, anger, anxiety, shame, hopelessness, and boredom toward reading) and literacy achievement

were the dependent variables (four repeated measurements per each dependent variable), and the RD group variable was an independent variable (fixed factor). In addition, to control for the effects of gender, pubertal status, depressive symptoms, the students' MD group, and classroom differences, these factors were added as covariates. Next, similar analyses were carried out in the math domain. In these analyses, math-related emotions (hope, enjoyment, pride, anger, anxiety, shame, hopelessness, and boredom toward mathematics) and math achievement were the dependent variables (four repeated measurements per each dependent variable). The MD group variable was an independent variable (fixed factor), and gender, pubertal status, depressive symptoms, the RD group, and classroom differences were set as covariates.

Results

Tables 2 and 3 show the means and standard deviations of literacy- and math-related academic emotions and literacy and math achievement for the different RD and MD groups separately at the different points in time. Table 4 shows the results of the repeated MANCOVA models for academic emotions and achievement for literacy and math domains separately across the transition from primary school to lower secondary school.

Table 2. *Means and standard deviations of literacy-related academic emotions and literacy grades for different time points, separately for RD groups.*

	Reading difficulty group			
	No RD (*n*=647)	Resolving RD (*n*=33)	Emerging RD (*n* = 24)	Persistent RD (*n* = 89)
Variable	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Positive emotions towards literacy				
Literacy enjoyment (Gr 6, fall)	3.11 (0.84)	3.09 (1.00)	3.22 (0.77)	2.98 (0.86)
Literacy enjoyment (Gr 6, spring)	3.16 (0.88)	3.05 (1.03)	3.07 (0.76)	3.04 (0.88)
Literacy enjoyment (Grade 7, fall)	3.29 (0.83)	3.25 (0.87)	3.16 (1.02)	3.26 (0.88)
Literacy enjoyment (Gr 7, spring)	3.01 (0.90)	3.05 (1.03)	2.91 (0.91)	2.95 (0.84)
Literacy hope (Gr 6, fall)	3.70 (0.80)	3.57 (0.83)	3.65 (0.78)	3.48 (0.88)
Literacy hope (Gr 6, spring)	3.70 (0.80)	3.52 (0.98)	3.59 (0.76)	3.54 (0.84)
Literacy hope (Gr 7, fall)	3.82 (0.78)	3.83 (0.76)	3.50 (1.01)	3.69 (0.81)
Literacy hope (Gr 7, spring)	3.52 (0.88)	3.59 (0.79)	3.29 (0.94)	3.35 (0.76)
Literacy pride (Gr 6, fall)	3.56 (0.87)	3.57 (0.83)	3.65 (0.72)	3.54 (0.91)
Literacy pride (Gr 6, spring)	3.51 (0.90)	3.53 (1.05)	3.39 (0.82)	3.43 (0.94)
Literacy pride (Gr 7, fall)	3.60 (0.83)	3.64 (0.88)	3.44 (1.06)	3.59 (0.96)
Literacy pride (Gr 7, spring)	3.39 (0.89)	3.60 (0.90)	3.20 (0.92)	3.36 (0.77)
Negative emotions towards literacy				
Literacy anger (Gr 6, fall)	1.68 (0.63)	1.93 (0.86)	1.89 (0.69)	1.83 (0.79)
Literacy anger (Gr 6, spring)	1.67 (0.62)	1.83 (0.73)	1.74 (0.53)	1.81 (0.79)
Literacy anger (Gr 7, fall)	1.58 (0.64)	1.70 (0.63)	1.85 (0.76)	1.75 (0.83)
Literacy anger (Gr 7, spring)	1.91 (0.79)	1.85 (0.79)	2.30 (1.03)	1.93 (0.80)
Literacy anxiety (Gr 6, fall)	1.78 (0.72)	2.21 (1.06)	2.10 (0.80)	2.14 (0.87)
Literacy anxiety (Gr 6, spring)	1.71 (0.73)	2.07 (0.94)	1.91 (0.75)	1.99 (0.98)
Literacy anxiety (Gr 7, fall)	1.60 (0.71)	1.60 (0.67)	1.96 (0.81)	1.85 (0.92)
Literacy anxiety (Gr 7, spring)	1.90 (0.83)	1.91 (0.76)	2.48 (1.04)	2.08 (0.83)
Literacy shame (Gr 6, fall)	1.68 (0.75)	1.95 (0.99)	2.11 (1.13)	1.97 (0.83)
Literacy shame (Gr 6, spring)	1.61 (0.89)	1.90 (1.03)	1.75 (0.84)	1.89 (0.91)
Literacy shame (Gr 7, fall)	1.51 (0.74)	1.61 (0.85)	1.78 (0.79)	1.72 (0.82)
Literacy shame (Gr 7, spring)	1.71 (0.79)	1.77 (0.78)	1.97 (0.95)	1.98 (0.93)
Literacy hopelessness (Gr 6, fall)	1.57 (0.69)	2.03 (1.05)	1.85 (1.01)	1.89 (0.87)
Literacy hopelessness (Gr 6, spring)	1.53 (0.70)	1.89 (1.06)	1.69 (0.77)	1.81 (0.86)
Literacy hopelessness (Gr 7, fall)	1.45 (0.68)	1.62 (0.88)	1.61 (0.76)	1.68 (0.78)
Literacy hopelessness (Gr 7, spring)	1.79 (0.88)	1.76 (0.80)	2.31 (1.10)	2.00 (0.85)
Literacy boredom (Gr 6, fall)	2.10 (1.02)	2.32 (1.14)	2.02 (0.89)	2.02 (0.99)

Literacy boredom (Gr6, spring)	2.04 (1.07)	2.05 (1.12)	1.76 (0.65)	1.91 (0.91)
Literacy boredom (Gr 7, fall)	1.90 (1.02)	1.84 (0.94)	1.83 (0.73)	1.89 (1.08)
Literacy boredom (Gr 7, spring)	2.34 (1.15)	2.24 (1.21)	2.34 (1.14)	2.07 (0.98)
Academic achievement in literacy				
Literacy grade (Gr 6, fall)	8.40 (0.80)	8.08 (0.80)	7.43 (0.75)	7.12 (0.83)
Literacy grade (Gr 6, spring)	8.47 (0.89)	8.12 (0.91)	7.57 (0.81)	7.21 (0.73)
Literacy grade (Gr 7, fall)	8.31 (0.98)	7.87 (0.86)	7.57 (0.93)	7.22 (0.81)
Literacy grade (Gr 7, spring)	8.27 (1.00)	7.83 (1.12)	7.29 (0.90)	7.24 (0.94)

Note. Gr 6 = Grade 6. Gr 7 = Grade 7.

Table 3. *Means and standard deviations of math-related academic emotions and math grades for different time points, separately for MD groups.*

	Math difficulty group			
	No MD (n = 597)	Resolving MD (n = 63)	Emerging MD (n = 42)	Persistent MD (n =74)
Variable	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Positive emotions towards math				
Math enjoyment (Gr 6, fall)	3.38 (0.93)	3.12 (0.93)	2.67 (0.88)	2.95 (0.90)
Math enjoyment (Gr 6, spring)	3.44 (0.94)	3.02 (0.75)	2.68 (0.77)	3.02 (1.02)
Math enjoyment (Grade 7, fall)	3.51 (0.89)	3.14 (0.85)	2.90 (0.92)	3.07 (0.97)
Math enjoyment (Gr 7, spring)	3.15 (0.95)	2.89 (0.97)	2.70 (0.76)	2.76 (0.89)
Math hope (Gr 6, fall)	3.86 (0.81)	3.56 (0.74)	3.34 (0.89)	3.40 (0.89)
Math hope (Gr 6, spring)	3.88 (0.81)	3.47 (0.72)	3.34 (0.82)	3.47 (0.80)
Math hope (Gr 7, fall)	3.95 (0.78)	3.59 (0.76)	3.40 (0.85)	3.50 (0.95)
Math hope (Gr 7, spring)	3.59 (0.87)	3.34 (1.01)	3.21 (0.83)	3.13 (0.91)
Math pride (Gr 6, fall)	3.70 (0.89)	3.31 (0.89)	3.20 (1.04)	3.44 (1.00)
Math pride (Gr 6, spring)	3.68 (0.92)	3.29 (0.90)	3.08 (0.93)	3.22 (0.94)
Math pride (Gr 7, fall)	3.71 (0.89)	3.31 (0.90)	3.26 (0.95)	3.31 (1.14)
Math pride (Gr 7, spring)	3.47 (0.91)	3.13 (1.00)	3.00 (0.99)	3.13 (0.92)
Negative emotions towards math				
Math anger (Gr 6, fall)	1.62 (0.61)	1.78 (0.75)	1.95 (0.83)	1.83 (0.83)
Math anger (Gr 6, spring)	1.60 (0.62)	1.70 (0.75)	1.83 (0.73)	1.78 (0.73)
Math anger (Gr 7, fall)	1.52 (0.61)	1.79 (0.74)	1.88 (0.94)	1.84 (0.94)
Math anger (Gr 7, spring)	1.89 (0.78)	2.03 (0.82)	2.25 (0.71)	2.00 (0.71)
Math anxiety (Gr 6, fall)	1.78 (0.75)	2.03 (0.89)	2.00 (0.92)	2.24 (0.98)
Math anxiety (Gr 6, spring)	1.74 (0.77)	2.10 (1.01)	1.85 (0.80)	2.05 (0.91)
Math anxiety (Gr 7, fall)	1.62 (0.73)	1.88 (0.97)	1.83 (0.89)	1.96 (0.94)
Math anxiety (Gr 7, spring)	1.94 (0.86)	2.19 (0.94)	2.31 (0.97)	2.09 (0.77)
Math shame (Gr 6, fall)	1.70 (0.78)	1.92 (0.81)	1.87 (0.86)	2.10 (0.95)
Math shame (Gr 6, spring)	1.66 (0.84)	2.02 (0.85)	1.64 (0.77)	1.87 (0.82)
Math shame (Gr 7, fall)	1.51 (0.73)	1.78 (0.86)	1.70 (0.82)	1.88 (0.91)
Math shame (Gr 7, spring)	1.77 (0.83)	1.83 (0.80)	2.10 (0.85)	2.02 (0.98)
Math hopelessness (Gr 6, fall)	1.56 (0.72)	1.89 (0.80)	1.88 (0.89)	2.01 (0.95)
Math hopelessness (Gr 6, spring)	1.52 (0.72)	1.94 (0.90)	1.76 (0.74)	1.86 (0.80)
Math hopelessness (Gr 7, fall)	1.46 (0.71)	1.84 (0.87)	1.78 (0.84)	1.83 (0.92)
Math hopelessness (Gr 7, spring)	1.83 (0.92)	2.21 (0.98)	2.35 (1.00)	2.08 (0.85)
Math boredom (Gr 6, fall)	1.96 (1.01)	2.19 (1.02)	2.20 (1.05)	2.01 (0.96)

Math boredom (Gr6, spring)	1.85 (0.97)	2.00 (0.98)	2.07 (0.99)	1.87 (1.02)
Math boredom (Gr 7, fall)	1.79 (0.95)	2.04 (1.07)	1.98 (0.91)	1.95 (1.13)
Math boredom (Gr 7, spring)	2.27 (1.11)	2.36 (1.24)	2.70 (1.11)	2.30 (1.05)
Academic achievement in math				
Math grade (Gr 6, fall)	8.41 (0.92)	7.52 (0.98)	7.12 (0.86)	6.88 (0.93)
Math grade (Gr 6, spring)	8.58 (0.94)	7.60 (0.93)	7.18 (0.85)	6.82 (0.85)
Math grade (Gr 7, fall)	8.51 (1.09)	7.74 (1.14)	7.05 (1.21)	7.16 (1.19)
Math grade (Gr 7, spring)	8.36 (1.19)	7.79 (1.16)	6.87 (1.09)	7.34 (1.19)

Note. Gr 6 = Grade 6. Gr 7 = Grade 7.

Table 4. *Results of repeated MANCOVA models for each reading-related academic emotion and reading achievement and for each math-related academic emotion and math achievement.*

	Literacy		
	Main effect of time	Time x RD group interaction	Main effect of RD group
Literacy enjoyment	**F(3, 648) = 5.43, p = .001, Partial η^2 = .02**	F(9, 1577) = 1.06, p = .390, Partial η^2 = .01	F(3, 650) = 0.61, p = .610, Partial η^2 = .00
Literacy hope	F(3, 645) = 0.90, p = .442, Partial η^2 = .00	F(9, 1569) = 1.39, p = .188, Partial η^2 = .01	F(3.647, df2) = 0.10, p = .962, Partial η^2 = .00
Literacy pride	F(3, 646) = 1.95, p = .121, Partial η^2 = .01	F(9, 1572) = 0.85, p = .574, Partial η^2 = .00	F(3, 232) = 0.52, p = .655, Partial η^2 = .00
Literacy anger	F(3, 642) = 2.22, p = .085, Partial η^2 = .01	F(9, 1562) = 1.80, p = .064, Partial η^2 = .01	F(3, 644) = 0.14, p = .939, Partial η^2 = .00
Literacy anxiety	**F(3, 642) = 3.41, p = .017, Partial η^2 = .02**	**F(9, 1563) = 3.05, p = .001, Partial η^2 = .01**	F(3, 644) = 1.48, p = .219, Partial η^2 = .01
Literacy shame	F(3, 653) = 1.69, p = .167, Partial η^2 = .01	F(9, 1589) = 0.73, p = .678, Partial η^2 = .00	F(3, 655) = 2.38, p = .068, Partial η^2 = .01
Literacy hopelessness	**F(3, 641) = 3.44, p = .017, Partial η^2 = .02**	**F(9, 1560) = 2.26, p = .016, Partial η^2 = .01**	F(3, 643) = 1.47, p = .223, Partial η^2 = .01
Literacy boredom	**F(3, 640) = 4.03, p = .007, Partial η^2 = .02**	F(9, 1558) = 1.43, p = .171, Partial η^2 = .01	**F(3, 642) = 3.88, p = .009, Partial η^2 = .02**
Literacy achievement	**F(3, 551) = 8.38, p = .000, Partial η^2 = .04**	F(9, 1341) = 1.52, p = .137, Partial η^2 = .01	**F(3, 533) = 25.82, p = .000, Partial η^2 = .12**
	Mathematics		
	Main effect of time	Time x MD group interaction	Main effect of MD group
Math enjoyment	F(3, 629) = 1.37, p = .250, Partial η^2 = .01	F(9, 1531) = 1.07, p = .386, Partial η^2 = .01	**F(3, 631) = 11.247, p = .000, Partial η^2 = .05**
Math hope	F(3, 627) = 0.29, p = .831, Partial η^2 = .00	F(9, 1526) = 0.809, p = .608, Partial η^2 = .00	**F(3.629, df2) = 10.37, p = .000, Partial η^2 = .05**
Math pride	F(3, 626) = 0.85, p = .467, Partial η^2 = .00	F(9, 1524) = 0.68, p = .733, Partial η^2 = .00	**F(3, 628) = 9.37, p = .000, Partial η^2 = .04**
Math anger	F(3, 633) = 2.39, p = .068, Partial η^2 = .01	F(9, 1541) = 0.635, p = .768, Partial η^2 = .00	**F(3, 635) = 4.34, p = .005, Partial η^2 = .02**
Math anxiety	F(3, 633) = 0.89, p = .445, Partial η^2 = .00	F(9, 1541) = 1.20, p = .290, Partial η^2 = .01	**F(3, 635) = 3.74, p = .011, Partial η^2 = .02**
Math shame	F(3, 642) = 1.04, p = .373, Partial η^2 = .01	F(9, 1563) = 1.85, p = .055, Partial η^2 = .01	**F(3, 644) = 3.24, p = .022, Partial η^2 = .02**
Math hopelessness	F(3, 632) = 2.71, p = .090, Partial η^2 = .01	F(9, 1538) = 1.21, p = .283, Partial η^2 = .01	**F(3, 634) = 8.04, p = .000, Partial η^2 = .04**
Math boredom	F(3, 630) = 2.52, p = .057, Partial η^2 = .01	F(9, 1533) = 0.63, p = .717, Partial η^2 = .00	F(3, 632) = 1.37, p = .250, Partial η^2 = .01
Math achievement	**F(3, 545) = 12.76, p = .000, Partial η^2 = .07**	**F(9, 1327) = 3.98, p = .000, Partial η^2 = .02**	**F(3, 547) = 50.95, p = .000, Partial η^2 = .22**

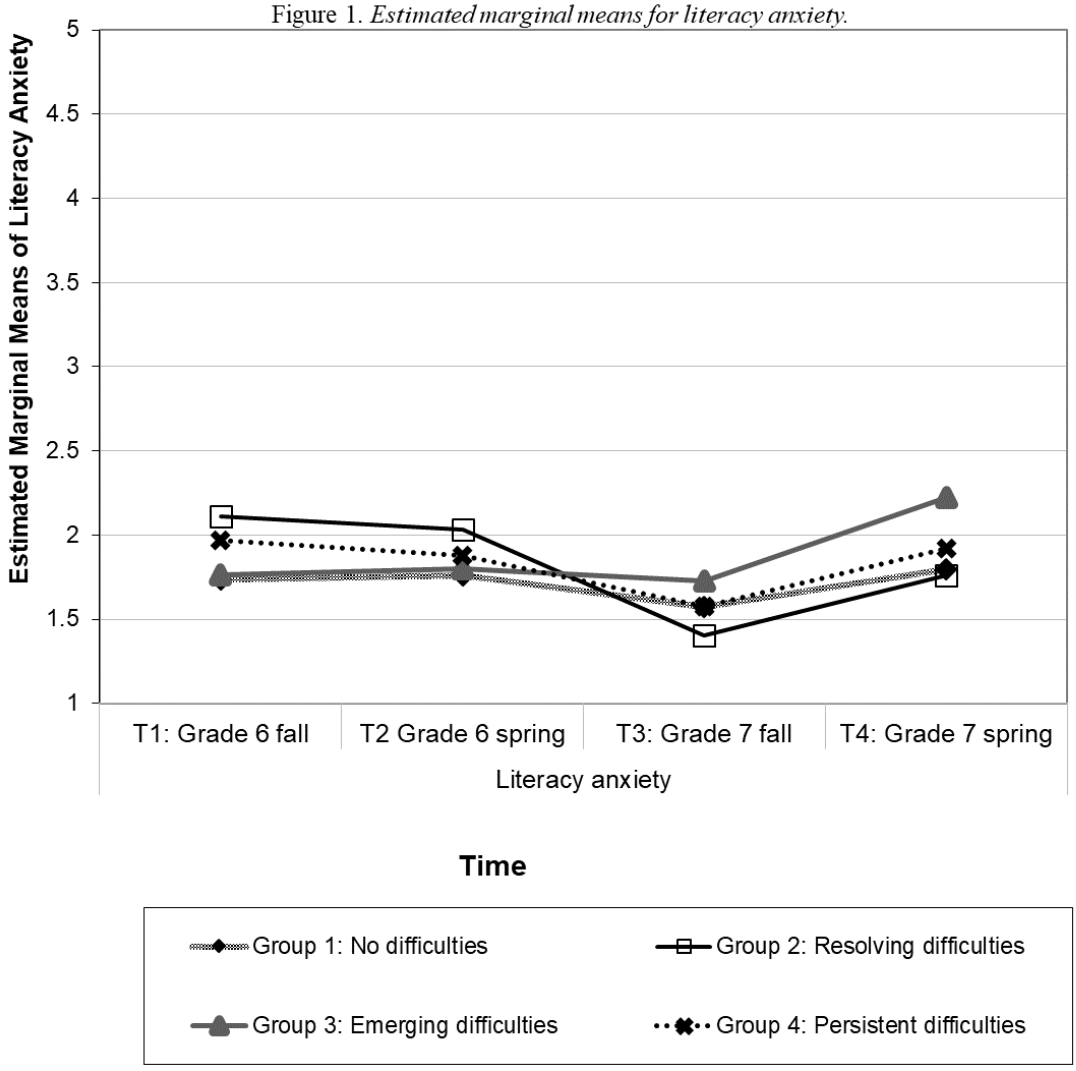
Note. Statistically significant effects in bold. The effects of gender, pubertal status, depressive symptoms, class, and the difficulties in the other subject domain (literacy or math) were controlled for in the analyses.

Repeated MANCOVAs of academic emotions and academic achievement

Literacy (Tables 2 and 4). The results for *literacy enjoyment* showed no time x group interaction. However, a statistically significant main effect of time was found. On average, students' literacy enjoyment decreased during the seventh grade (p = .021, partial η^2 = .01). There was no main effect of the RD group on literacy enjoyment.

The results for *literacy anxiety* showed a significant time x group interaction and a significant main effect of time. The estimated marginal means of each RD group's literacy anxiety in the four time points are shown in Figure 1. The results showed that literacy anxiety changed over time for students with resolving (partial η^2 = .09), emerging (partial η^2 = .07) and persistent RD (partial η^2 = .02), whereas there were no changes across time in literacy anxiety for students with no RD (partial η^2 = .00). Literacy anxiety decreased from Grade 6 spring to Grade 7 fall for students with resolving RD (partial η^2 = .04), whereas literacy anxiety increased from Grade 7 fall to Grade 7 spring for students with emerging RD (partial η^2 = .06). For students with persistent RD, literacy anxiety first decreased from Grade 6 spring to Grade 7 fall (partial η^2 = .06) and then increased again from Grade 7 fall to Grade 7 spring (partial η^2 = .01).

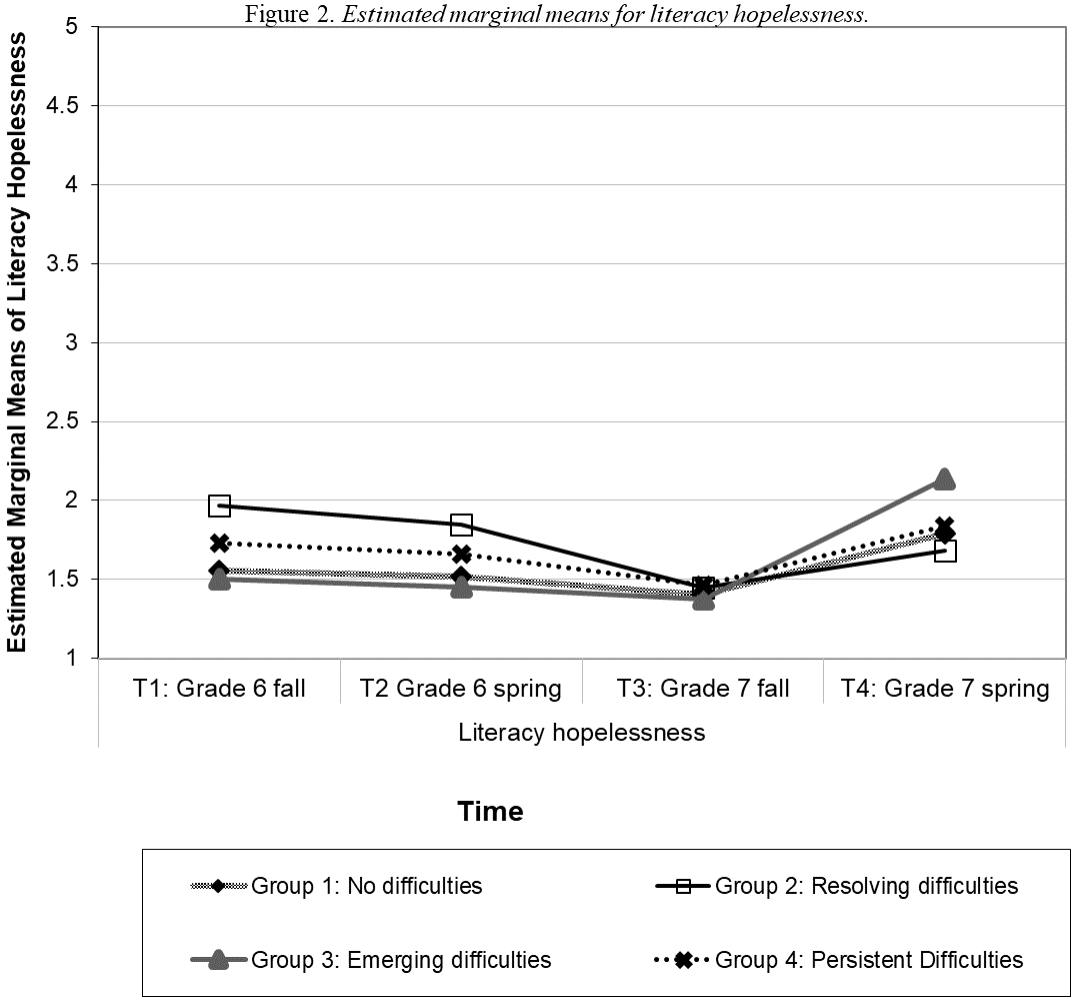
Figure 1. *Estimated marginal means for literacy anxiety.*



The results for *literacy hopelessness* showed a significant time x group interaction and a significant main effect of time. The estimated marginal means of each RD group's literacy hopelessness in the four time points are shown in Figure 2. The results showed that literacy hopelessness changed across time for students with resolving RD (partial $\eta^2 = .07$), emerging RD (partial $\eta^2 = .09$) and persistent RD (partial $\eta^2 = .02$), whereas literacy hopelessness did not change across time for students with no RD (partial $\eta^2 = .00$). Literacy hopelessness decreased from Grade 6 spring to Grade 7 fall for students with resolving RD (partial $\eta^2 = .14$), whereas

literacy hopelessness increased during the seventh grade for students with emerging RD (partial $\eta^2 = .10$).

Figure 2. *Estimated marginal means for literacy hopelessness.*



The results for *literacy boredom* showed no time x group interaction. In turn, main effects of both time and RD groups were found. Overall, the results revealed that literacy boredom among all students decreased from Grade 6 spring to Grade 7 fall ($p = .005$, partial $\eta^2 = .01$) and again increased from Grade 7 fall to Grade 7 spring ($p = .007$, partial $\eta^2 = .01$). Furthermore, students with no RD reported higher literacy boredom when compared to students with emerging RD ($p = .011$) and students with persistent RD ($p = .005$).

The results for *literacy hope, pride, anger, and shame* showed no statistically significant time x group interactions, nor main effects of time or RD group.

The analysis for *literacy achievement* showed no time x group interaction, but significant main effects of time and RD groups were found. The results revealed that students' literacy achievement in general decreased in particular from Grade 6 spring to Grade 7 fall ($p = .006$, partial $\eta^2 = .01$). Moreover, students with no RD had a higher literacy achievement than students with emerging RD ($p < .001$) and students with persistent RD ($p < .001$).

Overall, in *literacy domain*, time x RD group interactions were found in literacy anxiety and hopelessness. Furthermore, a significant main effect of time was found in literacy enjoyment, anxiety, hopelessness, boredom and achievement. In addition, a main effect of RD group was found in literacy boredom and achievement.

Mathematics (Tables 3 and 4). The results for *math enjoyment* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results revealed that students with no MD reported more math-related enjoyment than students with emerging MD ($p = .006$) and students with persistent MD ($p < .001$).

The results for *math hope* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results showed that students with no MD reported more math-related hope than students with resolving MD ($p = .001$), students with emerging MD ($p = .001$), and students with persistent MD ($p < .001$).

The results for *math pride* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results revealed that students with no MD reported more math-related pride when compared to students with resolving MD ($p < .001$), students with emerging MD ($p = .001$), and students with persistent MD ($p = .003$).

The results for *math anger* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results showed that students with no MD reported less math-related anger when compared to students with resolving MD ($p = .038$) and students with emerging MD ($p = .001$).

The results for *math anxiety* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results revealed that students with no MD reported less math-related anxiety when compared to students with resolving MD ($p = .012$) and students with emerging MD ($p = .001$).

The results for *math shame* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results showed that students with no MD reported less math-related shame when compared to students with resolving MD ($p = .036$), students with emerging MD ($p = .003$), and students with persistent MD ($p = .045$).

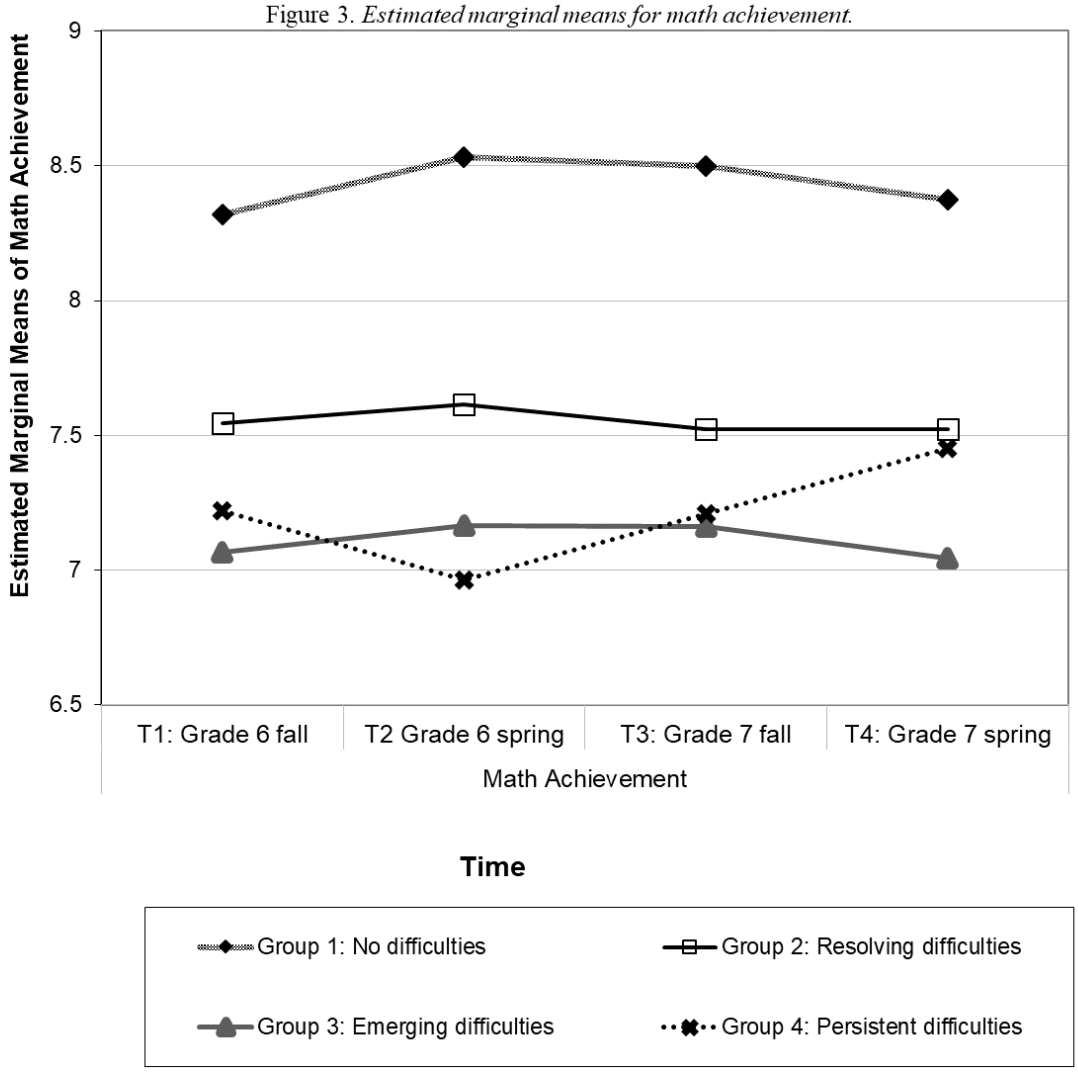
The results for *math hopelessness* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results revealed that students with no MD reported less math-related hopelessness when compared to students with resolving MD ($p < .001$), students with emerging MD ($p < .001$), and students with persistent MD ($p = .041$).

The results for *math boredom* showed no statistically significant time x group interactions, nor main effects of time or MD groups.

The results for *math achievement* showed a significant time x group interaction, a significant main effect of time, and a significant main effect of MD groups. The estimated marginal means of each MD group's math achievement in the four time points are shown in Figure 3. The results showed that the math achievement of students with no MD (partial $\eta^2 = .03$), students with resolving MD (partial $\eta^2 = .08$), and students with emerging MD (partial $\eta^2 =$

.04) decreased from Grade 6 spring to Grade 7 fall in particular. However, math achievement increased from Grade 6 spring to Grade 7 fall for students with persistent MD (partial $\eta^2 = .06$). In addition, students with no MD had generally higher math achievement than students with resolving MD ($p < .001$), students with emerging MD ($p < .001$), and students with persistent MD ($p < .001$).

Figure 3. *Estimated marginal means for math achievement.*



In summary, *in math domain,* a time x MD group interaction and a main effect of time was found in math achievement. Furthermore, a main effect of MD group was found in math enjoyment, hope, pride, anxiety, shame, hopelessness and achievement.

Discussion

The transition from primary school to lower secondary school is crucial for adolescents' subsequent learning and adjustment outcomes (e.g., Anderson et al., 2000; Ryan et al., 2013; West et al., 2010). Learning difficulties are known to compromise students' learning throughout the school years (Holopainen et al., 2017; Judge & Watson, 2011; Smart et al., 2001). In this study, we investigated the role of learning difficulties in students' academic emotions and achievement in literacy and mathematics across the critical transition. The results showed that students overall, but specifically students with learning difficulties, were vulnerable to experiencing more negative and fewer positive academic emotions, as well as to showing lower achievement across the transition to lower secondary school. This study also revealed differences between the academic domains: math-related emotions were more often associated with MD grouping (i.e., different developmental paths in MD) and were more constant across time, whereas literacy-related emotions mainly showed a general developmental pattern common to all students and were only partly associated with the RD groups.

Learning difficulties and academic emotions during the educational transition

In literacy, four of the eight emotions (enjoyment, anxiety, hopelessness, and boredom) changed over time as we expected, and these changes were partly related to having RD. The results revealed that literacy enjoyment generally decreased during Grade 7, whereas literacy boredom first decreased from Grade 6 spring to Grade 7 fall and then increased again from fall to spring in Grade 7. The fact that students tend to experience a decrease in literacy boredom during the transition may indicate that, in addition to transition-related worries, students also have positive expectations concerning learning and social relationships in their new learning environment (Anderson et al., 2000; Zeedyk et al., 2003). Furthermore, after the transition

commonly experienced decrease in literacy enjoyment and an increase in literacy boredom may relate to adolescents' challenges in maintaining interest and valuing literacy studies in the changed school environment (Pekrun et al., 2011). Interestingly, and against our hypothesis, increasing boredom was reported particularly by students with no RD. This may indicate that literacy studies in lower secondary school do not offer sufficient cognitive challenges for students who perform well.

In addition, literacy anxiety and hopelessness were found to be important academic emotions when considering the differences between RD groups. Literacy anxiety and hopelessness decreased during the transition for students with resolving RD and increased for students with emerging RD. Furthermore, literacy anxiety increased after the transition for students with persistent RD. Both hopelessness and anxiety are known to relate to expected academic success or failure (Pekrun, 2006; Pekrun et al., 2011). Students with learning difficulties typically have a long history of struggling with school work and thus, higher literacy anxiety and hopelessness may indicate that specifically RD students are vulnerable to experiencing uncertainty and lack of control over their studies (Pekrun et al., 2011) when moving to lower secondary school. This is probably due to new demands in the school work and may indicate that the transition is especially stressful for students with emerging or persistent RD (see also Anderson et al., 2000).

Also, against our hypotheses, four literacy-related emotions (hope, pride, anger, and shame) did not show mean-level changes across the transition. It is possible that these emotions are not as dependent on changes in learning environment, but rather reflect the students' more permanent ways of reacting to learning outcomes. However, it is a question for future research to find out why some literacy-related emotions change over time and others show a constant pattern over time.

In the math domain, against our hypotheses, none of the eight academic emotions changed on average across time. However, the differences in academic emotions between the MD groups were larger than in the literacy domain. Thus, as we expected, math-related emotions varied between the MD groups in all emotions except boredom, and these differences between the MD groups were constant across the transition. This constancy across time confirms the findings of previous research showing that mathematics is often regarded as a laborious and difficult school subject and is associated with negative emotions (Goetz et al., 2007), specifically with math anxiety (e.g., Suárez-Pellicioni et al., 2016). Those who struggle with mathematics also tend to have rather persistent difficulties (e.g., Andersson, 2010; Mazzocco et al., 2013) which is likely to cause repeated experiences of failure, lack of interest, and uncertainty about one's skills, which, in turn, may promote continual negative math-related emotions (Goetz et al., 2007; Pekrun, 2011).

Learning difficulties and academic performance during the educational transition

When considering academic achievement, our findings were in line with our hypotheses and with previous research (e.g., Ryan et al., 2013) by showing that students' academic achievement measured as school grades mostly declined across the transition. As expected, literacy achievement declined from sixth grade to seventh grade across all RD groups, whereas math achievement declined for students with no MD and students with resolving or emerging MD. However, students with no learning difficulties continued to have substantially higher literacy/math achievement than students with RD/MD, despite a general decline in literacy and math achievement. Declines in achievement have most often been associated with fundamental changes in the students' learning environment when entering lower secondary school (Anderson et al., 2000; Eccles et al., 1993; Ryan et al., 2013; West et al., 2010). The transition means

increasing demands in school work and, at the same time, decreasing support, as the one-teacher classroom is replaced by a number of subject teachers and changing classrooms and peers. According to Eccles and Roeser (2011), the lower secondary school environment accommodates the adolescents' basic needs of relatedness, competence, and autonomy poorly, which, in turn, challenges students' learning motivation and achievement.

In addition, surprisingly, and against our hypotheses, math achievement increased across time for students with persistent MD. In lower secondary school student-teacher relationships tend to be more distant than in primary school (e.g., Anderson et al., 2000). Thus, it is possible that secondary school teachers rate students' abilities closer to a general average in the beginning of secondary school, since knowledge of the students' skills has not yet been gathered. It is notable that, despite their increasing math achievement, students with persistent MD still continued to report generally fewer positive and more negative academic emotions than students with no MD, which may indicate that mathematics is still considered a challenging school subject, due to students' continued struggles with maths (Suárez-Pellicioni et al., 2016). However, it remains a question for future research to examine why students with persistent MD in particular show an increase in achievement, while other students' achievement appears to have a contrary pattern across the transition.

Limitations and future directions

The reader should be aware of the limitations of this study. The academic emotions were based on the adolescents' self-reports (for the validity of AEQ, see Pekrun et al., 2011). However, more knowledge on academic emotions could be achieved by examining also facial expressions or physiological responses in learning and achievement situations (see also Lehikoinen et al., 2019; Pekrun, 2006). It should also be noted that the reliability of some of the

emotion measures (especially anger and shame) was relatively low, which may partly explain why no significant results were found for these emotions. Furthermore, academic emotions were examined as trait emotions over the school semester, that is, emotions that students experience fairly constantly toward literacy or mathematics. However, it is likely that there is also state-like within-person variability in academic emotions between different situations (e.g., during lessons, tests, or doing homework) as well as between different days (Pekrun, 2006). Hence, more research is needed to better understand both state and trait aspects of academic emotions and related dynamics.

Furthermore, RD and MD were identified by using group-administered tests with rather lenient cut-off criteria. Consequently, the results may not be generalized to students with more severe, diagnosed learning disabilities. In addition, although the groups were clearly identifiable, the sizes of RD and MD groups were rather small, which is expected in community samples due to low prevalence of RD and MD. With a larger number of participants in each group, the pattern of results could have been clearer. The reader should also notice that although the results partly supported our hypotheses, the effect sizes in this study were relatively small.

Finally, although 90% of adolescents participated in the study at all four measurement points, 10% of adolescents had missing data at least in one out of four time points. Although the amount of missingness was relatively small, it was not completely at random. Adolescents with complete data had better academic performance and they reported more positive and less negative emotions than adolescents without complete data. This selectivity in the analysis sample might partly decrease the obtained effect sizes of the main analyses of the present study.

Conclusions and practical implications

This study showed that the transition-related negative consequences in academic emotions and achievement were common for all students but specifically for students with learning difficulties across the transition from primary school to lower secondary school. Furthermore, this study revealed a disparity in academic emotions between the academic domains, which may be due to the differences in literacy and mathematics as school subjects (see also Goetz et al., 2007). In the literacy domain, most students have reached a sufficient level of reading skills by the time they enter lower secondary school, and although reading is laborious to RD students, they can lean on their acquired reading skills (Eklund et al., 2015). MD, however, typically emerge in different areas of arithmetic, which is why mastering one area of math studies does not guarantee that another mathematics concept is learned (Kuhn, 2015). This may cause more uncertainty and task-avoidant behaviour in math when compared to literacy studies, which in turn may promote more constant negative emotions towards mathematics (see Pekrun et al., 2011).

Overall, as the transition to lower secondary school typically means negative consequences for students it is essential to pay attention to secondary school as a learning environment (Anderson et al., 2000; Eccles & Roeser, 2011). This can be done by modifying the learning environment to be more suitable for adolescents, which means offering both reasonable challenges and sufficient support in adjusting to the new learning environment (Coelho et al., 2017; Eccles & Roeser, 2011). As academic emotions are related to the value a student gives to learning and achievement, as well as to the sense of control over one's studies (Ahmed et al., 2013; Pekrun, 2006), students' participation in planning their own learning could promote adaptive academic emotions. In addition, attention should be paid to the proper timing of special

educational support for students struggling with their studies. Specifically, identifying risk factors for students with emerging RD/MD is fundamental. Future research would do well to also examine possible protective factors in transition-related negative changes, especially among students with RD or MD.

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