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Petra Sainio

The Role of Learning Difficulties in Adolescents' Academic Emotions and Achievement across the Transition from Primary School to Lower Secondary School

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF EDUCATION AND PSYCHOLOGY

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ABSTRACT

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The aim of the present research was to investigate rarely examined relations between learning difficulties (LD), academic emotions, and school achievement during the critical educational transition from primary school to lower secondary school. In addition, the protective role of student–teacher relationships in emotions and achievement was examined. The research is a part of the first phase of the broader STAIRWAY longitudinal study, which follows 848 Finnish adolescents across the transition from primary school to lower secondary school. Reading (RD) and math (MD) difficulties were identified based on tested reading and math skills in grades 6 and 7. Study I examined associations between RD/MD and subject-specific academic emotions, and academic achievement during Grade 6. In Study II, the role of stability of learning difficulties (i.e. resolving, emerging, or persistent RD/MD) in the development of academic emotions and achievement across the transition was examined. Finally, Study III examined teacher closeness as a protective factor in academic emotions and achievement among adolescents with and without RD/MD after the transition to lower secondary school. The results showed, first, that positive academic emotions and achievement decreased, whereas negative academic emotions increased for students in general across the transition. Second, the results revealed that LD students were more vulnerable to experiencing less positive and more negative academic emotions than were their peers, which had detrimental consequences for their subsequent achievement. LD students also lagged behind their peers in achievement across the transition. Third, the results indicate that warm and close teacher relationships are equally beneficial for both LD and non-LD students during the first year in lower secondary school. The results suggest that LD students' maladaptive academic emotions should be taken into account when planning educational support during the critical school transition. Identifying the different kinds of trajectories in LD across the transition is also essential to profit timely support for learning and related emotions. In addition, it is essential to pay attention to high-quality student–teacher relationships during the first year of lower secondary school as warm and supportive teacher relationships appear to promote positive academic emotions.

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

TIIVISTELMÄ (FINNISH ABSTRACT)

Sainio, Petra
Oppimisvaikeuksien merkitys oppimiseen liittyvissä tunteissa ja koulusuoriutumisessa siirryttäessä alakoulusta yläkouluun
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Tämän tutkimuksen tavoite oli tarkastella oppimisvaikeuksien, oppimiseen liittyvien tunteiden ja koulusuoriutumisen välisiä yhteyksiä siirtymävaiheessa alakoulusta yläkouluun. Lisäksi tarkasteltiin opettaja-oppilassuhteen merkitystä tunteissa ja koulusuoriutumisessa. Tutkimus on osa laajemman TIKAPUU-tutkimushankkeen ensimmäistä vaihetta, jossa on tarkasteltu 848 varhaisnuoren oppimista ja hyvinvointia alakoulusta yläkouluun siirtymän vaiheessa. Lukemisen ja matematiikan oppimisvaikeuksien määrittely perustui lukemis- ja laskemistaitoja mittaaviin testeihin, jotka toteutettiin 6. ja 7. luokalla. Ensimmäisessä osatutkimuksessa tutkittiin oppimisvaikeuksien, oppimiseen liittyvien tunteiden ja koulusuoriutumisen välisiä yhteyksiä 6. luokan aikana. Toisessa osatutkimuksessa tarkasteltiin muutoksia oppimiseen liittyvissä tunteissa ja koulusuoriutumisessa 6. luokan syksyltä 7. luokan keväälle. Oppilaat, joilla oli oppimisvaikeuksia, jaettiin kolmeen ryhmään: yläkoulussa väistyvät oppimisvaikeudet, yläkoulussa esiin tulevat oppimisvaikeudet ja alakoulusta yläkouluun jatkuvat oppimisvaikeudet. Kolmannessa osatutkimuksessa tarkasteltiin opettaja-oppilassuhteen läheisyyttä ja sen yhteyttä oppimiseen liittyviin tunteisiin ja koulusuoriutumiseen 7. luokan aikana. Tulokset osoittivat, että yläkouluun siirtymän vaiheessa myönteiset oppimiseen liittyvät tunteet vähenivät ja kielteiset tunteet lisääntyivät sekä koulusuoriutuminen heikkeni yleisesti. Toiseksi tulokset osoittivat, että ne, joilla oli oppimisvaikeuksia olivat muita oppilaita alttiimpia kokemaan enemmän kielteisiä ja vähemmän myönteisiä oppimiseen liittyviä tunteita sekä suoriutuivat heikommin kuin oppilaat, joilla oppimisvaikeuksia ei ollut. Lisäksi tulokset osoittivat, että läheiseksi koettu opettajasuhde tuki myönteisiä oppimiseen liittyviä tunteita. Tämän tutkimuksen mukaan oppimiseen liittyvät tunteet olisi tärkeää huomioida, kun suunnitellaan tukea oppimisvaikeuksiin yläkouluun siirtymässä. Olennaista on myös erityyppisten oppimisvaikeuksien oikea-aikainen tunnistaminen sekä tuen antaminen niin taitojen oppimiseen kuin tunteisiinkin. Lisäksi yläkoulussa olisi tärkeää kiinnittää huomiota opettaja-oppilassuhteen laatuun, sillä läheinen opettajasuhde näyttää lisäävän myönteisiä oppimiseen liittyviä tunteita.

Avainsanat: oppimisvaikeudet, oppimiseen liittyvät tunteet, koulusuoriutuminen, koulutussiirtymä, opettajasuhteen läheisyys

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LIST OF ORIGINAL PUBLICATIONS

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Taking into consideration the supervisor's and co-authors' comments and instructions, the author of the present dissertation wrote the original research plan, conducted the analyses in collaboration with co-authors and wrote the reports of the three publications.

FIGURE

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ORIGINAL PAPERS

1 INTRODUCTION

Learning difficulties (LD) can continually compromise students' learning from primary to lower secondary school (Smart et al., 2001). As they reach the developmental phase of adolescence, students with LD typically have a rather long history of repeated academic failures (e.g., Hakkarainen et al., 2015) which, in turn, may lead to lower motivation, more negative and less positive academic emotions (Lackaye et al., 2006; Rosenstreich et al., 2015), and even increase the risk of mental-health problems (Aro et al., 2019; Lindén-Boström & Persson, 2015) and dropping out of school (Hakkarainen et al., 2015). Reading difficulties (RD) and math difficulties (MD) were selected as the focus of this research as fluency in reading and mathematics skills are central aspects of learning throughout comprehensive school (National Core Curriculum, 2016), and they fundamentally influence performing succesfully in other school subjects as well.

Students frequently experience academic emotions that are both positive (such as enjoyment, hope, and pride) and negative (such as anxiety, anger, hopelessness, shame, and boredom) in their learning context, and these can either enhance or hinder their learning (Pekrun, 2006). Furthermore, positive academic emotions are known to be associated with higher learning outcomes whereas negative academic emotions relate to negative trajectories in learning and achievement situations (Pekrun et al., 2011). However, less attention has been paid to the possible role of emotions in academic failure among students with LD and to the extent to which LD has a detrimental effect on academic achievement through maladaptive emotional reactions. Yet, it is essential to understand the role of LDs in adolescents' academic emotions and achievement to find out new and more appropriate ways to support LD students' school tracks specifically during the critical school transition.

The transition from primary school to lower secondary school takes place in the developmental phase of adolescence and forms a context of multiple changes in adolescents' learning environment including several new teachers, increasing demands in school work and more resposibility over one's learning (West et al., 2010). The transition and the first year in the new schooling system is known to be critical to adolescents' learning motivation, subjective wellbeing,

and academic performance, all of which tend to decrease during the transition (Coelho et al., 2017). For students with LD, school transition typically means additional stress due to a combination of environmental changes in learning context and learning difficulty related additional struggles in school studies (Anderson et al., 2000; West et al., 2010).

Environmental support, such as warm and close teacher relationships, has been demosntrated to be positively related to students' social, academic and behavioral outcomes, and it may have a meaningful role in students' adjusting to a new learning environment during their first year in lower secondary school (Hamre & Pianta, 2001; McGrath & van Bergen, 2015; Sabol & Pianta, 2012). There is also evidence that positive student–teacher relationships are important for secondary school students, and that these are associated with with higher engagement (Roorda et al., 2017) and improved academic achievement (Frenzel et al., 2018; Roorda et al., 2011). Furthermore, based on at-risk perspective it has been suggested that specifically at-risk students, including students with LD, could benefit from warm and close teacher relationships due to their vulnerability to more negative pathways during the transition (Al-Yagon, 2012; Hamre & Pianta, 2001; McGrath & van Bergen, 2015; Sabol & Pianta, 2012; Spilt et al., 2012). Although it is known that students with LD commonly need educational support across the school path due to problems in learning, there is a lack of knowledge on the protective role of teacher closeness in LD students' typically more negative academic emotions and lower achievement.

As a consequence, the aim of this research was to examine the role of adolescents' reading and math difficulties in academic emotions and achievement during the critical school transition, as well as to figure out how the developmental paths of RDs and MDs associate to changes in academic emotions and achievement across the transition to lower secondary school. In addition, the role of teacher closeness in LD and non-LD students' academic emotions and achievement during the first post transition year was considered.

1.1 Learning difficulties

Fluent reading and math skills are essential not only to complete comprehensive school but also to progress through upper-secondary education and cope with everyday issues (Hakkarainen et al., 2015). Learning difficulties (LD), in turn, have been found to occur for various reasons among 12% to 30% of students (Westwood, 2004). The estimates on the prevalence of learning difficulties (LD) vary due to the differences in the definitions and cut-offs of learning difficulties (see e.g., Hallahan et al., 2020). LDs have been shown to be rather persistent, and students with LD are often burdened with a long history of academic struggles, as learning difficulties are usually identified during the early school years (Eklund et al., 2015; Landerl & Wimmer, 2008). As they move to lower secondary school, students with difficulties in reading or math struggle with learning while simultaneously facing increasing demands in literacy studies, with increasingly

difficult and longer texts to read, as well as in math studies, where mastery of basic skills is required in order to acquire new and more advanced skills. Furthermore, after not being visible during earlier school years, learning difficulties can emerge as late as in adolescence (Torppa et al., 2015).

Learning difficulties can manifest as borderline intellectual functioning that extensively compromises learning in multiple domains (Peltopuro et al., 2014) or as specific learning disabilities, such as specific reading disability (dyslexia) or mathematical disability (dyscalculia) (Landerl et al., 2009), that hinder the learning of certain academic skills. According to the *Diagnostic and statistical manual of mental disorders* (DSM-5, Fifth Edition; American Psychiatric Association, 2013), the prevalence of specific learning disorders (impairments in reading, writing and math) varies between 5% and 15% of the school-aged population. The etiology of developmental disorders has been shown to be multifactorial (van Bergen et al., 2014; Wilcutt et al., 2013). Difficulties in reading and in math are independent difficulties with unique characteristics of impairment, but they also have shared cognitive impairments and can appear together (Willcutt et al., 2013). Such shared cognitive features in RD and MD appear to be working memory deficits and problems with rapid naming (Koponen et al., 2016; Landerl et al., 2009; Willcutt et al., 2013; Wise et al., 2008). The comorbidity of reading and math difficulties has been shown to be rather common (Korpipää et al., 2020; Landerl & Moll, 2010), but it was considered in this research by controlling for math difficulties in the literacy domain and reading difficulties in the math domain.

LDs can also manifest as milder difficulties or as more severe ones. In the research literature, the term *learning disability* refers to severe learning difficulties that meet diagnostic criteria of dyslexia or dyscalculia. To determine if an individual has a learning disability, individually administered standardized tests are typically used, and in research strict cut-off criteria (often the 10th percentile) are used (e.g., Puolakanaho et al., 2007; van Bergen et al., 2011; Willcutt et al., 2013). However, milder LDs can be determined by group testing, and a more lenient cut-off score of -1 SD is also commonly used (e.g., Landerl et al., 2009; Snowling et al.; Wise et al., 2008). In this research, the term *learning difficulties* will be used instead of learning disability, because group testing was used instead of individually administered tests.

Previous research has shown that learning difficulties as well as learning disabilities can compromise students' academic achievement (e.g., Smart et al., 2001; Wise et al., 2008) by predisposing students to frequent struggles and failures in their studies. Students with learning difficulties are commonly provided special educational support during their school track (Hakkarainen, et al., 2015). In Finnish compulsory school, a part-time educational support is available for students whose need for support in learning and schooling is identified. However, despite educational support, students with LD typically continue having lower academic achievement than their peers (Holopainen & Hakkarainen, 2019).

1.1.1 Reading difficulties

Skilled reading typically appears as fluent word identification (i.e., fast and accurate), which happens easily and without noticeable effort (see Share, 2008). In transparent orthographies such as Finnish, the acquisition of accuracy in reading is fast and is typically obtained during the early school grades (Aro & Wimmer, 2003). As reading skills develop faster, it enables reading of lengthier and more complex texts. Difficulties in reading fluency, in turn, have been seen to be critical in reading skill development (e.g., Landerl & Wimmer, 2008; Share, 2008). For this reason, RD students' reading is typically characterized by slower and more laborious reading when compared to non-RD readers, especially after the early school grades (e.g., de Jong & van der Leij, 2003; Landerl & Wimmer, 2008). According to DSM–5, individuals with a reading disability also have difficulties in "understanding the meaning of what is read" (American Psychiatric Association, 2013, p. 66). Yet, when proceeding to upper classes, students with reading difficulties (RD) have usually achieved moderate skills in word- and text-reading accuracy, which gives them a reasonable basis for reading comprehension, too (Eklund et al., 2015). However, when compared to their peers in lower secondary school, students with RD need to spend more time with schoolwork and apply more effort to adopt the extensive and more difficult content in school subjects due to slow and laborious reading, and to difficulties in reading comprehension (Eklund et al., 2018). Students with RD also commonly need the support of special education to complete their lower secondary school studies successfully.

Reading difficulties may also emerge in later grades, after reading acquisition, when reading development is mainly characterized by increased reading fluency. Late-emerging reading difficulties refer to students who during their early school years (grades 1–3) have appeared as conventional readers, but during later school years (grades 4–8) are noticed to be slow or inaccurate readers when compared to their peers (e.g., Catts et al., 2012; Torppa et al., 2015). In addition, small subgroups with resolving difficulties have also been found (Torppa et al., 2015). 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). However, there is a lack of knowledge on how the developmental paths of RD are constructed during the transition to lower secondary school and how these developmental RD groups differ in academic emotions and learning outcomes.

1.1.2 Math difficulties

In mathematics, the fundamental skills are comprehension of the numeral system and arithmetic facts, magnitude processing, mathematical-calculation fluency, and using advanced counting and mathematical problem-solving strategies (e.g., Aunola et al., 2004; Koponen et al., 2016; Landerl et al., 2009; Purpura et al., 2013). In turn, various cognitive deficits are known to be in the background of math difficulties (MD), showing that manifestation of MD is not homogeneous

(Bartelet et al., 2014; Kuhn, 2015). Students with MD can have various difficulties with their arithmetic skills, such as deficits in number fact knowledge or in numerical and magnitude processing skills, immature calculation strategies and difficulties in retrieval of arithmetical facts (Bartelett et al., 2014; Kuhn, 2015; Landerl et al., 2009). Math skills have been shown to develop in hierarchical manner, and the adoption of new mathematical concepts is required continuously across one's study years (Aunola et al., 2004; Purpura et al., 2013). Thus, students with MD early on may end up having severe problems understanding mathematical concepts later in more advanced classes. Furthermore, there is evidence that the differences between students with MD and those without MD tend to increase as the two groups proceed to higher grades (Aunola et al., 2004).

Unlike with reading difficulties, there is hardly any evidence for resolving or late-emerging MD. On the contrary, math difficulties are commonly regarded to be continual (Judge & Watson, 2011; Mazzocco et al., 2013). As an exception, Judge and Watson (2011) examined students from kindergarten to fifth grade and differentiated MD groups based on the school year the difficulties were identified. Their basic finding was that in the case of late emerging math difficulties (in grade 4 or 5), students had lower math achievement already in kindergarten. Furthermore, there is also some evidence of the low math achievement of a group of students during one school year not being visible in the next year (Geary, 2011; Stock et al., 2010). Even though math skills are built hierarchically, it is possible that some of the students who struggle with math can manage easier math studies in primary school but face increasing difficulties during lower secondary school as math studies grow more demanding. In this research, similarly to literacy domain, developmental groups (no difficulties, late-emerging, resolving, and persistent difficulties) were formed in the math domain to investigate possible developmental paths in MD and related academic emotions and achievement during the transition to lower secondary school.

1.2 Learning difficulties and academic achievement

Academic achievement in primary school and particularly in lower secondary school is pivotal as it gives direction to adolescents' future educational tracks. Learning difficulties, in turn, are known to compromise students' learning considerably throughout the compulsory school years (Andersson, 2010; Landerl & Wimmer, 2008; Smart et al., 2001). In the literacy domain, RD is typically detected in early school years, and RD students' struggles with reading have been shown to be relatively persistent (Eklund et al., 2015; Geary, 2011; Landerl & Wimmer, 2008). Similarly, students with MD tend to have rather persistent difficulties, and students who struggle with math in early school years also typically display poorer math performance in upper grades when compared to their peers (Judge & Watson, 2011; Mazzocco et al., 2013). Furthermore, previous research suggests that students with LD acquire lower academic achievement not

only in the domain of difficulty but also in general (Landerl et al., 2009; Willcutt et al., 2013).

A critical phase in students' school performance during the comprehensive school years is the transition from primary school to lower secondary school which, in general, relates to negative changes in adolescents' academic outcomes (Eccles & Roeser, 2011; Ryan et al., 2013; Vierhaus et al., 2016). The transition has been suggested to be particularly laborious for students with LD (Andersson, 2010; Holopainen et al., 2017; West et al., 2010), which presumably makes them vulnerable to an even more abrupt decrease in school grades than their peers without LD. Specifically, for students with emerging difficulties the transition may be detrimental because their learning difficulties may not be noticed early enough (Torppa et al., 2015).

Overall school achievement in lower secondary school is critical as, through students' educational tracks, it impacts their future careers (Hakkarainen et al., 2013). LD students' commonly lower school achievement reduces their possibilities after comprehensive school, since applying to upper secondary education is based on previous school achievement. In addition, students with LD have been shown to more often choose vocational education than academic school track in upper secondary education (Savolainen et al., 2008). This, in turn, may influence LD students' career options when entering working life. Thus, it is essential to offer sufficient educational support for students' learning difficulties during the comprehensive school years so as to reduce the risks for school dropouts and expand LD students' educational and occupational choices. Besides educational support for students with LD in practising their skills, it is essential to pay attention to students' academic emotions which may substantially effect students' learning outcomes (Pekrun et al., 2011).

1.3 Academic emotions: the role of learning difficulties

Emotions are affective appraisals that arise in different kinds of situations and play a crucial role in modifying individual's behaviour. Emotions are composed of reciprocal processes of motivational, cognitive, and affective cycles, and can also be observed in changes of facial expressions and physiological responses (Pekrun, 2006; Scherer, 2009). Academic emotions are defined as emotions that arise in learning activities and which relate closely to learning outcomes (Pekrun, 2006; Pekrun et al., 2011). In his *control-value theory of achievement emotions*, Pekrun (2006, 2017) states that students frequently experience a variety of emotions, such as enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom in learning and achievement-related situations. This includes when they are taking tests, attending classes, and doing homework. Academic emotions can be divided into prospective, retrospective and activity-related emotions. Prospective emotions (such as hope, anxiety, and hopelessness) relate closely to expected success or failure in learning situations whereas retrospective emotions (such as pride and shame) arise when evaluating learning outcomes afterwards

and are related to interpretations of whether failure or success is caused by oneself or the others (Pekrun 2006, 2017; Pekrun et al., 2011). Activity emotions (such as enjoyment, boredom, and anger), in turn, are emotions that students experience in learning or achievement situations and can either promote or hinder learning (Buff, 2014; Pekrun et al., 2014). Academic emotions can be defined by their valence (positive or negative) or by their activation, that is, considering emotions' effects on making an individual active or passive in learning situations (Pekrun et al., 2011). Academic emotions can be defined as state-like academic emotions which arise in certain situations (e.g., test anxiety) or specific learning-related emotions that are habitually associated with specific school subjects (e.g., math anxiety) (Maloney et al., 2015; Pekrun, 2006; Suárez-Pellicioni et al., 2016). Furthermore, academic emotions are known to organize in a domain-specific manner, meaning a student can frequently experience anxiety in literacy studies but not when studying math (Goetz et al., 2007; Pekrun et al., 2011).

Pekrun (2006) argues that individuals' control and value beliefs are determinants of academic emotions (Figure 1). Lower experienced control over a learning or achievement situation is typically related to negative academic emotions whereas higher experienced control is in the background of positive academic emotions (Buff, 2014; Pekrun et al., 2014). Furthermore, depending on the subjective value a student places on the learning situation or achievement either positive or negative academic emotions can arise: a typically high subjective importance of learning situation is associated with positive academic emotions whereas learning situations marked with a lower subjective value typically promote negative academic emotions (Pekrun, 2017; Pekrun et al., 2011). As an example, enjoyment can be assumed to be related to learning situations which are regarded to be fairly well managed and which are valuated positively (Buff, 2014). Academic emotions are therefore fundamental to students' learning and achievement in school, since positive emotions (such as enjoyment, hope, and pride) can positively affect students' learning by promoting effective learning strategies, benefitting self-regulation and motivation, and even leading to higher learning outcomes (Ahmed et al., 2013; Goetz et al., 2007; Pekrun et al., 2011). Negative emotions (such as anger, anxiety, shame, hopelessness, and boredom), in turn, commonly challenge students' learning by promoting non-effective learning strategies, poorer self-regulation, and lower motivation in learning and achievement situations, as well as be associated with lower learning outcomes (e.g., Ahmed et al., 2013; Pekrun et al., 2014; Suárez-Pellicioni et al., 2016).

However, academic emotions are associated not only with students' inner experience of control and values regarding current learning or achievement but also to environmental features of the learning context (Figure 1), such as classroom instructions, test procedures, classroom climate or interaction between students and teachers (Frenzel et al., 2007; Frenzel et al., 2018; Goetz et al., 2011; Mainhard et al., 2018; Pekrun, 2017). As an example, positive student–teacher relationships have an energizing function that activates positive academic-

related emotions (Furrer & Skinner, 2003). There is also some evidence that academic emotions can be transmitted from teacher to students and vice versa in classroom situations, such as how a teacher's enjoyment positively enhances students' enjoyment (Frenzel et al., 2018). In addition, students' temperament and personal traits, cognitive recourses, and learning-related skills as well as environment influence each other in reciprocal ways (Pekrun, 2006; 2017).

The results of previous research on academic emotions in students of different ages are somewhat contradictory. There seems to be no longitudinal settings to study the stability of students' academic emotions specifically across the transition to lower secondary school. In their cross-sectional study, Raccanello et al. (2013) examined the academic emotions of students in the fourth, seventh and eleventh grades, and found that younger students had higher positive emotions (pride, hope, relaxation) and older students typically had higher negative emotions (anxiety, boredom). However, when Goetz et al. (2007) compared academic emotions (enjoyment, pride, anxiety, anger, and boredom in maths, physics, German and English lessons) both with students in Grade 8 and students in Grade 11, they found that within domains there were no differences in academic emotions between the two age groups of students. Thus, unless academic emotions have been examined among school-aged children, knowledge on adolescents' academic emotions and related possible changes during the transition to lower secondary school is sparse. Consequently, in this research, the knowledge of adolescents' academic emotions in literacy and math domains was gathered through students' self-reports during the transition to lower secondary school. In line with previous research, academic emotions were presumed to act in a domain-specific way (Goetz et al., 2007). Adolescents therefore reported their academic emotions separately in literacy and math studies.

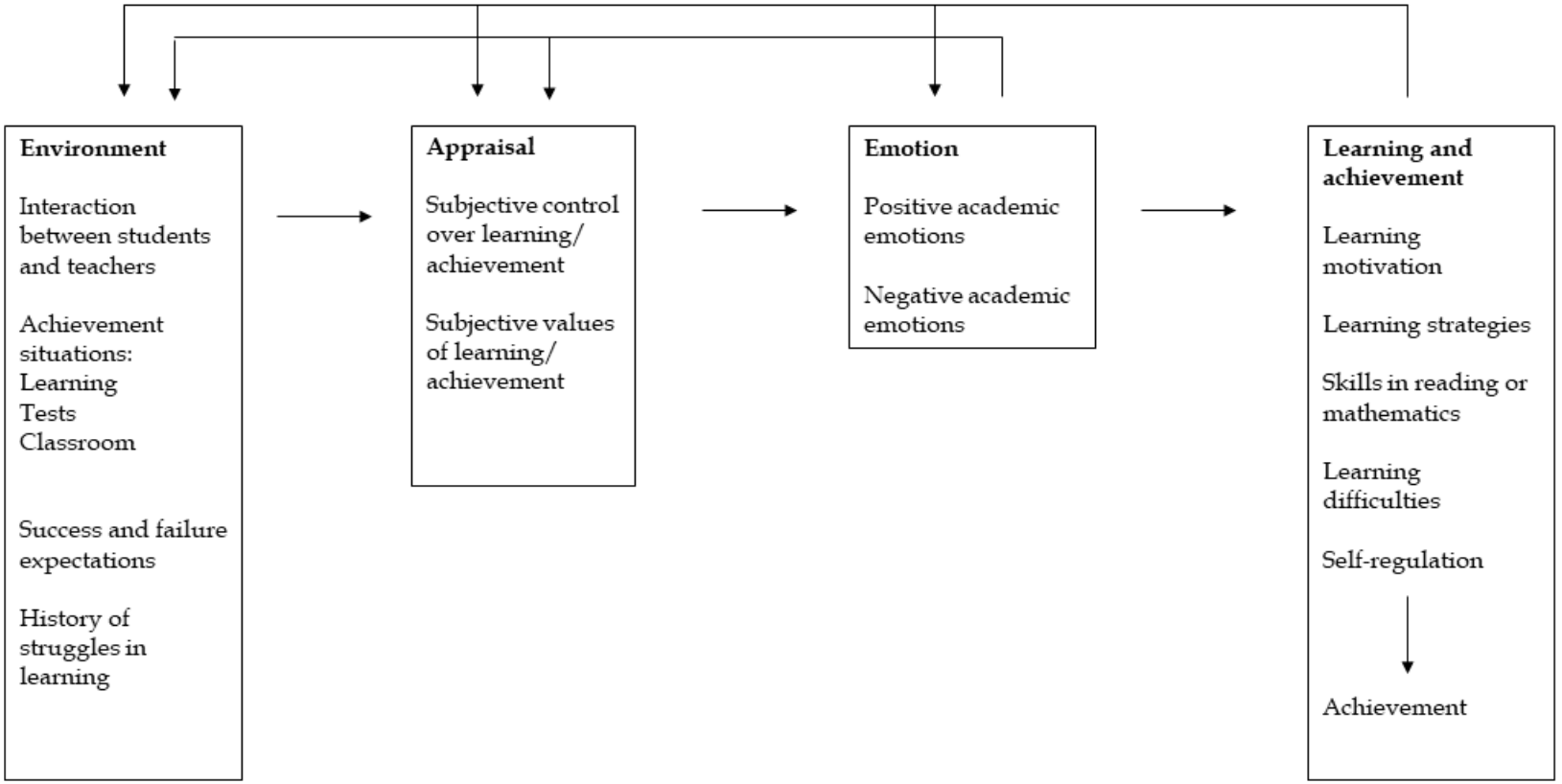

FIGURE 1 Academic emotions: antecedents and effects according to the Control-Value theory. Adapted and modified from Pekrun, 2006 and Pekrun, 2017

According to control-value theory (Pekrun, 2006, 2017), academic emotions are closely linked to students' motivational and cognitive resources (Figure 1). Learning difficulties, in turn, predispose students to repetitive failures and lower achievement across the school years, which typically affects negatively LD students' self-esteem as a learner, self-efficacy beliefs and motivation in learning contexts (Kiuru et al., 2011; Lackaye et al., 2006). Hence, it is presumable that learning difficulties predispose students to more negative and less positive academic emotions, and LDs may even have a detrimental effect on learning and school performance through maladaptive academic emotions (Orly & Margalit, 2014; Trigwell et al., 2012). LD students' increased negative and decreased positive academic emotions may even hinder the progress in academic skills due to low perceived control over studies and low subjective importance directed toward learning (Pekrun et al., 2014). This, in turn, may promote deactivation in learning tasks, increasing learning-related worrying and task avoidant behaviour in learning and achievement situations (Nurmi et al., 2003; Pekrun et al., 2009).

Math anxiety has been a widely examined academic emotion, and it has been related to poor learning outcomes in the math domain (Ahmed et al., 2013; Aldrup et al., 2019; Maloney et al., 2015; Suárez-Pellicioni et al., 2016). There is some evidence of increased math anxiety among students with dyscalculia when they are compared with a control group (Rubinstein & Tannock, 2010). Besides the studies on math anxiety, lower hope has been suggested to be a typical academic emotion among students with LD, as struggles often characterizes their academic lives (Lackaye et al., 2006; Rosenstreich et al., 2015). Furthermore, lower hope has been related to lower self-esteem as a learner (Lackaye et al., 2006), as well as to failure expectations and task-avoidance behaviour (Pekrun et al., 2009). However, results of these studies are difficult to generalise, as only Lackaye et al. (2006) examined hope among adolescents with LD. In their study hope was also defined as learning-related hope in general, but not domain specifically, which is why the knowledge on subject-specific hope remains sparse.

The knowledge of LD students' academic emotions is limited in the following ways: There are hardly any studies on the role of other academic emotions in LD students' learning and achievement except to the mentioned hope and math-related anxiety. Furthermore, no studies have been conducted on the possible mediating role of academic emotions between LD and academic achievement although researchers generally relate LDs to lower achievement. Thus, the current research makes a unique contribution to earlier research by focusing on LD students' academic emotions and achievement in the math as well as literacy domains among students in a crucial developmental phase of adolescence and during the fundamental changes in school environment.

1.4 The transition to lower secondary school

The transition from primary school to lower secondary school takes place concurrently with the developmental phase of adolescence. It is known that the

school transition commonly challenges adolescents' cognitive, emotional, and motivational adjustment (Eccles & Roeser, 2011; Ryan et al., 2013; West et al., 2010). On the other hand, students' ability to adjust to a new learning environment may have long-lasting positive consequences for mental health and achievement (Kiuru et al., 2020; West et al., 2010). Adolescence is characterized with rapid changes in physiological, psychological, cognitive, and behavioural domains which profoundly shape adolescents' personal, social, and emotional lives (Crosnoe & Johnson, 2011). In their *stage-environment fit theory*, Eccles and Midgley (1989) argue that there is a mismatch between the learning environment of lower secondary school and the developmental phase of adolescence. It has been suggested that the adolescents' developmental needs of autonomy, competence, and relatedness (see also Deci & Ryan, 2000) are not met in lower secondary schools' social and academic environments (Eccles & Roeser, 2011). When fulfilled, these basic psychological needs promote individual growth and wellbeing (Deci & Ryan, 2000).

The transition represents a time of major changes in learning environments. School workload demands and achievement expectations typically increase when adolescents proceed to lower secondary school. However, adolescents' need for competence may be met when both reasonable academic challenges and sufficient support are provided (Coelho et al., 2017; Eccles & Roeser, 2011). Also, higher teacher control and fewer possibilities to influence one's learning are typical in lower secondary schools (Eccles & Roeser, 2011), which challenges adolescents' need for autonomy. Furthermore, a shift from the school class teacher system to changing classrooms, and multiple teachers specialised in one school subject is one of the fundamental changes after the transition (Coelho et al., 2017). This may form a background for the finding that adolescents' teacher relationships tend to be more distant than among younger students (Eccles & Roeser, 2011). It has been suggested, however, that adolescents commonly have increased need for social support in a new school environment (Roorda et al., 2017).

It is known that at-risk students suffer more often from transition-related stress and anxiety, as well as have more difficulties in adjusting to new school environment and related academic demands than their peers do (Anderson et al., 2000; West et al., 2010). In lower secondary school, students with LD need to put more effort into learning than do their peers as schoolwork becomes more demanding with more extensive content in a range of school subjects. At the same time, students with LD lag behind their peers in reading and mathematical fluency skills (Eklund et al., 2015; Geary et al., 2012; Landerl & Wimmer, 2008). Students with LD have also been recognized to have an elevated risk for experiencing low-quality transitions (Anderson et al., 2000; West et al., 2010). This risk is due to their lower school achievement, as these students tend to be less prepared for the educational transition (Anderson et al., 2000) and due to their continual difficulties tend to have more needs for support in their learning (Hakkarainen et al., 2015).

Although learning difficulties have been recognized as a risk factor for poorer school transition in previous research, LD students' academic emotions and achievement, and their related developmental pathways across the transition to lower secondary school have rarely been taken as the focus of research.

1.5 Teacher closeness

Positive student–teacher relationships have been shown to be important for students' engagement (Roorda et al., 2017) and academic emotions (Goetz et al., 2021; Lei et al., 2018; Mainhard et al., 2018) not only in early school years, but also in adolescence. Teacher closeness has been defined as a warm and supportive relationship between student and teacher (Sabol & Pianta, 2012), which is known to benefit students' social skills, school engagement, learning outcomes and adaptive behavior (Hamre & Pianta, 2001; McGrath, & van Bergen, 2015; Roorda et al., 2017; Sabol & Pianta, 2012; Spilt et al., 2012). Several theoretical models, such as attachment perspective, motivational theories, and ecological systems theory have been used to conceptualize teacher–student relationship quality (Verschueren, 2015). In the attachment perspective, a sensitive teacher's role has been understood as being an ad hoc attachment figure who functions as a safe haven and secure base at school, for younger children as well as for adolescents (Verschueren & Koomen, 2012; Verschueren, 2015). Sensitive teachers, by helping students to feel safe, promote coping with the demands of school and positively impact on students' learning and engagement (Bergin & Bergin, 2009; Pianta, 2001; Verschueren, 2015). In turn, self-determination theory (SDT) posits that supportive interpersonal relationships may fulfil students' basic psychological need for social relatedness (Deci & Ryan 2000). When this need is met, students feel connected to their teachers, which fosters their academic engagement and enjoyment of learning (Furrer & Skinner, 2003). From a wider perspective, ecological systems theory argues that dyadic interpersonal relationships are the key promoters of developmental changes (Bronfenbrenner & Morris, 2006).

When entering lower secondary school, students face the changing school system with multiple unfamiliar teachers and as a consequence they need to build up teacher relationships anew (Eccles & Roeser, 2011; Roorda et al., 2019). Furthermore, there is evidence that during the school transition students have an increased need for forming supportive interpersonal relationships with peers and teachers (Roorda et al., 2011). Thus, warm and close teacher relationships may have a considerable role in supporting adolescents' adaptive academic emotions and achievement at the beginning of lower secondary school and assist adolescents' adjustment to their newly changed learning environment (Ahmed et al., 2010; Holas & Huston, 2012; Lei et al., 2018; Mainhard et al., 2018; Pekrun, 2017; Wang & Eccles, 2012).

There is evidence that at-risk students typically have lower closeness in their teacher relationships in general than their peers do (McGrath & van Bergen, 2015; Roorda et al., 2011; Roorda et al., 2011; Sabol & Pianta, 2012). Previous

research has suggested that a student's characteristics influence student–teacher relationships (see e.g., Nurmi & Kiuru, 2015). It is therefore possible that teachers find it is easier to form positive relationships with students who perform well and put effort into their schoolwork. On the contrary, students with LD typically struggle with their learning, have lower motivation, and do not easily reach the expected goals in learning, which may negatively influence their teacher relationships (Kiuru et al., 2013; Nurmi & Kiuru, 2015). Furthermore, as students with LD frequently face academic failures which in turn have been related to lower self-esteem, more negative self-efficacy beliefs, and more negative learning-related emotions (Holopainen et al., 2017; Lackaye et al., 2006; Nurmi et al., 2003), it is possible that students with LD are more dependent on teachers' support and feedback than their peers. It has been suggested that supportive teacher relationships could form a protective factor specifically for at-risk students (Kiuru et al., 2013; McGrath & van Bergen, 2015; Sabol & Pianta, 2012). Furthermore, warm and close teacher relationships in the domain where difficulties are faced could help students with LD to create more positive approaches to learning through gains in socio-emotional adjustment in the school context (Al-Yagon, 2012; Murray & Greenberg, 2006; Sabol, & Pianta, 2012) and thereby promote more positive learning-related emotions (see also Aldrup et al., 2019; Mainhard et al., 2018; Spilt et al., 2012).

There is some previous research on teacher closeness among LD students. Hughes, and Cao (2018) found that during the transition teacher closeness predicted higher math achievement, whereas in the post-transition period teacher closeness predicted neither math nor literacy achievement. There is also evidence that students with lower literacy skills typically have declining trajectories in teacher closeness across elementary school, which was partly related to lower achievement (Spilt et al., 2012). Murray and Greenberg (2001), in turn, compared students with LD and students with other kinds of difficulties and found that students with LD actually had higher teacher affiliations than did students with other kinds of difficulties, such as emotional disturbance.

In this research, students' teacher relationships were examined separately in literacy and math domains as there is evidence that students typically form distinct teacher relationships in different school subjects (Roorda et al., 2019). It has been related to, for example, students' motivation, experienced hardship in a specific school subject and experienced distance vs. closeness in a certain teacher relationship (Roorda et al., 2019; see also Nurmi & Kiuru, 2015). Academic emotions are also known to organize in a domain-specific manner (Goetz et al., 2007). From the perspective of at-risk theory (Bosman et al., 2018; Sabol & Pianta, 2012; Spilt et al., 2012), relationships with literacy and math teachers can be seen as fundamental when considering teacher closeness as a protective factor in RDs and MDs. All in all, it is essential to investigate the role of teacher closeness in LD students' academic emotions and achievement to better understand whether warm and supportive teacher relationships could reduce LD students' typically negative pathways in academic emotions and achievement after the transition to lower secondary school.

1.6 Aims of the research

The main focus of this research was to examine the differences between LD and non-LD students in their academic emotions and academic achievement separately in literacy and math domains during the transition from primary school to lower secondary school.

Study I focused on the period before lower secondary school, meaning the end of primary school (Grade 6), and examined the differences between RD/MD and non-RD/MD students in their academic emotions (i.e., hope, enjoyment, and anxiety) in literacy/math in the fall semester of Grade 6. Study I also examined if adolescents' reading/math-related hope, enjoyment, and anxiety in Grade 6 mediate the effect of LD on concurrent and subsequent literacy/math achievement and overall academic achievement. In addition, the mediation role of adolescents' literacy/math-related hope, enjoyment, and anxiety on the changes in literacy/math achievement and overall academic achievement from the fall semester of Grade 6 to the spring semester of Grade 6 were examined.

In Study II the aspect of the school transition was introduced, and the aim of the study was to investigate the changes in the domain-specific academic emotions (enjoyment, hope, pride, anxiety, anger, shame, hopelessness, and boredom) and achievement of students with and without RD/MD across the transition to lower secondary school (from Grade 6 to Grade 7). RD/MD groups with different developmental paths of difficulties (resolving, emerging, and persistent) were formed in order to determine if adolescents' learning difficulties (resolving, emerging or persistent RD/MD) were 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.

Study III examined both LD and non-LD students' academic emotions and achievement after the critical transition during Grade 7 and added the aspect of teacher closeness as a protective factor in students' academic emotions (enjoyment, hope, pride, anxiety, anger, shame, hopelessness, and boredom) and achievement after the school transition. Study III examined the extent to which literacy or math teacher closeness was related to the changes in subject-specific academic emotions and literacy or math achievement during Grade 7, and if there were differences between LD and non-LD students. In addition, the possible moderating role of teacher closeness in the academic emotions and achievement of students with and without LDs was examined.

In all the studies, the effects of gender, students' difficulties in the other academic domain, classroom differences, and depressive symptoms were controlled for. In addition, pubertal timing was controlled for in Study II. Gender was set as a covariate as it has been shown that girls have more math-related difficulties than boys, whereas boys have more literacy-related difficulties than girls (Quinn & Wagner, 2015). The comorbidity of RD and MD has been shown to be rather common (Landerl et al., 2009; Willcutt et al., 2013). Thus, students' difficulties in the other academic subject were controlled for. Depressive

symptoms were controlled for in all the analyses as poor school transition has been shown to relate to adolescents' vulnerability to depressive symptoms (West et al., 2010). In addition, students with LD are known to be more vulnerable to mental health problems than their peers (Aro et al., 2019; Lindén-Boström & Persson, 2015). Furthermore, class differences were controlled for as students' academic emotions have been shown to differ also on a classroom level (Frenzel et al., 2007). Finally, in Study II, also students' pubertal status was set as a covariate, as it is known to vary between individuals and is related to other developmental trajectories in adolescence (Crosnoe & Johnson, 2011).

2 METHOD

2.1 Participants and procedure

The present research is part of the first phase (Ahonen & Kiuru, 2013–2017) of the broader STAIRWAY longitudinal study (www.jyu.fi/stairway), which 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 (girls 54%) adolescents in grades 6 and 7 who came from 30 different schools and 57 different classes (mean class size = 21.10; *SD* = 4.66). Parental written consent and child assent were required for student participation. The research plan was approved by the local ethics committee. 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 et al., 2018; Mauno et al., 2018).

The participants' age at the beginning of the study ranged from 11 to 13 years (mean = 12.3 years; *SD* = 4.36). The participants' mother tongue was Finnish in 95% of cases whereas 3% of the participants reported being bilingual with Finnish as the native language, and 2% had a mother tongue other than Finnish. At the beginning of the study, 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 had completed vocational upper secondary school; 40% of the mothers and 29% of the fathers had 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 were collected during normal school days. All the tests and questionnaires were administered by trained testers. The students' reading and math skills were tested as a group testing 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 separate times: in Grade 6 fall (2014) and spring (2015) and in Grade 7 fall (2015) and spring (2016). The students filled out a questionnaire concerning teacher closeness in the fall semester of Grade 7 (2015). In addition, the information on school achievement was gathered using students' self-reports in the fall and spring of Grade 6 (Study I) as well as from school registers at the four times mentioned above (Study II and III). The summary of the measures and statistical analyses used in Studies I to III are shown in Table 1.

Partly different sets of measures were used in Studies I to III (see Table 1). The focus of the three studies was in the changes in the academic emotions and achievement of students with and without LD over the different time points during the transition to lower secondary school. Study I analyzed two time points: Grade 6 fall and spring. Thus, in Study I, the measures of tested reading and math difficulties, three of the academic emotions (enjoyment, hope, and anxiety), and self-reported school achievement (grades in literacy and math, and grade point average) during Grade 6 were used. Study III analyzed time points of Grade 7 fall and spring. As measures, it used reading and math difficulties, literacy and math achievement acquired from school registers, academic emotions (enjoyment, hope, pride, anxiety, anger, shame, hopeless, and boredom) and teacher closeness reported by students. In Study II, the measures of both Grade 6 (fall and spring) and Grade 7 (fall and spring) were used, and the information was gathered on tested reading and math difficulties, literacy and math achievement acquired from school registers, as well as the eight academic emotions as reported by students.

TABLE 1 Summary of the measures and statistical methods used in Studies I-III.

Study and sample	Questionnaires and tests	Statistical methods
Study I: The Role of Learning Difficulties in Adolescents' academic emotions and Academic Achievement. **Sample of 845 adolescents (girls 54% and boys 46%)** **Two measurement points: Grade 6 fall and spring** **Reading difficulties:** • **Students without RD (*n* = 707, 84%)** • **Students with RD (*n* = 131, 16%)** **Math difficulties:** • **Students without MD (*n* = 684, 82%)** • **Students with MD (*n* = 153, 18%)**	Reading tests (Grade 6 fall): • Word Identification Test • Spelling Errors Test • Salzburg Reading Fluency Test Math tests (Grade 6 fall): • Basic Arithmetic Test Academic emotions (Grade 6 fall): • Achievement Emotions Questionnaire (AEQ): enjoyment, hope, and anxiety in literacy and in math Academic achievement (Grade 6 fall and spring): • grades in literacy and math, GPA (self-reported)	ANCOVAs (general linear model) separately in the literacy and math domains Path models (complex approach) separately in literacy and math domains
Study II: Adolescents' academic emotions and academic achievement across the transition to lower secondary school: The role of learning difficulties. **Sample of 848 adolescents (457 girls, 54%)** **Four measure points: Grades 6 and 7 fall and spring** **Reading difficulties:** • **Students without RD (*n* = 647, 81%)**	Reading tests (Grade 6 fall and Grade 7 spring): • Word Identification Test • Spelling Errors Test • Salzburg Reading Fluency Test Math test (Grade 6 fall and Grade 7 spring): • Basic Arithmetic Test Academic emotions (Grades 6 and 7 fall and spring): • Achievement Emotions Questionnaire (AEQ): Enjoyment, hope, pride, anxiety, anger, hopelessness, shame, and boredom in literacy and in math Academic achievement (Grades 6 and 7 fall and spring): grades in literacy and math (school registers)	Repeated MANCOVAs (general linear model) separately in the literacy and math domains

• **Students with RD (*n* = 146)**
  • **resolving RD (*n* = 33, 4%)**
  • **late-emerging RD (*n* = 24, 3%)**
  • **persistent RD (*n* = 89, 12%)**
 	
Math difficulties
• **Students without MD (*n* = 597, 77%)**
 	
• **Students with MD (*n* = 179)**
  • **resolving MD (*n* = 63, 8%)**
  • **late-emerging MD (*n* = 42, 5%)**
  • **persistent MD (*n* = 74, 10%)**		

Study III: The role of teacher closeness in emotions and achievement for adolescents with and without LD. **Sample of 848 adolescents (457 girls, 54%)** **Two measure points: Grade 7 fall and spring** **Reading difficulties:** • **Students without RD (*n* = 694, 86%)** • **Students with RD (*n* = 116, 14%)** **Math difficulties:** • **Students without MD (*n* = 676, 85%)** • **Students with MD (*n* = 116, 15%)**	Reading tests (Grade 7 spring): • Word Identification Test • Spelling Errors Test • Salzburg Reading Fluency Test Math test: (Grade 7 spring) • Basic Arithmetic Test Academic emotions (Grade 7 fall and spring): • Achievement Emotions Questionnaire (AEQ, Pekrun) • Enjoyment, hope, pride, anxiety, anger, hopelessness, shame, boredom in literacy and in math Academic achievement (Grade 6 spring and Grade spring): • grades in literacy and math (school registers) Teacher closeness (Grade 7 fall) • Student-Teacher Relationship Scale (STRS-Short Form)	ANCOVAs (general linear model) separately in literacy and math domains

2.2 Measures

2.2.1 Reading difficulties

Students reading skills were measured using three tests: Word Identification Test, Spelling Errors Test (Holopainen et al., 2004) and the short version of the Salzburg Reading Fluency Test (Landerl et al., 1997; translated into Finnish by Sini Huemer). The test-retest reliabilities were high in all of the three tests: in the Word Identification Test α = .70-.84; in the Spelling Errors Test α = .83 – .86 and in the original the Salzburg Reading Fluency Test α = .87 for eighth-grade students. All the tests were administered in a group setting during normal school days.

In all the studies, after standardizing the reading tests, an arithmetic mean across the students' scores in the three tests was calculated. The Cronbach's alpha reliability for the scale was .87 in Grade 6 fall and .89 in Grade 7 spring. In Studies I to III this scale score was used to classify the students into RD or non-RD groups. Students scoring below the 16th percentile (approximately one standard deviation below the mean of the whole sample) were considered to have RD (see e. g. Puolakanaho et al., 2007; Snowling et al., 2003). In Study II, the RD group was further divided into three subgroups based on the stability of students' difficulties: students having difficulties only in Grade 6 were considered as having resolving RD (4%), students with difficulties only in Grade 7 were considered as having emerging RD (3%), and students with difficulties in both Grade 6 and in Grade 7 were considered as having persistent RD (12%).

2.2.2 Math difficulties

In Studies I to III math skills were assessed with the Basic Arithmetic Test (Aunola & Räsänen, 2007; see also Zhang et al., 2020). In Study II, the Basic Arithmetic Test was administered both in Grade 6 fall and Grade 7 spring whereas in Study I the test was administered in the fall semester of Grade 6 only and in Study III spring semester of Grade 7 only. The test contains tasks of addition, subtraction, multiplication, and division. The students were asked to do mental calculations on 28 tasks and write their answers on the test paper. The Cronbach's alpha reliability for the scale was .82 in Grade 6 fall and .85 in Grade 7 spring.

In Studies I to III the students were classified into two groups based on their math skills using the standardized score on the scale of the Basic Arithmetic Test. Students scoring below the 16th percentile, which is approximately one standard deviation below the mean of the whole sample, were considered to have MD (see e.g., Landerl et al., 2009; Wise et al., 2008). In Study II, the MD group was divided into three subgroups (see Table 1) based on the stability of their difficulties: students having difficulties only in Grade 6 were considered to have resolving

MD (8%), students having difficulties only in Grade 7 were considered to have emerging MD (5%), and students having difficulties in Grade 6 as well as in Grade 7 were considered to have persistent MD (10%).

The comorbidity of RD and MD was rather common. Based on the cut-offs described above, a total of 44% of students who were identified as having either RD or MD were students with comorbid RD and MD in Grade 6 fall. Likewise, in Grade 7 spring, a total of 40% of students with either RD or MD were identified as having both RD and MD. To control for the effects of the other academic subject, MD was set as a covariate in literacy-related analyses and RD as a covariate in math-related analyses.

2.2.3 Academic emotions

Students completed the Finnish version of the Achievement Emotions Questionnaire (AEQ; Pekrun et al., 2011) four times during grades 6 and 7. Confirmatory factor analysis was used to assess factorial validity and time invariance of academic emotions separately for literacy and mathematics. The measurement models, assuming measurement invariance across time, fit the data well: RMSEA = 0.00–0.06, CFI = 0.95–1.00, and SRMR = 0.01–0.06. The standardized estimates of factor loadings for the key constructs were also high, with none of them lower than .40. The questionnaire was adapted for school age students, and students were instructed to rate their academic emotions concerning tests, lessons and learning separately in literacy and math domains. In Study I students rated their enjoyment, hope and anxiety whereas in Studies II and III students rated their enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom regarding learning, attending classes, and test situations separately in literacy and math domains. The academic emotions were measured with three questions each except for boredom which was measured with two questions. The Cronbach's alpha reliabilities for the emotions in literacy and mathematics in Studies I to III 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.

2.2.4 Academic achievement

In Study I, students provided information on their overall academic achievement (grade point average) as well as achievement in literacy and math in the fall and spring semesters of Grade 6. In Studies II and III, information on the students' academic achievement in literacy and mathematics was acquired from school registers. Self-reported school grades have been shown to correlate .86 with the actual grades from the school registers (Ahonen & Kiuru, 2014). In Finnish schools, the grades range from four to ten, with five being the lowest accepted grade and ten the highest.

2.2.5 Teacher closeness

In Study III, students completed the Student-Teacher Relationship Scale (STRS-Short Form; Pianta, 2001; see also Jerome, Hamre, & Pianta, 2009) of five questions to rate the closeness with their seventh-grade literacy and math teachers during the fall semester of Grade 7. Cronbach's alpha reliability for the scale was .80–.82. The mean scores across these ratings were calculated separately for ratings regarding literacy and math teachers.

2.2.6 Control variables

In Studies I-III, the students' gender (1 = girl; 2 = boy), difficulties in the other school subject (0 = no difficulties; 1 = difficulties), and school class identification number were used as control variables. Furthermore, the level of depressive symptoms (mean score of ten questions of the Depression Scale, DEPS, α = .91; Salokangas et al., 1995) was set as a control variable in all original Studies. In addition, in Study II, students' pubertal status was controlled for. Pubertal status (mean score of the Finnish version; Dick et al., 2001; Mustanski et al., 2004) was measured with the five-item Pubertal Development Scale (PDS, α = .73; Petersen, 1988).

2.3 Analysis strategy

In Study I ANCOVAs (general linear model) were used separately for the literacy and math domains. In the models for literacy, the variables of hope, enjoyment, and anxiety toward reading were dependent variables, and the RD variable (0 = without RD, 1 = with RD) was an independent variable (fixed factor). In addition, gender, depressive symptoms, and MD were added as covariates and classroom identification number was added as a random factor in the models to control for classroom differences. Similar analyses were carried out in the math domain. Second, path models were run separately for literacy and math domains. The path models were carried out by applying the complex approach (Muthén & Muthén, 1998–2016). This method estimates the models at the level of the whole sample but corrects possible distortions of standard errors caused by the clustering of observations (classroom differences).

In Study II the research questions were analyzed using repeated MANCOVAs (general linear model) 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, gender, pubertal status, depressive symptoms, and the students' MD group were added as covariates, and classroom

identification number was added as a random factor to control the classroom differences. Similar analyses were carried out in the math domain.

In Study III, the descriptive analyses were conducted by exploring means and standard deviations with independent samples *t* tests. The research questions were analyzed using ANCOVAs (General Linear models). The analyses were run separately in the literacy and math domains. In the models, subject-specific emotions and literacy/math achievement in the spring of Grade 7 were the dependent variables, whereas literacy/math teacher closeness and RD/MD variable were independent variables. Gender, difficulties in other academic domain, depressive symptoms, and classroom differences were set as covariates in all the analyses. The particular interest of Study III was the interaction terms of the RD/MD and literacy/math teacher closeness variables.

3 OVERVIEW OF THE ORIGINAL STUDIES

3.1 Study I: The role of learning difficulties in adolescents' academic emotions and academic achievement

The aim of Study I was to first investigate the extent to which adolescents with and without reading/math difficulties differ regarding their academic emotions (hope, enjoyment, and anxiety) in literacy/math in the fall semester of Grade 6. It was hypothesized that adolescents with LD in reading or math experience lower reading- or math-related hope and enjoyment, as well as higher reading- or math-related anxiety than those without LD.

The second aim of Study I was to investigate the extent to which adolescents' academic emotions toward reading/math in the fall semester of Grade 6 mediate the effects of LD on the following: (1) concurrent literacy/math achievement and overall academic achievement in the fall semester of Grade 6, and (2) changes in literacy/math achievement and overall academic achievement from the fall semester of Grade 6 to the spring semester of Grade 6. A schematic model according to Pekrun's control-value theory (Pekrun, 2006, 2017) was formed in line with the control-value theory (Pekrun, 2006; Pekrun et al., 2011). Reading difficulties were expected to relate to poorer literacy achievement and poorer overall academic achievement in the fall and spring semesters of Grade 6 via lower literacy-related hope and enjoyment and higher literacy-related anxiety. A similar ratio was also assumed in the math domain between math difficulties and academic achievement via math-related hope, enjoyment, and anxiety. To answer these research questions, the analyses were run separately for literacy and math domains by using ANCOVAs (general linear model) and path models.

The results in the literacy domain revealed first that the students with RD reported less hope and more anxiety toward literacy than did students without RD. The results also showed that the students' RD was related to lower hope and higher anxiety in literacy. Second, the results showed that RD was also associated

to adolescents' poorer academic achievement, both concurrently and longitudinally. In addition, after controlling for previous achievement, RD was associated with poorer overall achievement and poorer literacy achievement in the spring semester of Grade 6. Third, among the academic emotions examined, hope in literacy was associated with achieving both higher academic achievement and higher literacy achievement in the fall and spring semesters of Grade 6. When considering the indirect effects of students' RD on academic achievement via academic emotions, the results showed that students with RD had a lower level of hope toward literacy, which in turn was related to lower overall academic achievement and literacy achievement in the fall semester of Grade 6.

The results in math domain revealed that the students with MD reported less hope, less enjoyment, and more anxiety toward math than those without MD. The results show, first, that the students' MD was related to lower hope, lower enjoyment, and higher anxiety in math. Second, the results revealed that MD also predicted academic achievement, both concurrently and longitudinally. Math difficulties were associated with poorer math achievement and overall academic achievement in the fall semester of Grade 6. In addition, math difficulties were related to poorer math achievement and lower overall academic achievement in the Spring semester of Grade 6 after controlling for earlier academic achievement. Third, academic emotions were associated concurrently with academic achievement. The higher the hope in math, the higher the math achievement and overall academic achievement of students in the fall semester of Grade 6. Math enjoyment was related to higher math achievement in the fall semester of Grade 6. Furthermore, enjoyment associated to higher math achievement and higher overall academic achievement in the spring semester of Grade 6 after controlling for earlier achievement. Anxiety, in turn, was related to both poorer overall academic achievement and to poorer math achievement in the fall semester of Grade 6.

The results overall, indicated that LD increases students' vulnerability to experiencing more negative and fewer positive emotions toward learning in school subjects in which difficulties were faced. Besides enjoyment and anxiety, which have been well examined as academic emotions in extant research, particularly hope was found to be a significant academic emotion in both the literacy and math domains.

3.2 Study II: Adolescents' academic emotions and academic achievement across the transition to lower secondary school: The role of learning difficulties

Study II focused on the transition from primary to lower secondary school and related changes in adolescents' academic emotions and achievement over four time points from Grade 6 fall to Grade 7 spring. Consequently, the aim was to

examine if adolescents' domain-specific academic emotions (enjoyment, hope, pride, anxiety, anger, shame, hopelessness, and boredom) and achievement in literacy and mathematics change across the transition to lower secondary school. It was expected that the level of students' positive emotions would decrease and that the level of their negative emotions would increase from Grade 6 spring to Grade 7 fall and spring. In addition, academic achievement was assumed to decline temporarily during the transition, that is, from Grade 6 spring to Grade 7 fall.

The second aim was to examine if adolescents' learning difficulties (RD or MD) were associated with the levels and changes of domain-specific academic emotions and academic achievement in literacy and mathematics across the transition. It was hypothesized that students without 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. Furthermore, it was expected that RD/MD groups with different developmental paths of difficulties (resolving, emerging, and persistent) differ from each other in academic emotions and achievement. These research questions were analysed using repeated MANCOVAs (general linear model) for literacy and math domains separately.

In the literacy domain, the results showed that four of the eight emotions (enjoyment, anxiety, hopelessness, and boredom) changed over time as was 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 for all students. However, students without RD reported higher literacy boredom when compared to students with emerging or persistent RD. Furthermore, literacy anxiety and hopelessness decreased during the transition for students with resolving RD and increased for students with emerging RD. In addition, literacy anxiety increased after the transition for students with persistent RD. The results for four literacy-related emotions (hope, pride, anger, and shame) did not show mean-level changes across the transition. When considering literacy achievement, the results showed expectedly that literacy achievement declined from Grade 6 to Grade 7 across all RD groups. However, students without RD continued to have substantially higher literacy achievement than students with RD, despite a general decline in literacy achievement.

In the math domain, the results showed that against the 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. 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. In general, students without MD reported more math-related enjoyment, hope and pride as well as less math-related anxiety, anger, hopelessness, and shame than did students in MD groups. For math

achievement, the results revealed that math achievement declined for students without MD as well as for students with resolving or emerging MD. In addition, against the hypotheses, math achievement increased across time for students with persistent MD. However, students without MD continued to have substantially higher math achievement than students in resolving, late emerging and persistent math difficulty groups.

All in all, the results of Study II revealed that the transition-related negative consequences in academic emotions and achievement were common for all students but specifically for LD students across the transition from primary school to lower secondary school. This study also showed a disparity in academic emotions between the academic domains, which may be due to the differences in literacy and mathematics as school subjects. In addition, the character of RD and MD differ and consequently the typical challenges caused for students' learning are distinct, which in turn may cause different kinds of patterns in subject-specific academic emotions.

3.3 Study III: The role of teacher closeness in emotions and achievement for adolescents with and without learning difficulties

The aim of Study III was to investigate to what extent students' experienced teacher closeness is related to the changes in subject-specific academic emotions and academic achievement during Grade 7. Higher experienced teacher closeness was expected to be associated with increasing positive and decreasing negative academic emotions as well as higher academic achievement separately in literacy and math domains.

Second, Study III aimed to examine if the associations in teacher closeness with subject-specific academic emotions and academic achievement differ between students with RD/MD and students without RD/MD. It was expected that all students would benefit of higher teacher closeness in their academic emotions and achievement. However, higher teacher closeness was expected to be a protective factor specifically for students with LD by forming academic emotions that are more positive and less negative, and by fostering better academic achievement. These research questions were analysed using repeated ANCOVAs (general linear model) for literacy and math domains separately. The effects of gender, students' difficulties in the other academic domain, depressive symptoms and classroom differences were controlled in all the analyses.

Against the hypothesis, the results in the literacy domain showed no time x RD group interactions. However, the main effect of literacy teacher closeness was found, and the results indicate that higher teacher closeness was related to increasing literacy enjoyment, hope, and pride whereas lower literacy teacher closeness was related to increasing literacy anger and boredom during Grade 7. Furthermore, the main effects of RD groups were found in anxiety and boredom.

RD students reported higher literacy anxiety than non-RD students did in the spring semester of Grade 7 after controlling for literacy anxiety in the fall of Grade 7. Non-RD students, in turn, reported higher literacy boredom than RD students did in the spring semester of Grade 7 after controlling for literacy boredom in the fall of Grade 7. Against the hypothesis no main effects of literacy teacher closeness on changes in literacy anxiety, hopelessness, and shame were found nor the main effects of RD groups on literacy enjoyment, hope, pride, anger, hopelessness, or shame were found.

The results in the math domain showed statistically significant MD group x math teacher closeness interaction. Higher teacher closeness was associated with increasing math enjoyment for students without MD but not for students with MD during Grade 7. Furthermore, a main effect of teacher closeness on math hope and pride was found. Reported higher teacher closeness was associated with increasing math hope and math pride during Grade 7. Finally, a main effect of MD group on the changes in math enjoyment was found. Students without MD reported higher math enjoyment than students with MD in the spring semester of Grade 7 after controlling for math enjoyment in the fall of Grade 7. When considering negative math-related emotions, a significant main effect of teacher closeness was found on math anger and boredom. Lower teacher closeness was related to increasing math anger and math boredom during Grade 7. No main effect of MD group on changes in any of the negative math emotions was found.

The results for literacy achievement showed no teacher closeness x RD group interactions. However, experienced higher teacher closeness was related to increasing literacy achievement during Grade 7. A main effect for the RD group on changes in literacy achievement was not found. The results for math achievement showed no statistically significant MD group x math teacher closeness interactions, nor main effects of time or MD.

All in all, the results showed that higher teacher closeness is beneficial for students' positive academic emotions and literacy achievement whereas lower teacher closeness was related to increasing anger and boredom in both academic domains during Grade 7. Against the hypothesis, the patterns of teacher closeness in academic emotions were mostly similar for students with and without LD.

4 DISCUSSION

The aim of this research was to examine the academic emotions and academic achievement of students with and without LD across the transition from primary to lower secondary school. In addition, the role of teacher relationships in students' academic emotions and achievement were investigated. The present research uniquely adds to the previous research by showing that the role of LD in students' academic emotions and achievement is crucial and needs to be taken into account when educational support for learning difficulties is considered. More specifically, Study I examined associations between RD/MD and subject-specific academic emotions, and academic achievement during Grade 6 as well as the mediating role of emotions between LD and achievement. In turn, Study II investigated the stability of learning difficulties (resolving, emerging, or persistent RD/MD) in the development of academic emotions and achievement across the school transition. Finally, Study III examined teacher closeness as a protective factor in academic emotions and achievement among adolescents with and without RD/MD during the first year in lower secondary school, that is, during Grade 7.

4.1 Learning difficulties as a risk factor for adolescents' academic emotions and achievement

The central goal of the present research was to examine the role of RD/MD in students' academic emotions and achievement. The results support the current knowledge of learning difficulties and their negative consequences for students' learning and achievement (Holopainen et al., 2017; Judge & Watson, 2011; Smart et al., 2001). In addition, the present research significantly adds to the current literature on academic emotions (e.g., Ahmed et al., 2013; Goetz et al., 2007; Pekrun, 2017; Pekrun et al., 2011) by focusing on the differences in academic emotions and achievement among students with and without LD. The findings

indicate that, in general, students with LD are more vulnerable to less positive and more negative academic emotions than are their peers without LD.

The results on the role of LD in academic emotions showed that students with LD reported less learning-related hope and more anxiety than did students without LD in both the literacy and math domains during Grade 6, even after controlling for the effects of gender, depressive symptoms, LD in the other school subject domain, and classroom differences. In addition, lower math enjoyment was typical for MD students. The findings in the math domain add significantly to previous research, which has focused mostly on the association between math anxiety and MD (e. g. Maloney et al., 2015; Rubinsten & Tannock, 2010). As a novel finding, the present research showed that besides higher anxiety, lower math enjoyment was also typical among MD students. Furthermore, the findings support earlier findings by indicating that lower hope is typical among students with RD and students with MD (see Lackaye et al., 2006; Rosenstreich et al., 2015). Overall, the findings on LDs' role in academic emotions confirm previous knowledge of LD students' long-term struggles in learning and related experiences of repeated failures both in the literacy and math domains (e.g., Holopainen et al., 2017), and indicate that these struggles predispose students with RD/MD to lower learning-related hope and but higher anxiety, which then impact students' learning and achievement. Lower levels of hope and higher levels of anxiety are known to associate to LD students' typically lower self-esteem as a learner (Lackaye et al., 2006), task avoidance behaviour and failure expectations (Nurmi et al., 2003; Pekrun et al., 2009) as well as increased learning-related worrying (Pekrun et al., 2011; Suaréz-Pellicioni et al., 2016). The results concerning enjoyment showed a difference between the literacy and math domains, as lower enjoyment was typical with MD but not RD, which may indicate that persistent difficulties and requirements to adopt new mathematical concepts continuously in math studies (Andersson, 2010; Mazzocco et al., 2013) prevents the joy of learning and decreases the interest and motivation in math studies.

When considering the results on school achievement, Study I was particularly interested in the role of academic emotions in LD students' achievement. The results showed that during Grade 6, RD was related to poorer literacy achievement and poorer overall achievement through lower literacy hope, whereas MD was related to poorer math achievement and poorer overall achievement through lower math enjoyment and lower math hope. The findings on indirect relations between LD and achievement through lower positive academic emotions are novel and add substantially to previous knowledge on LD students' achievement. It is known that achievement among students with LD is typically lower when compared to students without LD due to deficits in skills and related continuous struggles in learning (e.g., Andersson, 2010; Kuhn, 2015; Smart et al., 2001). The present findings indicate that not only skills training but also support for coping with maladaptive academic emotions is needed to aid students with LD in their learning-related struggles. It is also notable that specifically lower hope was found to be a central academic emotion in

achievement. Previously, it has been shown that lower hope is related to lower academic self-efficacy (Lackaye et al., 2006). Lower hope and enjoyment also typically relate to lower perceived control over studies and lower subjective importance for learning, which is then associated with ineffective learning strategies (Pekrun, 2006; Pekrun et al., 2011, see also Orly & Margalit, 2014). Thus, having LD and related lower levels of hope and enjoyment may lead to detrimental cumulative cycles between less adaptive academic emotions and related behavior, skill development and achievement.

4.2 School transition as a context of changing academic emotions and achievement

One of the aims of this research (Study II) was to examine the possible changes in adolescents' academic emotions and achievement across the transition from primary school to lower secondary school. The results of Study II support earlier findings by showing that academic achievement typically decreases across the transition (e.g., Anderson et al., 2000; Ryan et al., 2013). Furthermore, the findings on the changes in academic emotions are in line with earlier research on decreasing motivation and overall wellbeing during the school transition (e. g. Eccles & Roeser, 2011; Rice et al., 2011; Zeedyk et al., 2003; West et al., 2010). Thus, the results on increasing negative and decreasing positive academic emotions confirm the earlier findings which suggest that multiple negative changes are common across school transition. In addition, the novel finding of Study II was that academic emotions showed partly changes and partly constant patterns across the transition. Furthermore, students with LD were found to be particularly prone to more negative and fewer positive academic emotions and have substantially lower achievement across the transition when compared to students without LD, which contributes to the theories on at-risk students' poorer transitions (Anderson et al, 2000; West et al., 2010).

The results in the literacy domain showed changes in literacy enjoyment, anxiety, hopelessness, and boredom across the transition. Decreasing literacy enjoyment and increasing boredom were typical for students in general, whereas literacy anxiety and hopelessness were related to RD. It is known that academic emotions are associated to the value a student gives to learning and achievement, as well as to the sense of control over one's studies (e. g. Ahmed et al., 2013; Pekrun et al., 2011). Decreasing literacy enjoyment and increasing literacy boredom may indicate that students have challenges to keep up their interest and motivation, and that they are insecure about their abilities in literary studies after the transition. However, it should be also noted that literacy 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.

The results on math-related emotions showed no changes across the transition, and thus showed constant patterns. More negative and fewer positive emotions were typical for students with MD which is likely to associate to MD students' repeated failures and lower self-efficacy beliefs in math domain (Ahmed et al., 2013; Suaréz-Pellicioni et al., 2016). The differences between literacy- and math-related emotions may be explained through differences between literacy and mathematics as school subjects. Distinct development and the consequences of RD and MD (Judge & Watson, 2011; Landerl et al., 2009; Torppa et al., 2015; Willcutt et al., 2013), as well as the domain specificity of academic emotions (Goetz et al., 2007) may be in the background of different patterns in literacy- and math-related emotions. As math difficulties are typically long lasting, it is possible that math-related emotions form early on rather constantly (see e.g., Maloney et al., 2015; Suaréz-Pellicioni et al., 2016). Furthermore, math skills are built in a cumulative manner, which is why students with MD may have a lack of skills or very poor skills in a certain area of mathematics, which then hinders learning in upper classes (Andersson, 2010; Aunola et al., 2004; Mazzocco et al., 2013). However, further research is needed to fully understand why the patterns of academic emotions differ between the literacy and math domains.

When considering the findings on academic achievement, this research showed that both literacy and math achievement decreased in general across the transition. Thus, this research confirms previous findings by indicating that students in general face challenges in keeping up their former achievement during the transition (see e.g., Anderson et al., 2000; Coelho et al., 2017; Ryan et al., 2013; West et al., 2010). It seems that all students need to adapt to a new learning environment and its demands, which may explain decreasing achievement. Negative changes in achievement, together with decreasing enjoyment and increasing boredom in the literacy domain, form a situation where it is assumed positive competence beliefs and motivation in learning are difficult to maintain, which in turn may cause maladaptive behavior in learning situations (Eccles & Roeser, 2011; Pekrun et al., 2006; Pekrun et al., 2014). In addition, the results showed that students with RD or MD continued having substantially lower achievement, as well as more negative and fewer positive academic emotions than their peers did. This research is in line with previous studies, which have assumed that students with LD commonly suffer from low-quality transitions due to their struggles in learning and the related negative consequences for motivation and achievement (Anderson et al., 2000; West et al., 2010).

4.3 Different trajectories in learning difficulties across the transition to lower secondary school

One of the central aims of this research was to investigate the changes in academic emotions and achievement across the transition to lower secondary school. In Study II, LD students' developmental paths were defined, and RD and MD groups of resolving, emerging and persistent difficulties were formed (e.g., Catts et al., 2012; Torppa et al., 2015). The results of the present research revealed that different LD groups were clearly visible, and distinct pathways in LD students' academic emotions and achievement can be identified across the school transition. This research indicates that students with LD are not a uniform group but that variance in both RD and MD can be found even in adolescence (see also Torppa et al., 2015). It is pivotal to identify resolving, emerging and persistent difficulties in order to grant appropriate and timely support for LD students' learning and academic emotions during the transition. It is also important to note that general negative trends in achievement and emotions may complicate identifying specifically those students with emerging difficulties. Due to multiple environmental and individual changes, there is an elevated risk for negative pathways in learning for all students, but specifically for those whose learning difficulties have not yet been detected.

The results revealed that in the literacy domain, anxiety and hopelessness changed across time in RD groups: literacy anxiety and hopelessness decreased for students with resolving RD and increased for students with emerging RD during the transition. Both anxiety and hopelessness are known to relate to expected academic success or failure (Pekrun, 2006; Pekrun et al., 2011). It is worth noting that changes in these negative emotions are closely associated with the character of students' RD. An increase in negative emotions among students with emerging difficulties should be noted in particular, as these students commonly have fairly conventional history in learning and only newly faced problems (see also Torppa et al., 2015). Thus, it is crucial that specifically students with emerging RD are identified early enough to reduce detrimental circles between negative emotions and learning difficulties. Furthermore, the results showed that literacy anxiety increased after the transition for students with persistent RD. Anxiety is typically related to increased worrying which assumable relates to these students' continuous struggles in literacy studies and facing higher learning and achievement related demands of lower secondary school (e. g. Anderson et al., 2000; Hakkarainen et al., 2013). In addition, higher levels of literacy boredom were reported particularly by students without RD, which may indicate that literacy studies in lower secondary school do not offer sufficient cognitive challenges for students who perform well.

Meanwhile, the results concerning math-related emotions showed that, in the math domain, constant patterns across the transition were typical, and all emotions, except boredom, were related to developmental groups of MD. Among students with emerging math difficulties, reports on less math-related

enjoyment, hope, and pride and more math-related anger, anxiety, shame, and hopelessness were typical when compared to students without MD. Among students with persistent MD, less math enjoyment, hope, and pride along with more math-related shame and hopelessness were common. The variety of MD-related less positive and more negative emotions add substantially to the results in math anxiety research (e.g., Suárez-Pellicioni et al., 2016) by showing that not only anxiety, but also other negative emotions associate with MD. When considering the results of the stability of math-related emotions, the results of the present study add to the rather contradictory findings of previous research (see e.g., Goetz et al., 2007; Raccanello et al., 2013). The present study reaffirms the assumption that math-related emotions tend to be stable across time, just as math difficulties are.

The results concerning academic achievement showed that both students with RD and students with MD continued to have substantially lower achievement than their non-LD peers in general. However, also differences between RD/MD groups were found. In literacy domain, students without RD had significantly higher achievement than students with emerging or persistent RD, which was presumable. In math domain, math achievement decreased for students without MD, students with resolving MD and students with emerging MD. However, for students with persistent MD, math achievement increased across the transition. This finding was against the hypothesis and calls for further investigation of the mechanisms that could explain why achievement among the persistent MD group increases while in all the other MD and RD groups achievement declines. It may be due to new teachers whose knowledge of students' skills is incomplete and thus the evaluation of the skills may be more favourable in the case of persistent MD. Another explanation could be that in persistent difficulties, students' needs for special education have been identified in the transitional period and they have received enough support to be able to increase their achievement, yet they continue to lag behind their peers without MD. However, it is notable that the results revealed that despite increasing math achievement, students with persistent MD still continued to report generally more negative and fewer positive academic emotions than did students without MD, a likely indicator that they continue to struggle with math studies (Suárez-Pellicioni et al., 2016).

4.4 Teacher closeness as a protective factor in adolescents' learning

This research also examined the role of teacher closeness in academic emotions and achievement among students with and without LD during Grade 7. The results of Study III revealed that in both literacy and math domains, warm and close teacher relationships were related to increasing positive academic emotions, whereas lower teacher closeness was associated with learning-related anger and

boredom. This result supports earlier findings on student–teacher relationships' significance in students' academic emotions (Goetz et al., 2021; Lei et al., 2018; Mainhard et al., 2018, see also Martin & Dowson, 2009). The pattern of teacher closeness in academic emotions and achievement was mostly common for all students. The results indicate that both students with and without LD benefit from close and supportive teacher relationships in their academic emotions and literacy achievement during the first year in lower secondary school. This finding is crucial as after the school transition students commonly need to build several new school-related relationships. Thus, close and supportive teacher relationships may in part fulfil students' need for social relatedness as well as support students' emotional security and need for belonging at school (Bergin & Bergin, 2009; Martin & Dowson, 2009, see also Deci & Ryan 2000), which can be specifically important after the critical school transition. Furthermore, when supporting students' socio-emotional wellbeing, high-quality teacher relationships can benefit students' learning in several ways, such as via promoting positive self-perceptions of one's abilities, approving the experience of control over one's learning and learning-related emotion regulation, as well as advance the use of flexible learning strategies (Goetz et al., 2021; Pekrun et al., 2011; Verschueren et al., 2012; Zee & de Bree, 2018).

In addition, the findings concerning distant teacher relationships showed an opposite pattern: a lack of closeness associated with increasing learning-related anger and boredom which, in turn, are likely to predispose students to negative spirals in learning by decreasing self-regulation in learning situations as well as increasing avoidance behaviours and failure expectations (Goetz et al., 2021; Nurmi et al., 2003; Pekrun et al., 2011). However, teacher closeness was not associated with learning-related anxiety, shame, or hopelessness in either academic domain during Grade 7. Future research should investigate whether these intensive negative emotions relate to the negative aspect of teacher relationships, which is usually conceptualized as teacher conflict (see e.g., Hamre & Pianta, 2001; McGrath & van Bergen, 2015).

When considering the differences between students with and without LD in the associations between teacher closeness and academic emotions and achievement, the results were surprising and against the hypothesis of Study III. Based on the academic risk perspective (e.g., Al-Yagon, 2012; Bosman et al., 2018; Murray & Greenberg, 2006; Sabol & Pianta, 2012; Spilt et al., 2012) it was presupposed that students with LD would benefit from teacher closeness in their learning-related emotions even more than students without LD do. However, the present study showed that teacher closeness acts as a protective factor for both students with LD and those without LD in their literacy- and math-related academic emotions. In addition, in math domain, teacher closeness was found to be a moderating factor in math enjoyment (i.e., one out of eight investigated emotions). Only the pattern of the effect of the math teacher's emotional support differed from what was expected: teacher closeness was found to be a protective factor specifically for students without MD but not for students with MD. In addition, students without MD reported higher levels of teacher closeness than

students with MD. Thus, it is likely that for those students without MD who have fairly good math skills and higher math enjoyment, it is easier to build high-quality teacher relationships which in turn promote positive emotions (Buff, 2014; Goetz et al., 2021; Pekrun, 2017). Students with MD, in turn, commonly suffer from rather long-lasting difficulties and continual lower math enjoyment, which may prevent them from benefitting from math teacher closeness in their math enjoyment (see also Al-Yagon, 2012).

The general trend in achievement was a declining one across the transition (Study II). In Study III, the relatedness of teacher relationships to changes in literacy/math achievement during Grade 7 were investigated. The results showed that literacy teacher closeness was related to increasing literacy achievement during Grade 7, whereas in the math domain math teacher closeness had no effects on math achievement. The findings were partly in line with previous research which has shown diverse results for associations of teacher relationships and achievement (see e.g., Ahmed et al., 2010; Hajovsky, Mason, & McCune, 2017; Hughes & Cao, 2018; Hamre & Pianta 2001; Spilt et al., 2012; Zee & de Bree, 2018). Differences between literacy and math domains concerning achievement may result from students' tendency to typically form distinct teacher relationships in different school subjects (Roorda et al., 2019). However, it seems that more exact knowledge on the role of teacher closeness and its effects on adolescents' school performance in different school subject domains is needed.

All in all, this research showed that both students with and without LD equally benefit from high-quality teacher relationships in their academic emotions and in literacy achievement during Grade 7. This finding indicates that besides support for individuals, also school-wide perspective is needed when planning adaptation programmes for students at the beginning of Grade 7. Furthermore, importance of high-quality teacher relationships should be considered, when reforming school environments to be more suitable for adolescents' basic need for belonging (see e.g., Deci & Ryan, 2000; Bronfenbrenner & Morris, 2006).

4.5 Limitations and future directions

The reader should be aware of the limitations of the present research. First, although the results partly supported the hypothesis, the effect sizes were rather small, though statistically significant, throughout this research. However, it should be noted that in all analyses the effects of the covariates were controlled for, that is, gender, depressive symptoms, LD in the other school subject domain, and classroom differences in all the original studies. Additionally, in Study II, the timing of puberty was also included as a covariate. Furthermore, the earlier levels of academic emotions and achievement were controlled for, which assumably partly reduce the effect sizes. The relatively small effect sizes may be due to multiple factors besides academic emotions that influence LD and non-LD

students' learning and achievement. For example, it remains a future challenge to examine empirically what the specific behavioural processes are (e.g., effort, task-focused behaviour, and self-regulation) that relate to adolescents' LD and thus modify academic emotions.

Second, when considering the identification of the students with RD or MD (Studies I–III), it should be noted that learning difficulties were measured by using group testing and, therefore, employing a rather lenient cut off (being in the 16th percentile, at least −1 SD below the age mean; see also Landerl et al., 2009; Snowling et al., 2003; Wise et al., 2008). The results may not, therefore, be generalized to students with more severe diagnosed reading or math disabilities. It should be further noted that the tests chosen in this research assessed fluency in reading and math skills. Thus, the results may not be generalized to students whose reading or math difficulties are of different kind (such as difficulties in reading comprehension in literacy or difficulties in geometry in math domain) than those manifesting as problems in fluency. However, it is worth noting that previous research has shown that fluency is the main characteristic of reading disability in transparent orthographies (e.g., Landerl & Wimmer, 2008; Share, 2008) as well as math disabilities (Aunola et al., 2004; Koponen et al., 2016).

Furthermore, in Study II, the RD and MD groups were further divided into resolving, emerging and persistent RD/MD. Although these groups were clearly identifiable, the sizes of RD and MD groups were rather small, which is expected in community samples due to the low prevalence of RD and MD. However, with a larger number of participants in each group, the pattern of results could have been clearer. In addition, the comorbidity of MD and RD was considered by controlling for students' difficulties in the other academic subject as the comorbidity of RD and MD is rather common. Future research should further examine academic emotions among students with comorbid learning difficulties and also among students with severe diagnosed learning disabilities. In addition, a future challenge for research could be to examine both domain specificity and cross-domain effects of LD in academic emotions in the same study. Thus, to find out whether RD related negative emotions could also modify math-related emotions although difficulties in math domain are not faced.

Third, in all the studies, the academic emotions were measured using the adolescents' self-reports (for the validity of AEQ, see Pekrun et al., 2011). More knowledge on academic emotions could be gained by examining also facial expressions or physiological responses in learning and achievement situations (see also Kiuru et al., 2021; Lehikoinen et al., 2019; Pekrun, 2006). Furthermore, academic emotions were examined as trait emotions over the school semester, that is, emotions that students experience fairly constantly toward literacy or mathematics. It is likely, however, 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). More research is needed to better understand both state and trait aspects of academic emotions and related dynamics. In addition, it should 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.

Fourth, the timeline in all the studies was rather short. The study design in Studies I and III comprised only two time points, and despite the cross-lagged design, Studies I and III were correlational, which inhibits confident assertions on causality. In turn, in Study II, LDs, academic emotions and achievement were investigated across four time points. The results of Study II revealed that some literacy-related emotions changed over time and others showed a constant pattern over time whereas in the math domain emotions did not change over time. This may indicate that some emotions are dependent on changes in the learning environment while others reflect the students' more permanent ways of reacting to learning outcomes. However, a longer timeline is needed to explain more exactly why some emotions change over time and others show a constant pattern over time. In the future, it could be beneficial to investigate the changes in academic emotions in a longitudinal setting of several years across two educational transitions. The follow-up phase of STAIRWAY study offers a possibility to further examine the associations between LDs and academic emotions across the transition from lower secondary school to higher secondary education. This could provide important information for the extension of compulsory education in Finland which has been recently carried out.

Finally, in Study III student–teacher relationships were defined as teacher closeness. However, student-teacher relations can also be conceptualized as teacher conflict, which describes negative aspects in student–teacher relations (e. g., Hamre & Pianta, 2001; McGrath & van Bergen, 2015). Study III showed that lower levels of teacher closeness were related to increasing anger and boredom, but there were no associations with other negative academic emotions. It remains for future research to investigate if considering teacher relationships from the perspective of teacher conflict would reveal connections with other negative emotions as well. Furthermore, the knowledge of experienced teacher closeness was gathered from the students' self-reports. However, it would be good to combine reports by students and teachers on teacher closeness to find out how uniform these reports are and whether combined reports reveal more about the interpersonal nature of teacher relationships.

4.6 Practical implications

The results of the present research indicate that association between maladaptive academic emotions and students' LD should be considered when efforts are made to aid students with LD in coping with the transition to lower secondary school. It is essential that students with LD meet with positive learning experiences and would receive support for both effective learning strategies and positive self-efficacy beliefs. Received support could help students maintain hopeful thinking in learning and achievement situations (Lackaye et al., 2006; Pekrun et al., 2011) as well as enhance enjoyment of learning (Buff, 2014; Pekrun

et al., 2014). This could actualize when participating in literacy/math classes via a literacy/math teacher, as well as via special educational support. Attention should also be paid to the proper timing of special educational support for students who struggle with their studies. Specifically, identifying risk factors for students with emerging RD/MD during the transition is fundamental. In addition, the MD students' typically more constant negative math-related emotions should be paid attention for, in order to understand that not only practising the compromised skills but also support for coping with math-related emotions is crucial.

Furthermore, the results of this research indicate that it is crucial to recognize the negative consequences of decreasing achievement and changes in academic emotions that are commonly related to the transition to lower secondary school, as well as to pay attention to the learning environments in lower secondary school (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.

When considering teacher closeness, the findings indicate that close and warm teacher relationships are beneficial for students' positive academic emotions in the literacy and math domains, and for literacy achievement during the first year of lower secondary school. Thus, teacher relationships seem to have a crucial role in the development of adolescents' academic emotions during the seventh grade. Student–teacher relationships and related academic emotions can thus form positive spirals, which promote learning, or negative spirals, which hinder learning (Goetz et al., 2021; Mainhard et al., 2018; Pekrun 2006; Roorda et al., 2017). Increasing knowledge on the associations between academic emotions and teacher relations in adolescents' learning contexts could help lower secondary schools to build learning environments where attention is paid to constructing high-quality student–teacher relationships which ensure a sufficient amount of emotional support and a sense of relatedness for adolescents, thereby promoting more adaptive academic emotions (Martin & Dowson, 2009).

4.7 Concluding remarks

All in all, the findings of this research showed that negative changes in academic emotions and achievement were common for all students but specifically for students with LD across the transition from primary to lower secondary school. The present research contributes to previous findings by demonstrating that subject-specific academic emotions are an essential aspect to consider when examining students' LD and its consequences for academic achievement in

adolescence. The findings suggest that LDs increase students' vulnerability to experiencing more negative emotions and fewer positive ones toward learning in school subjects in which difficulties were faced. Furthermore, both students with and without LDs were found to benefit from high-quality teacher relationships in their academic emotions and in literacy achievement during the first year of lower secondary school. Thus, experienced teacher closeness is likely to offer a sense of social relatedness which promotes students' better emotional and motivational adjustment in the new school environment. This indicates that also broader, school-wide approach is needed when developing lower secondary schools' learning environments. Finally, this research revealed a disparity in academic emotions between academic domains, which may be due to the differences in literacy and mathematics as school subjects and thus, the distinct features of RD and MD. LDs combined with maladaptive academic emotions may have detrimental effects not only on students' short-term learning outcomes but also throughout their later educational tracks, and even into their working lives. For these reasons, it is necessary to pay attention to the role of academic emotions in LDs.

YHTEENVETO (SUMMARY)

Oppimisvaikeuksien merkitys oppimiseen liittyvissä tunteissa ja koulusuoriutumisessa siirtymässä alakoulusta yläkouluun

Oppimisvaikeuksien tiedetään vaikeuttavan oppimista ja heikentävän oppimistuloksia varhaisista kouluvuosista asti aina yläkouluun saakka (Smart et al., 2001). Nuoruusikään mennessä niille, joilla on oppimisvaikeuksia on tavallisesti ehtinyt kertyä oppimisvaikeuksiin liittyvää painolastia, joka tulee esiin heikompana koulusuoriutumisena (esim., Hakkarainen ym., 2015), vähäisempänä motivaationa sekä kielteisempinä oppimiseen liittyvinä tunteina (Lackaye ym., 2006; Rosenstreich ym., 2015). Oppimisvaikeudet ovat myös riskitekijä jopa mielenterveyspulmille (Aro ym., 2019; Lindén-Boström & Persson, 2015) ja koulupudokkuudelle (Hakkarainen ym., 2015). Tässä tutkimuksessa tarkasteltiin oppimisvaikeuksina lukivaikeutta ja laskemisvaikeutta, koska ne tulevat esiin keskeisissä oppiaineissa, äidinkielessä ja matematiikassa, minkä lisäksi ne haittaavat oppimista usein myös muissa oppiaineissa.

Oppimiseen liittyvien tunteiden osalta taustateoriana tässä tutkimuksessa viitataan Pekrunin (2006, 2017) kontrolli-arvoteoriaan (Control-value theory of achievement emotions). Pekrunin mukaan oppilaat kokevat säännönmukaisesti oppimiseen liittyviä myönteisiä (oppimisen ilo, toiveikkuus, ylpeys) ja kielteisiä tunteita (ahdistuneisuus, vihaisuus, toivottomuus, häpeä ja tylsistyminen) oppimis- ja suoriutumistilanteissa. Oppimiseen liittyvät tunteet voivat joko edistää tai vaikeuttaa oppimista. Tavallisesti myönteisten oppimiseen liittyvien tunteiden on katsottu liittyvän parempaan suoriutumiseen, kun taas kielteisillä tunteilla on ajateltu olevan kielteisiä seuraamuksia suoriutumiselle, vaikkakin myös muunlaiset yhteydet ovat mahdollisia (Pekrun ym., 2011). Vaikka oppimiseen liittyä tunteita on tutkittu melko laajasti, niin tutkimuksessa ei ole aiemmin kiinnitetty huomiota juuri lainkaan oppimisvaikeuksien merkitykseen oppimiseen liittyvissä tunteissa.

Oppimisvaikeuksia ja oppimiseen liittyviä tunteita tarkasteltiin alakoulusta yläkouluun siirtymän vaiheessa, joka on merkittävä muutosvaihe peruskoulun oppilaille. Yläkouluun siirtyminen merkitsee usein koulun vaihtumista, siirtymistä luokanopettajajärjestelmästä aineenopettajajärjestelmään sekä luokkatovereiden ainakin osittaista vaihtumista. Lisäksi yläkoulussa oppilaiden odotetaan ottavan enemmän vastuuta oppimisestaan ja kouluasioidensa hoitamisesta (esim. West ym., 2010). Siirtymän yläkouluun tiedetään olevan kriittinen vaihe varhaisnuorten koulumotivaatiolle, hyvinvoinnille ja koulusuoriutumiselle, joissa kaikissa tapahtuu tyypillisesti kielteisiä muutoksia tämän koulutussiirtymän aikana (Coelho ym., 2017). On esitetty, että kielteiset muutokset eivät olisi niinkään seurausta itse siirtymästä, vaan siitä, että varhaisnuorten kehitykselliset tarpeet eivät tule kohdatuiksi yläkoulun oppimisympäristössä (Eccles & Roeser, 2011). Oppimisvaikeusoppilaille siirtymä on tavallisesti stressaavampi kuin muille oppilaille johtuen heikommasta matematiikan ja lukemisen taitotasosta (Eklund ym., 2015;

Geary ym., 2012; Landerl & Wimmer, 2008) ja siihen liittyvästä oppimisen työläydestä sekä oppimiseen liittyvän vaatimustason noususta (Anderson ym., 2000; West ym., 2010).

Uuteen kouluympäristöön sopeutumisessa sosiaalisilla suhteilla on tärkeä merkitys. Aiemmassa tutkimuksessa on havaittu, että opettajasuhteen läheisyys voi tukea myös yläkouluikäistä oppilasta koulutussiirtymään liittyvässä muutosvaiheessa (Hamre & Pianta, 2001; McGrath & van Bergen, 2015; Sabol & Pianta, 2012). Läheinen ja tukea antava opettaja-oppilassuhde on liitetty myös parempaan kouluun sitoutumiseen (Roorda ym., 2017) ja parempaan koulusuoriutumiseen (Frenzel ym., 2018; Roorda ym., 2011). Lisäksi on esitetty, että oppilaat, joilla on riskitekijöitä, kuten oppimisvaikeuksia, voisivat erityisesti hyötyä läheisestä opettajasuhteesta (Al-Yagon, 2012; Hamre & Pianta, 2001; McGrath, & van Bergen, 2015; Sabol & Pianta, 2012; Spilt ym., 2012). Opettajaläheisyyden ja oppimiseen liittyvien tunteiden välisiä yhteyksiä ei kuitenkaan ole juurikaan tutkittu oppimisvaikeuksien näkökulmasta.

Tässä tutkimuksessa tarkasteltiin oppimisvaikeuksien, oppimiseen liittyvien tunteiden ja koulusuoriutumisen välisiä yhteyksiä sekä opettaja-oppilassuhteen merkitystä oppimiseen liittyvissä tunteissa ja koulusuoriutumisessa. Lukemisen ja matematiikan oppimisvaikeuksien määrittely perustui lukemis- ja laskemistaitoja mittaaviin testeihin, jotka toteutettiin 6. luokan syyslukukaudella ja 7. luokan kevätlukukaudella. Lisäksi oppilaat täyttivät lomakekyselyn koskien äidinkielen ja matematiikan opiskeluun liittyviä tunteita (6. luokan syksy ja kevät sekä 7. luokan syksy ja kevät) ja koettua opettajaläheisyyttä (7. luokan kevät). Tiedot oppilaiden matematiikan ja äidinkielen arvosanoista sekä keskiarvosta kerättiin oppilaiden itsensä raportoimista arvosanoista ensimmäisessä osatutkimuksessa, kun taas kahdessa muussa osatutkimuksessa hyödynnettiin koulujen rekisteritietoja todistusarvosanoista.

Ensimmäisessä osatutkimuksessa tutkittiin oppimisvaikeuksien, oppimiseen liittyvien tunteiden (oppimisen ilo, toiveikkuus ja ahdistuneisuus) ja koulusuoriutumisen välisiä yhteyksiä 6. vuosiluokan aikana. Lisäksi oppimiseen liittyviä tunteita tarkasteltiin oppimisvaikeuksien ja koulusuoriutumisen välittävinä tekijöinä. Tutkimuksen oletuksena oli, että oppimisvaikeusnuorilla on enemmän kielteisiä ja vähemmän myönteisiä oppimiseen liittyviä tunteita. Oppimisvaikeuksien oletettiin myös heikentävän koulusuoriutumista oppimiseen liittyvien tunteiden välityksellä. Tulokset osoittivat, että oppilaat, joilla oli oppimisvaikeuksia (joko lukivaikeus tai laskemisvaikeus) kuudennella luokalla, kokivat vähemmän toiveikkuutta ja enemmän ahdistuneisuutta siinä oppiaineessa, jossa vaikeuksia oli. Lisäksi oppimisen ilo oli vähäisempää matematiikassa niillä oppilailla, joilla oli oppimisvaikeuksia matematiikassa verrattuna oppilaisiin, joilla vaikeuksia ei ollut. Tulokset osoittivat myös, että matalampi toiveikkuus oli välittävä tekijä oppimisvaikeuksien ja koulusuoriutumisen välillä sekä äidinkielen että matematiikan osa-alueilla ts. vähäisempi toiveikkuus osittain heikensi suoriutumista kuudennella luokalla siinä oppiaineessa, jossa oppimisvaikeuksia oli. Tämän lisäksi vähäisempi oppimisen ilo heikensi matematiikassa suoriutumista

niillä oppilailla, joilla oli laskemisvaikeuksia. Kaiken kaikkiaan ensimmäisen osatutkimuksen tulokset viittaavat siihen, että oppimisvaikeusnuoret kokevat enemmän kielteisiä ja vähemmän myönteisiä oppimiseen liittyviä tunteita kuin ne, joilla oppimisvaikeuksia ei ole. Nämä oppimiseen liittyvät tunteet ovat oppiainekohtaisia. Erityisesti toiveikkuudella näytti olevan tärkeä rooli oppimisvaikeusnuorten kohdalla, sillä vähäisempi toiveikkuus näytti osittain liittyvän heikompaan koulusuoriutumiseen.

Toisessa osatutkimuksessa tarkasteltiin oppimisvaikeuksia, oppimiseen liittyviä tunteita ja koulusuoriutumista alakoulusta yläkouluun siirtymän yli ts. kuudennen luokan syksystä seitsemännen luokan kevääseen. Oppilaat, joilla oli oppimisvaikeuksia joko lukemisessa tai laskemisessa, jaettiin kolmeen ryhmään: väistyvät oppimisvaikeudet (oppimisvaikeuksia 6. luokalla, mutta ei enää 7. luokalla), myöhemmin ilmenevät oppimisvaikeudet (oppimisvaikeuksia 7. luokalla, mutta ei 6. luokalla) sekä pysyvät oppimisvaikeudet (oppimisvaikeuksia sekä 6. että 7. luokalla). Oppilaat arvioivat oppimiseen liittyviä tunteitaan (oppimisen ilo, toiveikkuus, ylpeys, ahdistuneisuus, vihaisuus, toivottomuus, häpeä ja tylsistyminen) kyselylomakkeen avulla. Tutkimuksen tulokset osoittivat, että myönteiset oppimiseen liittyvät tunteet vähenivät ja koulusuoriutuminen heikkeni, kun taas kielteiset oppimiseen liittyvät tunteet lisääntyivät kuudennelta luokalta seitsemännelle luokalle. Oppiaineiden välillä oli eroja oppimiseen liittyvissä tunteissa: äidinkieleen liittyvissä tunteissa tapahtui muutoksia siirtymän yli ja osa näistä muutoksista oli riippuvaisia siitä, mihin oppimisvaikeusryhmään oppilas kuului. Äidinkielen osa-alueella oppimisen ilo väheni ja tylsistyminen lisääntyi yleisesti kaikilla oppilailla siirtymän yli. Tylsistyminen oli siirtymän jälkeen tyypillistä niille, joilla ei ollut lukivaikeutta. Ahdistuneisuus ja toivottomuus vähenivät oppilailla, joiden lukivaikeus oli väistymässä ja lisääntyi niillä oppilailla, joiden lukivaikeus tuli esiin 7. luokalla. Lisäksi oppilailla, joiden lukivaikeus oli pysyvää 6. luokalta 7. luokalle, kokivat enemmän ahdistuneisuutta kuin oppilaat, joilla lukivaikeutta ei ollut. Matematiikkaan liittyvät tunteet olivat tyypillisesti pysyvämpiä luonteeltaan kuin äidinkieleen liittyvät tunteet, mutta matematiikan osa-alueella laskemisvaikeuksia omaavat oppilaat raportoivat keskimäärin enemmän kielteisiä ja vähemmän myönteisiä matematiikkaan liittyviä tunteita kuin oppilaat, joilla ei ollut laskemisvaikeuksia.

Kolmannessa osatutkimuksen tarkasteltiin opettajaläheisyyden yhteyttä oppimiseen liittyviin tunteisiin ja koulusuoriutumiseen yläkouluun siirtymisen jälkeen, 7. luokan aikana. Tutkimuksen oletuksena oli, että kaikki oppilaat hyötyvät läheisestä ja tukea antavasta opettajasuhteesta oppimiseen liittyvien tunteiden säätelyssä, mutta erityisen hyödyllistä tämä olisi niille, joilla on oppimisvaikeuksia. Siten opettajan läheisyyden oletettiin olevan suojaava tekijä oppimiseen liittyvissä tunteissa ja koulusuoriutumisessa. Tulosten mukaan korkeampi opettajaläheisyys oli yleisellä tasolla yhteydessä lisääntyviin myönteisiin oppimiseen liittyviin tunteisiin seitsemännellä luokalla. Matalampi opettajaläheisyys oli puolestaan yhteydessä lisääntyvään vihaisuuteen ja tylsistymiseen sekä äidinkielen että matematiikan osa-alueilla. Tulokset olivat pääosin yhteneväisiä, kun verrataan oppilaita, joilla oli oppimisvaikeuksia ja niitä, joilla oppimisvaikeuksia ei

ollut ts. kaikki oppilaat hyötyivät läheisestä ja tukea antavasta opettajasuhteesta seitsemännellä luokalla.

Kaiken kaikkiaan tutkimuksen tulokset osoittivat, että oppimisvaikeuksien ja oppimiseen liittyvien tunteiden väliset yhteydet olisi otettava aiempaa paremmin huomioon, kun suunnitellaan siirtymävaiheen tukitoimia oppilaille, joilla on oppimisvaikeuksia. Kielteiset oppimiseen liittyvät tunteet olivat tämän tutkimuksen mukaan yhteydessä oppimisvaikeuksiin, ja osittain jopa vaikuttivat oppimisvaikeusnuorten oppimistuloksiin. Lisäksi oppimisvaikeusnuorilla oli vähemmän myönteisiä oppimiseen liittyvä tunteita verrattuna oppilaisiin, joilla oppimisvaikeuksia ei ollut. Oppimiseen liittyvät tunteet esiintyivät selkeästi oppiaineittain ja tämän tutkimuksen tulosten valossa näyttää siltä, että matematiikkaan liittyvät tunteet olivat pysyvämpiä kuin äidinkieleen liittyvät tunteet. Lisäksi yläkoulussa olisi tärkeää kiinnittää huomiota opettaja-oppilassuhteen laatuun: kaikki oppilaat hyötyivät läheiseksi koetusta opettajasuhteesta oppimiseen liittyvissä tunteissaan ts. läheiseksi koettu ja tukea antava opettajasuhde voi tukea oppilaiden myönteisiä oppimiseen liittyviä tunteita, kun taas huonompilaatuinen opettaja-oppilassuhde näyttää liittyvän kielteisiin oppimiseen liittyviin tunteisiin. Tulos viittaa siihen, että yksilöllisen tuen lisäksi yläkouluun siirtymässä olisi tärkeää hyödyntää myös koko kouluyhteisöön kohdentuvia tuen muotoja, jotka luovat edellytyksiä laadukkaiden vuorovaikutussuhteiden syntyyn kouluyhteisössä.

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ORIGINAL PAPERS

I

THE ROLE OF LEARNING DIFFICULTIES IN ADOLESCENTS' ACADEMIC EMOTIONS AND ACADEMIC ACHIEVEMENT

by

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The Role of Learning Difficulties in Adolescents' Academic Emotions and Academic Achievement

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Abstract

The present study examines associations between learning difficulties (LD), academic emotions, and academic achievement among 845 Grade 6 adolescents (455 girls, 390 boys). Reading difficulties (RD) and math difficulties (MD) were identified based on tested reading and math skills in the fall semester of Grade 6. At this time, the students also rated their hope, enjoyment, and anxiety regarding literacy and math. Information on students' achievement in literacy and math, as well as their overall academic achievement, was gathered using questionnaires in both the fall and spring semesters of Grade 6. The results show, first, that students with RD had lower hope and higher anxiety toward reading than those without RD. Also, students with MD reported lower enjoyment, lower hope, and higher anxiety than those without MD. Furthermore, the results show that hope partly played a mediating role between LD and academic achievement in both the literacy and math domains. In addition, enjoyment played a mediating role in the math domain. The present study's results indicate that subject-specific academic emotions should be taken into account when considering relations between LD and academic achievement.

Keywords

learning difficulties, reading difficulties, math difficulties, academic emotions, academic achievement

Learning difficulties (LD) can significantly compromise students' academic learning and motivation (Smart, Prior, Sanson, & Oberklaid, 2001; Willcutt et al., 2013) and even increase the risk of mental-health problems and dropping out of school (Hakkarainen, Holopainen, & Savolainen, 2015; Lindén-Boström & Persson, 2015). Reading and math are the two most central academic skills in primary school (Opetushallitus, 2016). Fluent reading and math skills are essential not only to complete primary school but also to progress through upper-secondary education and cope with everyday issues. LD in reading and math is usually detected during early school years and has been shown to be persistent (e.g., Eklund, Torppa, Aro, Leppänen, & Lyytinen, 2015; Geary, 2011; Landerl & Wimmer, 2008), although in some cases, LD can emerge as late as in adolescence (e.g., Catts, Compton, Tomblin, & Bridges, 2012; Torppa, Eklund, van Bergen, & Lyytinen, 2015).

Although evidence suggests that LD predisposes students to academic failures (e.g., Hakkarainen et al., 2015), less attention has been paid to the possible role of emotions in academic failure among students with LD. In particular, only little is known about the role of LD in academic emotions associated with reading and math. Also, no previous studies have examined the extent to which LD has a detrimental effect on academic achievement through maladaptive emotional reactions. Thus, the present study adds uniquely to extant research by examining the role of LD in reading and math in students' subject-specific academic emotions (hope, enjoyment, and anxiety) and academic achievement.

LD and Academic Emotions

LD has been found to occur for various reasons among 12% to 30% of students (Westwood, 2004). LD can also manifest as specific learning disorders, such as specific reading disability (dyslexia) or math disability (dyscalculia) (Landerl, Fussenegger, Moll, & Willburger, 2009), that hinder the ability to learn certain academic skills. According to the *Diagnostic and Statistical Manual of Mental Disorders* (Fifth Edition; American Psychiatric Association, 2013), the prevalence of specific learning disorders (i.e., impairments

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in reading, writing, and math) varies between 5% and 15% of the school-age population.

The etiology of developmental disorders is multifactorial, and the nature of any disorder is continuous and quantitative rather than discrete and qualitative; therefore, any cutoff criteria are somewhat arbitrary (van Bergen, van der Leij, & de Jong, 2014). Diagnosing an individual with a learning disability usually is based on individually administered standardized tests and strict cutoffs (often the 10th percentile; e.g., Puolakanaho et al., 2007; Willcutt et al., 2013). However, a more lenient cutoff score of −1 standard deviation also is used commonly (e.g., Landerl et al., 2009; Snowling, Callagher, & Frith, 2003; Wise et al., 2008). In this study, the term *learning difficulties* (LD) is used instead of *learning disabilities* because we used group testing instead of individually administered tests.

Skilled reading is often paralleled to fluent (i.e., fast and accurate) word identification, which happens with ease and without noticeable effort (see Share, 2008). In turn, difficulties in reading fluency are seen as a bottleneck on reading skills, especially in transparent orthographies (e.g., Landerl & Wimmer, 2008; Share, 2008) where the acquisition of accuracy is fast (Aro & Wimmer, 2003). Likewise, in math, previous research has shown that mathematical-calculation fluency is a fundamental skill, in addition to magnitude processing and using counting strategies, when comparing students with and without math difficulties (e.g., Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Koponen et al., 2016; Landerl et al., 2009). Therefore, in this study, we used tests that assess students' fluency in reading and math skills to identify individuals with LD.

Students with LD face frequent struggles with schoolwork (Hakkarainen et al., 2015), which may increase their vulnerability to experiencing more negative and fewer positive emotions associated with academic subjects. The *control-value theory of achievement emotions* (Pekrun, 2006) suggests that students' self-experienced control over achievement situations and the subjective value that students attribute to achievement play a significant role in academic emotions. Academic emotions can be defined as emotions that arise in learning and achievement situations and relate to achievement outcomes.

In the present study, we focused on hope, enjoyment, and anxiety, as they have been shown to be fundamentally important academic emotions for students' academic performance (Orly & Margalit, 2014; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). Anxiety has been examined widely in the math domain (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Suárez-Pellicioni et al., 2016), and evidence indicates that it is related to math difficulties (Rubinsten & Tannock, 2010). We also focused on enjoyment, as it has been suggested as a particularly important academic emotion among primary school students (Ahmed, van der Werf, Kuyper, & Minnaert, 2013). In addition, we focused on hope, which can be assumed to be a relevant emotion among students with LD, as struggles often characterize their academic lives (Lackaye, Margalit, Ziv, & Ziman, 2006; Orly & Margalit, 2014; Rosenstreich, Feldman, Davidson, Maza, & Margalit, 2015). Furthermore, as reading and math difficulties have separate profiles (Landerl et al., 2009; Willcutt et al., 2013), and academic emotions have been shown to be domain specific (Goetz, Frenzel, & Pekrun, 2006), we examined both reading difficulties (RD) and math difficulties (MD) and their relationship to subject-specific academic emotions.

Associations Between LD, Academic Emotions, and Academic Achievement

Previous research suggests that LD is related both to lower academic achievement in general (Hakkarainen et al., 2013; Landerl et al., 2009; Willcutt et al., 2013) and specifically in the domain of difficulty (e.g., math; Mazzocco, Murphy, Brown, Rinne, & Herold, 2013). The control-value theory states that learning-related emotions play a significant role in students' academic achievement (Pekrun, 2006). Yet, no study so far, to our knowledge, has examined academic emotions as possible mediators between LD and academic achievement.

Positive activating emotions, such as hope and enjoyment, can have a positive impact on learning, for example, through increased motivation and benefits for self-regulation and learning strategies (see also Greulich et al., 2014). Previous research has shown that increased enjoyment of learning is associated with higher achievement in math among students in seventh and eighth grades (Ahmed et al., 2013). High enjoyment and hope levels regarding learning also have been found to be related to higher academic achievement and test-performance levels among young adults (Pekrun, Elliot, & Maier, 2009; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011).

Conversely, negative academic emotions (e.g., anxiety and hopelessness) might impact learning through different behavioral mechanisms, such as by deactivating action, by increasing worrying (which detracts resources from the task), and through an increased tendency toward avoiding achievement situations that could trigger negative emotions (Pekrun et al., 2011). Anxiety often has been examined in math studies (Rubinsten & Tannock, 2010; Suárez-Pellicioni et al., 2016) and typically is related to poor learning outcomes (Ahmed et al., 2013; Suárez-Pellicioni et al., 2016). Compared with math, less is known about associations between literacy-related emotions and academic achievement.

According to the control-value theory (Pekrun, 2006), academic emotions are closely linked to students' motivational and cognitive resources. Hence, it is possible that LD also has a detrimental effect on subsequent academic

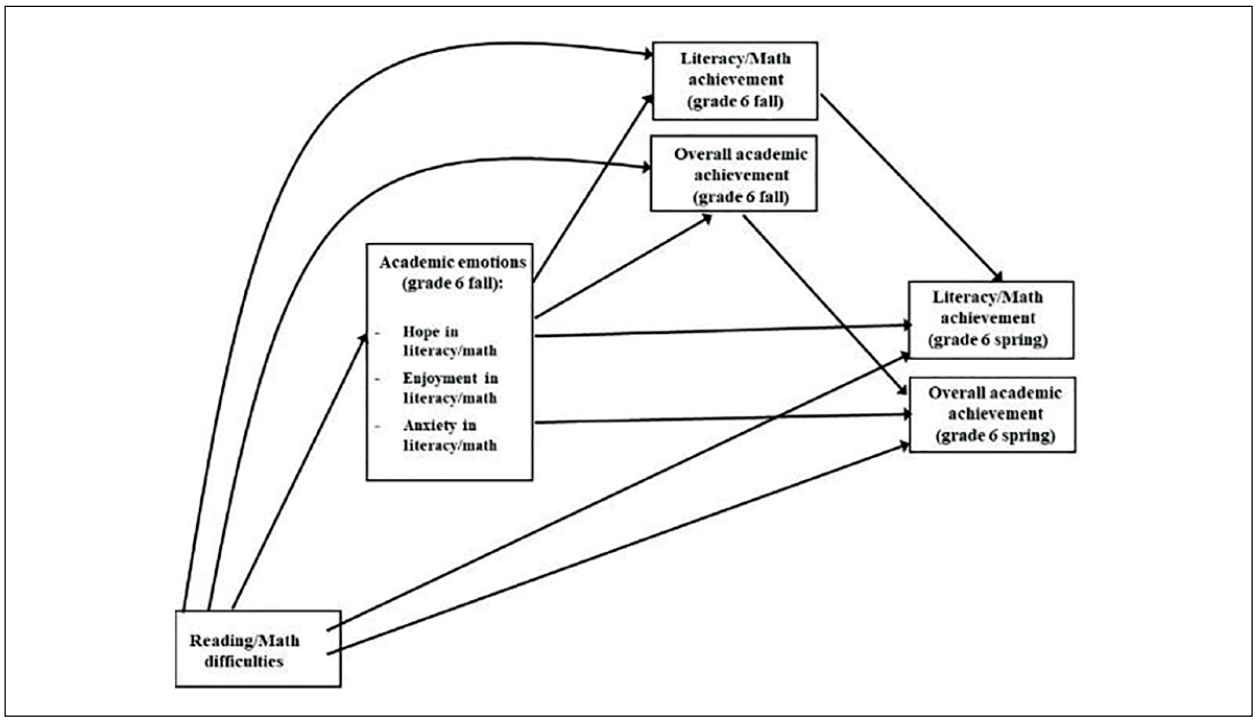

Figure 1. Schematic model of the role of learning difficulties (LD) in students' academic emotions and school grades.

performance through maladaptive academic emotions (Trigwell, Ellis, & Han, 2012). For example, increased negative academic emotions tend to be related to low perceived control over studies and low subjective importance directed toward learning, which may promote task avoidance in learning and achievement situations, hindering progress in academic skills (Pekrun et al., 2011).

Previous research on the associations among LD, academic emotions, and academic achievement is limited in the following ways: First, research rarely has considered students with LD when viewing associations between academic emotions and achievement. Second, extant studies on academic emotions in the literacy domain are lacking, although reading is a central academic skill. Third, as far as we know, no studies have been conducted on the possible mediating role of academic emotions between LD and academic achievement. All said, the current research adds to earlier research by focusing on the role of LD in academic emotions and achievement in the math and literacy domains.

Research Questions and Hypotheses

We formed a schematic model according to Pekrun's (2006) control-value theory, which is presented in Figure 1. According to our schematic model, we formed the following two research questions, which were investigated separately in the math and literacy domains (for academic emotions' domain specificity, see Goetz et al., 2006; Pekrun, 2006):

(1) To what extent do adolescents with and without RD/MD differ regarding their academic emotions (i.e., hope, enjoyment, and anxiety) in literacy/math in the fall semester of Grade 6?

Hypothesis 1: We expected that adolescents with LD in reading or math experience lower reading- or math-related hope and enjoyment as well as higher reading- or math-related anxiety than those without LD.

(2) To what extent do adolescents' academic emotions toward reading/math in the fall semester of Grade 6 mediate the effects of LD on (a) concurrent literacy/math achievement and overall academic achievement in the fall semester of Grade 6 and (b) changes in literacy/math achievement and overall academic achievement from the fall semester of Grade 6 to the spring semester of Grade 6?

Hypothesis 2: In line with the control-value theory (Pekrun, 2006; Pekrun et al., 2011), we expected RD to predict poorer literacy achievement and poorer overall academic achievement in the fall and spring semesters of Grade 6 via lower literacy-related hope and enjoyment

and higher literacy-related anxiety. Also, we assumed a similar ratio in the math domain between MD and academic achievement via math-related hope, enjoyment, and anxiety.

Gender has been shown to be related to LD such that girls have more math-related difficulties than boys, and boys have more literacy-related difficulties than girls (Quinn & Wagner, 2015). Thus, we controlled for the effect of gender in our analyses. Furthermore, as research has shown that some students have difficulties in both math and reading (Landerl et al., 2009; Willcutt et al., 2013), we also controlled for students' difficulties in the other academic subject, respectively. Finally, as students with LD have been shown to be more vulnerable to mental health problems than their peers (Lindén-Boström & Persson, 2015), we also controlled for depressive symptoms in the analyses to let us draw stronger conclusions about academic subject-specific associations.

Method

Participants and Procedure

The present study is part of the broader longitudinal study, which follows a community sample of Finnish students across the transition from primary school to lower-secondary school. Data were collected during ordinary school days. Trained testers administered all tests and questionnaires. Parental written consent and child assent were required for student participation. The research plan was approved by the local ethics committee.

This study's sample comprised 845 sixth-grade adolescents in primary school (54% girls; mean age 12.3 years, $SD = 4.38$). They were studying at 30 different schools in 57 different classes in large, urban (80% of participants) or midsize, semirural (20%) towns in central Finland. For 98% of participants, Finnish was their mother tongue. Most participants lived with both parents in one household (75%), others switched back and forth between separated parents in two households (12%), and 8% lived with only one parent. A total of 4% of the mothers and 8% of the fathers reported no vocational education after comprehensive school; 30% and 42%, respectively, completed lower-secondary school; 40% and 29%, respectively, completed vocational college; and 26% and 21%, respectively, held a master's degree or higher.

Measures

Reading difficulties (Grade 6, fall semester). Students' reading fluency was measured with three tests. First, we standardized students' scores in all three reading tests, after which we calculated an arithmetic mean across students' scores in the three tests ($\alpha = .87$). Using this reading-fluency scale score, the students were then classified into two groups: 0 = without RD, 1 = with RD. Students scoring below the 16th percentile (approximately 1 standard deviation below the mean of the whole sample) were marked as having RD. Commonly, cutoffs in reading research are set to 1 to 1.5 standard deviations below the mean of the population-based sample, being equivalent to 7% to 16% of the sample (e.g., Puolakanaho et al., 2007; Snowling et al., 2003).

The first decoding task, the *Word Identification* test, contains 100 written words in 25 word chains, with each comprising four different words written without spaces between the words (e.g., *tailorbilberryreadyhorse*). The students were instructed to identify words within each word chain and draw an upright line between the end and beginning of two consecutive words as fast and as accurately as they could (e.g., *tailor|bilberry|ready|horse*). The students received 1 point for each correctly drawn line within the time limit of 1 min 30 s (maximum score 100). According to the manual (Holopainen, Kairaluoma, Nevala, Ahonen, & Aro, 2004), this task's test-retest reliability has been high, at .70 to .84.

In the second decoding task, the *Spelling Errors* test, the students were instructed to search for spelling errors in 100 words, with a time limit of 3 min 30 s. Three different error types were used: incorrect, extra, or missing letters. Each word included one error that the students had to mark by drawing an upright line in the relevant position (for example, *carot: car|ot*). The students received 1 point for each correct line (maximum score 100). According to the manual (Holopainen et al., 2004), the task's test-retest reliability has been .83 to .86.

Third, in the short version of the Salzburg reading fluency test (see also Landerl, Wimmer, & Moser, 1997), the students were asked to read sentences silently one by one and mark whether the meaning of each sentence was true or false (e.g., "To pass a driving test, it is necessary to have good skills in swimming"). A time limit of 1 min 30 s was used, as the test featured only 36 sentences. The students received 1 point for each correct answer (maximum score 36). According to the test manual, the original Salzburg reading fluency test's test-retest reliability has been .95 for second-grade students and .87 for eighth-grade students (Das Salzburger Lese-Screening 2–9).

Math difficulties (Grade 6, fall semester). Math fluency was assessed with the *Basic Arithmetic* test (see also Räsänen, Salminen, Wilson, Aunio, & Dehaene, 2009), which contains tasks on addition, subtraction, multiplication, and division. The test contains 28 tasks (e.g., $527 + 31 = ?$; $15 - ? = 9$; $12 \times 28 = ?$), starting with easy ones and becoming more difficult throughout the test. The time limit for completing the test was 3 min. Students received 1 point for each correct answer (maximum score 28; $\alpha = .82$). The MD

variables were formulated based on the results of the tested math skills (0 = without MD, 1 = with MD). The cutoff point for having MD was defined, similarly to reading, as the 16th percentile, close to 1 standard deviation below the mean in a normal distribution (Landerl et al., 2009; Wise et al., 2008). Use of equivalent cutoff scores is necessary to retain comparability of associations among pupils with RD or MD.

Academic emotions (Grade 6, fall semester). Students' academic emotions concerning literacy and math were measured with the Finnish version of the *Achievement Emotions Questionnaire* (AEQ; Pekrun et al., 2011), which was adapted for school-age students (for validity of the AEQ, see Pekrun et al., 2011). The students rated their academic emotions toward learning, classes, and exams on a 5-point Likert-type scale (from 1 = *I disagree* to 5 = *I agree*). In this study, the focus was on hope (e.g., "I have an optimistic view toward studying"), enjoyment (e.g., "I enjoy acquiring new knowledge"), and anxiety (e.g., "I get tense and nervous while studying"), which were measured with three questions in both the literacy and math domains. The Cronbach's alpha reliabilities were adequate: for hope, they were .77 in literacy and .78 in math; for enjoyment, they were .72 in literacy and .76 in math; and for anxiety, they were .62 both in literacy and in math. Correlations between reading-related emotions and math-related emotions ranged from –.46 to .78.

Academic achievement (Grade 6, fall and spring semesters). Students provided information on their overall academic achievement (as a grade point average) in literacy (grade in literacy) and math (grade in math) achievement in the fall and spring semesters of Grade 6. In Finnish schools, the grades range from 4 to 10, with 5 being the lowest accepted grade and 10 the highest. Self-reported school grades have been shown to correlate .86 with the actual grades from the school registers (Ahonen & Kiuru, 2014).

Analysis Strategy

Analyses were carried out in the following way: Our first aim was to examine whether students with and without LD differ in their academic emotions. This research question was analyzed separately for the literacy and math domains using ANCOVAs (general linear model). In the models for literacy, the variables of hope, enjoyment, and anxiety toward reading were dependent variables, and the RD variable (0 = without RD, 1 = with RD) was an independent variable (fixed factor). In addition, to control for the effects from gender, depressive symptoms, and students' MD—as well as classroom differences in academic emotions—gender, depressive symptoms, and MD were added as covariates, and classroom identification number was added as a random factor in the models. Next, similar analyses were carried out in the math domain. In these analyses, math-related emotions were dependent variables, MD (0 = without MD, 1 = with MD) was an independent variable (fixed factor), and gender, depressive symptoms, and RD were set as covariates and classroom differences as a random factor.

Second, we run path models separately for literacy and math to test associations between subject-specific LD, subject-specific academic emotions, and their concurrent and longitudinal associations with academic achievement (see Figure 1). In these models, subject-specific academic emotions were predicted by subject-specific difficulties. Overall academic achievement and subject-specific achievement in the fall semester of Grade 6 were also predicted by concurrent academic emotions and LD. In addition, changes in academic achievement from the fall to spring semesters of Grade 6 (after controlling for achievement in the fall semester of Grade 6) were predicted by academic emotions and LD in the fall semester of Grade 6. In both models, gender and depressive symptoms were included as covariates. In addition, the effect of MD was controlled for in the model for literacy, and the effect of RD was controlled for in the model for math. The predictors and the dependent variables' residuals were allowed to correlate. Finally, the indirect effects from LD on concurrent and later academic achievement through academic emotions were also investigated. The path models were carried out by applying the complex approach (Muthén & Muthén, 1998–2016). This method estimates the models at the level of the whole sample but corrects possible distortions of standard errors caused by the clustering of observations (classroom differences).

For statistical analyses, we used IBM Statistics SPSS 22 software for Research Question 1 and the Mplus statistical package (Version 7.3) for Research Question 2. For Research Question 2, we estimated the models using full-information maximum likelihood estimation with robust standard errors. We also evaluated the model fit by using chi-square values, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). A model fits the data well when the p value associated with the chi-square test is insignificant. RMSEA values below .06, SRMR values below .08, and CFI values of close to .95 indicate a relatively good fit between the hypothesized model and the observed data (see also Hu & Bentler, 1999).

Results

Differences in Academic Emotions Between Students With and Without LD

Descriptive statistics are shown in Tables 1 and 2. The first aim of the present study was to investigate whether students

Table 1. Descriptive Statistics for Students With and Without Reading Difficulties (RD).

	Students With RD (n = 131, 16%)				Students Without RD (n = 707, 84%)			
Variable	*M*	*SD*	Range	*n* (%)	*M*	*SD*	Range	*n* (%)
Academic emotions								
Hope in literacy (Grade 6 fall)	3.4	0.89	1–5		3.7	0.80	1–5	
Enjoyment in literacy (Grade 6 fall)	3.0	0.89	1–5		3.1	0.84	1–5	
Anxiety in literacy (Grade 6 fall)	2.1	0.90	1–5		1.8	0.74	1–5	
School grades								
Literacy achievement (Grade 6 fall)	7.6	0.86	4–10		8.4	0.75	4–10	
Literacy achievement (Grade 6 spring)	7.7	0.82	4–10		8.5	0.85	4–10	
Academic achievement (Grade 6 fall)	7.8	0.68	4–10		8.4	0.61	4–10	
Academic achievement (Grade 6 spring)	7.8	0.71	4–10		8.5	0.63	4–10	
Control variables								
Gender (girls)				48 (37%)				405 (57%)
Math difficulties				58 (44%)				95 (14%)

Table 2. Descriptive Statistics for Students with and Without Math Difficulties (MD).

	Students With MD (n = 153, 18 %)				Students Without MD (n = 684, 82%)			
Variable	*M*	*SD*	Range	*n* (%)	*M*	*SD*	Range	*n* (%)
Academic emotions								
Hope in math (Grade 6 fall)	3.4	0.86	1–5		3.8	0.82	1–5	
Enjoyment in math (Grade 6 fall)	3.0	0.94	1–5		3.3	0.94	1–5	
Anxiety in math (Grade 6 fall)	2.1	0.95	1–5		1.8	0.77	1–5	
School grades								
Math achievement (Grade 6 Fall)	7.4	0.93	4–10		8.3	0.93	4–10	
Math achievement (Grade 6 spring)	7.5	0.98	4–10		8.5	1.0	4–10	
Academic achievement (Grade 6 fall)	7.9	0.66	4–10		8.4	0.63	4–10	
Academic achievement (Grade 6 spring)	8.0	0.70	4–10		8.5	0.66	4–10	
Control variables								
Gender (girls)				90 (59%)				363 (53.1%)
Reading difficulties				58 (38%)				73 (11%)

both with and without LD differ in subject-specific academic emotions when controlling for students' gender, difficulties in another academic subject, and classroom differences. These analyses were carried out separately for literacy and math subjects (for means and standard deviations, see Tables 1 and 2).

Literacy. The results of the ANCOVAs for the literacy domain show that, after controlling for students' gender, depressive symptoms, MD, and classroom differences in academic emotions toward literacy, students with and without RD differed regarding their hope in literacy, $F(1, 756) = 3.89$, $p = .049$, partial $\eta^2 = .01$, and anxiety in literacy, $F(1, 752) = 14.98$, $p < .001$, partial $\eta^2 = .02$, but not in their enjoyment of literacy, $F(1, 758) = 0.92$, $p = .34$, partial $\eta^2 = .00$. The students with RD reported less hope and more anxiety toward literacy than students without RD. The unique associations of RD (after accounting for the control variables) with hope and anxiety were small but statistically significant.

Mathematics. The results of the ANCOVAs for math show that students with and without MD differed in their academic emotions toward math, when controlling for gender, depressive symptoms, RD, and classroom differences. Differences were found in hope, $F(1, 743) = 21.74$, $p < .001$, partial $\eta^2 = .03$; enjoyment, $F(1, 747) = 14.10$, $p < .001$, partial $\eta^2 = .02$; and anxiety, $F(1, 751) = 7.82$, $p = .005$, partial $\eta^2 = .01$. The students with MD reported less hope, less enjoyment, and more anxiety toward math than those without MD. The unique associations of MD (after accounting for the control variables) with hope, enjoyment, and anxiety were small but statistically significant.

Table 3. Correlation Matrix (Correlations for Literacy-Related Variables Below the Diagonal and Correlations for Math-Related Variables Above the Diagonal).

Variable	1	2	3	4	5	6	7	8
1. RD/MD	—	−.18***	−.14***	−.15***	−.35***	−.37***	−.27***	−.29***
2. Hope toward literacy/math (Grade 6 fall)	−.10**	—	.73***	−.39***	.38***	.38***	.33***	.31***
3. Enjoyment toward literacy/math (Grade 6 fall)	−.05	.72***	—	−.32***	.34***	.36***	.25***	.26***
4. Anxiety toward literacy/math (Grade 6 fall)	.16***	−.38***	−.31***	—	−.23***	−.20***	−.21***	−.16***
5. Literacy/math achievement (Grade 6 fall)	−.36***	.36***	.51***	−.23***	—	.78***	.66***	.60***
6. Literacy/math achievement (Grade 6 spring)	−.33***	.35***	.26***	−.21***	.75***	—	.65***	.71***
7. Academic achievement (Grade 6 fall)	−.34***	.35***	.28***	−.24***	.75***	.69***	—	.78***
8. Academic achievement (Grade 6 fall)	−.36***	.34***	.28***	−.22***	.72***	.76***	.78***	—

Note: RD = reading difficulties; MD = math difficulties.
**$p < .01$. ***$p < .001$.

Concurrent and Longitudinal Associations Between LD, Academic Emotions, and Achievement

The correlations between the key variables are shown in Table 3. The next research question was whether LD is associated with students' academic achievements via their academic emotions. In other words, our aim was to examine to what extent RD or MD affects current and subsequent literacy or math achievement, respectively, as well as overall academic achievement, and whether these effects are mediated by academic emotions toward reading or math. The path models, accounting for the control variables, were carried out separately for literacy and math.

Literacy. First, the path model for literacy, corresponding to the schematic model (see Figure 1), was estimated. The final model for RD, academic emotions toward literacy, and academic achievement—containing statistically significant paths only—fit the data well: $\chi^2(17, N = 839) = 26.62, p = .06$, CFI = 1.00, RMSEA = 0.03, SRMR = 0.03. This model is shown in Figure 2. The results show, first, that the students' RD predicted lower hope and higher anxiety in literacy. Second, the results show that RD also predicted adolescents' academic achievement, both concurrently and longitudinally. RD was related to poorer literacy achievement and overall academic achievement in the fall semester of Grade 6. In addition, RD was associated with poorer academic achievement in the spring semester of Grade 6 after controlling for the academic achievement in the fall semester of Grade 6. After controlling for literacy achievement in the fall semester of Grade 6, the students' RD predicted significantly poorer literacy achievement in the spring semester of Grade 6. Third, among the academic emotions examined, hope was the only emotion related both concurrently and longitudinally to adolescents' academic achievement. Hope in literacy was associated with achieving both higher academic achievement and higher literacy achievement in the fall and spring semesters of Grade 6.

Aside from direct effects, we also tested for indirect effects of students' RD on academic achievement via academic emotions. Table 4 shows the results regarding indirect effects. The results show that the students with RD had a lower level of hope toward literacy, which in turn predicted significantly lower overall academic achievement and literacy achievement in the fall semester of Grade 6. RD had no significant indirect effects on academic or literacy achievement in the spring semester of Grade 6.

Mathematics. Next, the path model for math, corresponding to the schematic model (see Figure 1), was estimated. The final model for MD, academic emotions toward literacy, and academic achievement—containing statistically significant paths only—fit the data well: $\chi^2(15, N = 839) = 19.27, p = .20$, CFI = 1.00, RMSEA = 0.02, SRMR = 0.02. This model is shown in Figure 3. The results show, first, that the students' MD was related to lower hope, lower enjoyment, and higher anxiety in math. Second, the results revealed that MD also predicted academic achievement, both concurrently and longitudinally. MD was associated with poorer math achievement and overall academic achievement in the fall semester of Grade 6. In addition, MD predicted poorer math achievement and lower overall academic achievement in the spring semester of Grade 6 after controlling for earlier academic achievement. Third, academic emotions were associated concurrently with academic achievement. The higher the hope in math, the higher the math achievement and overall academic achievement of students in the fall semester of Grade 6. Math enjoyment was related to higher math achievement in the fall semester of Grade 6. Furthermore, enjoyment predicted higher math achievement and higher overall academic achievement in the spring semester of Grade 6 after controlling for earlier achievement. Anxiety, in turn, was related to both poorer overall academic achievement and poorer math achievement in the fall semester of Grade 6.

Aside from direct effects, we also tested for indirect effects of students' MD on academic achievement via math-related emotions. Table 4 shows the results

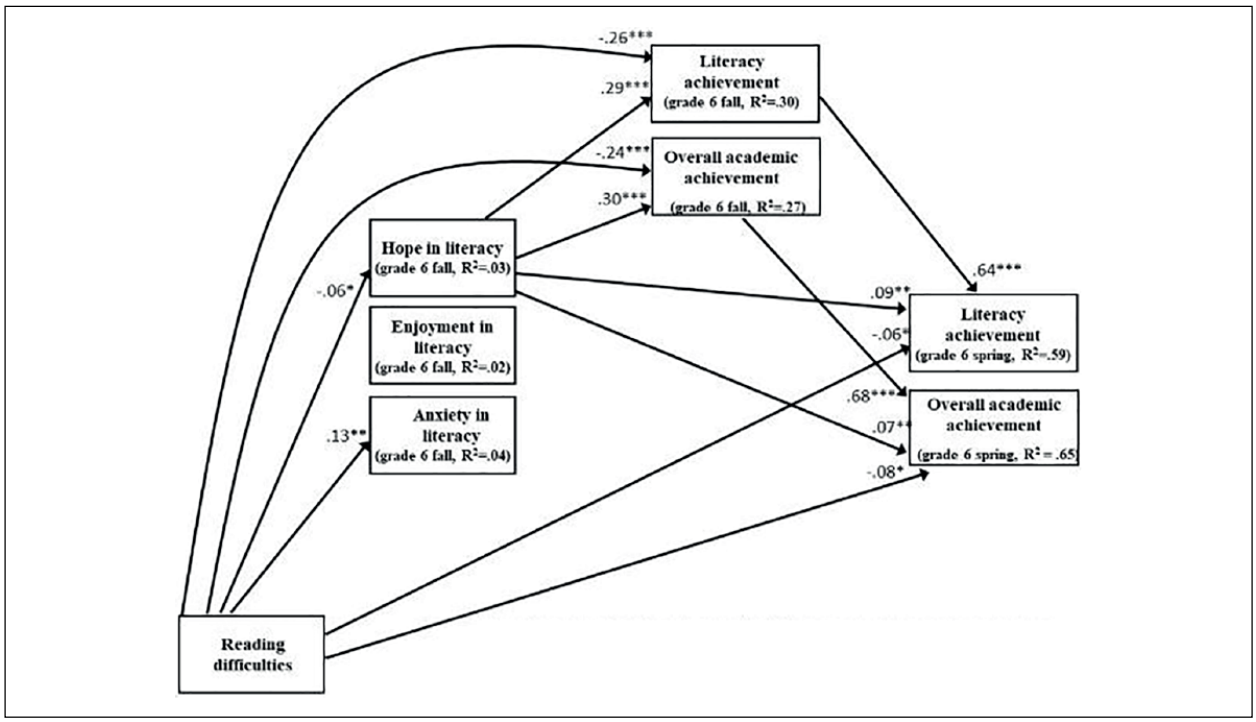

Figure 2. Final model of the role of reading difficulties in students' academic emotions toward reading, reading grade, and grade point average. The effects of gender and math difficulties are controlled for. Predictors are allowed to correlate and residuals of the predicated variables are allowed to correlate.
*$p \leq .05$. **$p < .01$. ***$p < .001$.

Table 4. Estimates of Indirect Effects in the Models for LD, Academic Emotions, and Academic Achievement ($N = 839$).

Indirect effect	Estimate (SE)	*p* value
Model for literacy		
RD → Hope toward literacy (Grade 6 fall) → Literacy achievement (Grade 6 fall)	−.04 (.02)	.041
RD → Hope toward literacy (Grade 6 fall) → Academic achievement (Grade 6 fall)	−.03 (.015)	.042
RD → Hope toward literacy (Grade 6 fall) → Literacy achievement (Grade 6 spring)	−.01 (.01)	.075
RD → Hope toward literacy (Grade 6 fall) → Academic achievement (Grade 6 spring)	−.01 (.01)	.114
Model for mathematics		
MD → Hope toward math → Math achievement (Grade 6 fall)	−.10 (.03)	.001
MD → Hope toward math → Academic achievement (Grade 6 fall)	−.07 (.02)	<.001
MD → Enjoyment toward math → Math achievement (Grade 6 fall)	−.03 (.02)	.143
MD → Anxiety toward math → Math achievement (Grade 6 fall)	−.01 (.01)	.181
MD → Anxiety toward math → Academic achievement (Grade 6 fall)	−.01 (.01)	.181
MD → Enjoyment toward math → Math achievement (Grade 6 spring)	−.04 (.02)	.005
MD → Enjoyment toward math → Academic achievement (Grade 6 spring)	−.02 (.01)	.026

Note: LD = learning difficulties; RD = reading difficulties; MD = math difficulties.

regarding the indirect effects. The results show that MD predicted lower levels of hope in math, which in turn were related to lower overall academic achievement and lower math achievement in the fall semester of Grade 6. Furthermore, MD was connected to lower math enjoyment, which was related to lower overall academic achievement and lower math achievement in the spring semester of Grade 6.

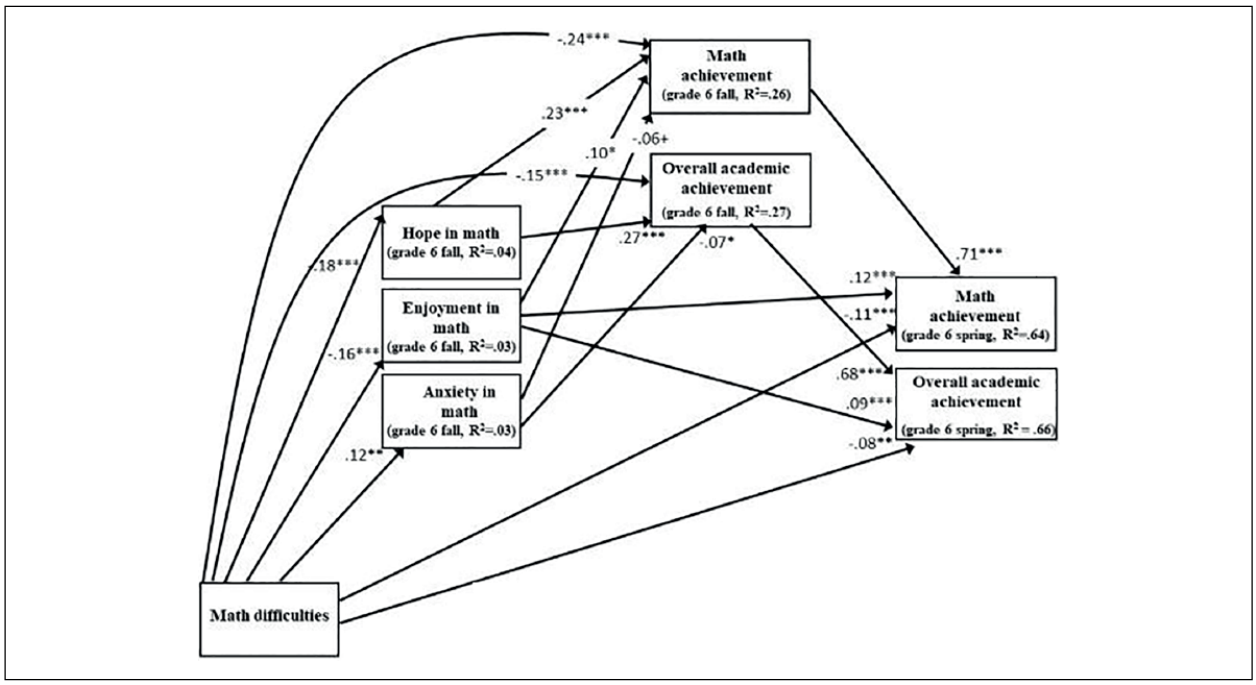

Figure 3. Final model of the role of math difficulties in students' academic emotions toward math, math grade, and grade point average. The effects of gender and math difficulties are controlled for. Predictors are allowed to correlate and residuals of the predicated variables are allowed to correlate.
*$p \leq .05$. **$p < .01$. ***$p < .001$.

Discussion

In this study, we investigated longitudinal associations between LD, academic emotions, and academic achievement among sixth-grade students. The present study adds uniquely to previous research by showing that the role of LD in students' academic emotions and achievement is important and needs to be considered when planning educational support for students with LD. One of our study's novel findings was that hope, in particular, is a crucial academic emotion among students with LD, as hope had a mediating role between LD and achievement. Furthermore, we found that direct and indirect associations between LD and academic achievement were slightly different between the literacy and math domains, supporting previous research on the subject specificity of academic emotions (e.g., Goetz et al., 2006).

The results showed, first, that students with RD had lower hope and higher anxiety toward reading than students without RD after controlling for the effects of gender, depressive symptoms, MD, and classroom differences. Although the effect size was small, this finding adds significantly to previous research, as associations between RD and reading-related emotions have rarely been examined before. RD is usually detected early at Finnish schools, and well-defined methods are available to aid students with RD (see also Eklund et al., 2015; Holopainen, Kiuru, Mäkihonko, & Lerkkanen, 2018). Those who, despite early educational support, are unable to keep up with their peers in reading development presumably struggle more often in their studies, which can predispose them to repeated failure and lead to fewer positive and more negative emotions toward literacy. In this study, lower hope and higher anxiety were typical, particularly for students with RD.

In the math domain, this study is in line with previous research on math anxiety (e.g., Maloney et al., 2015; Rubinsten & Tannock, 2010) by showing the relationship between MD and higher anxiety. It is notable that this study also indicates rarely studied associations between MD and math-related lower hope and lower enjoyment. Thus, students with MD had math-related lower hope, higher anxiety, and lower enjoyment, even after controlling for gender, depressive symptoms, RD, and classroom differences. The effect sizes were small but larger than those for reading. Extant literature on math-related anxiety (Rubinsten & Tannock, 2010; Suárez-Pellicioni et al., 2016) has presumed that math is often found to be a difficult and laborious school subject. It is also possible that some students' MD is not recognized early enough and that the support given to students is not as regular and systematic as that for RD, predisposing students to maladaptive academic emotions in math.

Subject-specific lower hope and higher anxiety were typical in both MD and RD. However, lower enjoyment was related only to MD. This may be due to the difference between reading and math as school subjects. Those who struggle with reading usually achieve moderate skills in word- and text-reading accuracy, giving these students a sufficient base for reading comprehension (Eklund et al., 2015). Math differs from literacy because in math, adoption of new mathematical concepts is required continuously across one's study years (Aunola et al., 2004; Purpura, Baroody, & Lonigan, 2013), which is why math typically is considered to be a difficult and laborious school subject (e.g., Suárez-Pellicioni et al., 2016). Students with MD early on may end up having severe problems understanding mathematical concepts later in more advanced classes, making them vulnerable to lower math-related enjoyment (see also Pekrun et al., 2011).

In line with the control-value theory (Pekrun, 2006), we also tested the assumption that LD would predispose students to poorer academic achievement through increased negative and decreased positive academic emotions. The results revealed a significant indirect effect from RD on academic achievement through literacy-related hope: RD was associated with lower literacy-related hope, which was related to lower current academic achievement. MD, in turn, was associated with lower math hope and lower math enjoyment, which were both related to lower academic achievement. Lower hope was related to current achievement, and lower enjoyment was related to subsequent achievement. Low hope and enjoyment are also known to relate to lower perceived control over studies and lower subjective importance on learning (Pekrun, 2006; Pekrun et al., 2011), which may be related to students' higher failure expectations, greater task avoidance, and other ineffective learning strategies (see also Greulich et al., 2014). It is possible that some of the indirect effects from LD on subsequent achievement through lower levels of positive emotions are mediated also through these factors.

Interestingly, we found that in the math domain, indirect associations were stronger than in the literacy domain. This may be explained by students' fairly good control over literacy studies despite their RD (e.g., Eklund et al., 2015) and by the considerable amount of educational support in literacy studies in early school years (Holopainen et al., 2018), both factors of which could have protected students from maladaptive academic emotions. Another possible explanation is that math skills develop in a more cumulative manner than those of literacy in the Finnish language (see also Aunola et al., 2004; Purpura et al., 2013), which may lead to detrimental cumulative cycles between less adaptive academic emotions and skill development, particularly in the math domain. In the end, it is notable that although the results supported the tested theory, the effect sizes of indirect effects were small. This may be due to multiple factors besides academic emotions affecting the academic achievement of students with LD.

Overall, the results clearly suggest that hope, in particular, is an important academic emotion for students with LD. Lower hope has been related to lower self-esteem as a learner (Lackaye et al., 2006) as well as to failure expectations and task avoidance behavior (Nurmi, Aunola, Salmela-Aro, & Lindroos, 2003; Pekrun et al., 2009), which can compromise learning results. The results indicate that teachers should be aware of the association between maladaptive academic emotions and students' LD. Special education's role is essential for students with LD to ensure positive learning experiences and to support the development of effective learning strategies and students' self-efficacy, which all are likely to maintain students' hopeful thinking in learning and achievement situations (Lackaye et al., 2006; Pekrun et al., 2011). Such educational support could increase students' experienced control over studies and their sense of subjective importance toward studies, thereby cultivating more positive academic emotions (see Pekrun, 2006). This means developing a new kind of approach to LD in which it is crucial that students not only practice their compromised skills but also receive support to cope with their negative emotions toward learning and developing more adaptive behavior in learning situations.

All said, the reader should also be aware of the limitations of this study. First, the students self-reported their academic emotions. In the future, it would be wise to complement self-reports with information from other sources, for example, by investigating facial expressions or physiological responses. Students also reported their own school grades, though they were based on numerical grades on actual school achievement and, thus, were unlikely to be biased. Furthermore, the reader should keep in mind that the tests used in this study to identify students with and without LD assessed fluency in reading and math skills. These tests were chosen as previous research has shown that fluency is the main characteristic of reading disability in transparent orthographies (e.g., Landerl & Wimmer, 2008; Share, 2008) as well as math disabilities (Aunola et al., 2004; Koponen et al., 2016). However, choosing fluency as our main target when identifying individuals with LD limits our opportunities to generalize our results to all students who have different kinds of difficulties in reading and math domains (e.g., reading comprehension problems or deficits in number fact knowledge). In addition, it is possible that associations would have been stronger if we had had students with diagnosed learning disabilities as our participants, but that remains an open question for future studies. Readers also should take note that in this study, we considered comorbidity of MD and RD by controlling for students' difficulties in the other academic subject. A future challenge to research could be to examine domain specificity and cross-domain

effects of LD in academic emotions in the same study. Finally, it is notable that although the results supported our study hypotheses even after accounting for the effects of gender, depressive symptoms, LD in the other subject domain, and classroom differences, the effect sizes were small.

Similarly, despite the cross-lagged design (in which controlling for the effect of earlier academic achievement may reduce effect sizes on changes in academic achievement), the present study was correlational, which inhibits confident assertions on causality. Our design also comprised only two time points, precluding us from investigating longer mediator chains. For example, it remains a future challenge to examine empirically through which specific behavioral processes (e.g., effort, task-focused behavior, and self-regulation) adolescents' LD and academic emotions might exert an effect on subsequent academic achievement. It is also evident that future studies should attempt to disentangle different emotional and motivational variables' unique effects on adolescents' academic achievement. All in all, our study adds to previous research by demonstrating that subject-specific academic emotions are one more aspect to consider when examining LD and its consequences for academic achievement. We found that LD increases students' vulnerability to experiencing more negative and fewer positive emotions toward learning school subjects in which difficulties were faced. Besides enjoyment and anxiety, which have been well examined as academic emotions in extant research, we also found hope to be a significant academic emotion in both the literacy and math domains. Associating fewer positive and more negative academic emotions with LD is crucial when considering LD's negative consequences, not only for students' short-term learning outcomes but also throughout their later educational tracks and even into their working lives. Future research directions concerning the role of LD in academic emotions would do well to consider subject-specific academic emotions' constancy during adolescence. It is also important to find out whether protective factors exist that may modify learning-related emotions to be more adaptive for students with LD.

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II

ADOLESCENTS' ACADEMIC EMOTIONS AND ACADEMIC ACHIEVEMENT ACROSS THE TRANSITION TO LOWER SECONDARY SCHOOL: THE ROLE OF LEARNING DIFFICULTIES

by

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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**

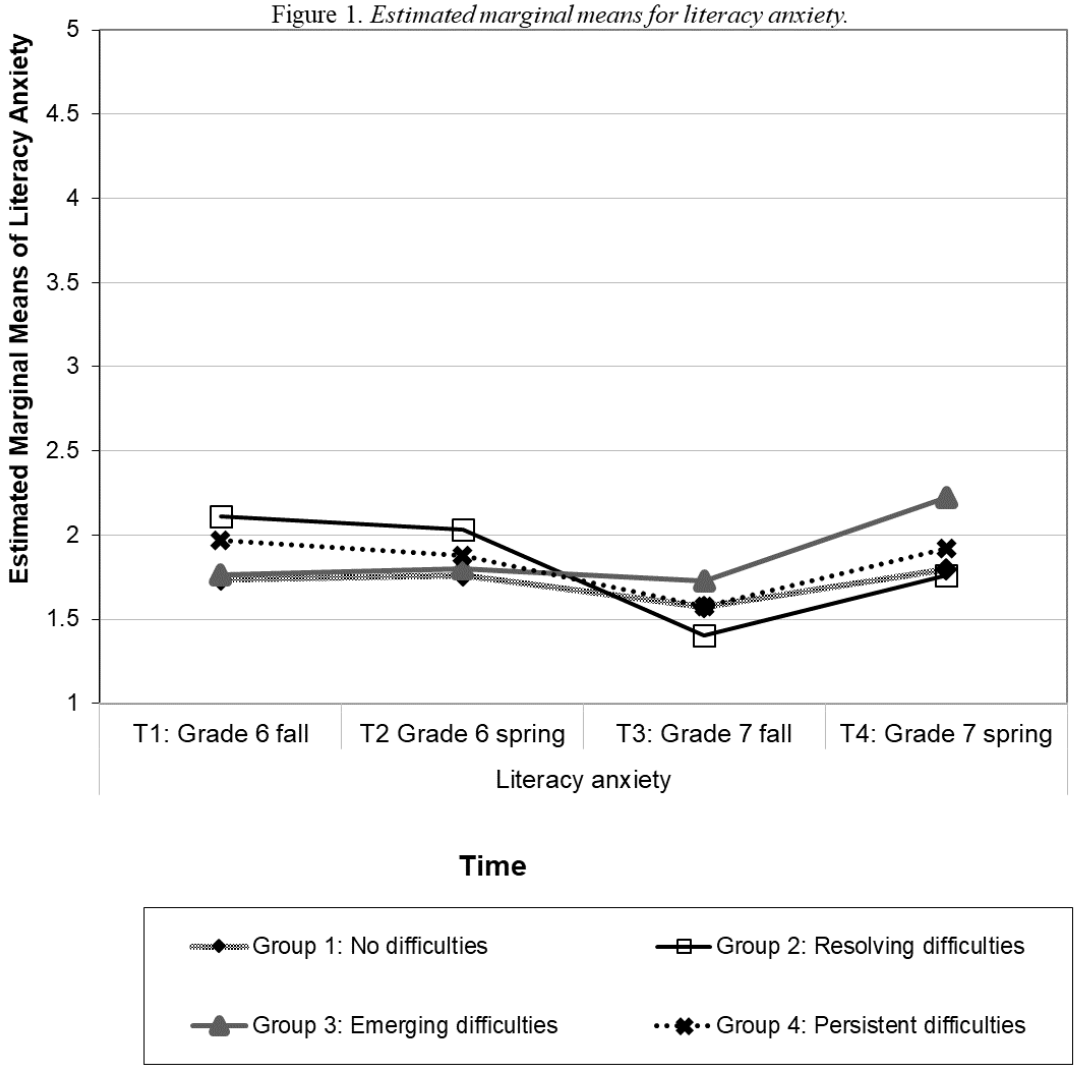
Note. Statistically significant effects in bold. The effects of gender, pubertal status, depressive symptoms, class, and the difficulties in the other subject domain (literacy or math) were controlled for in the analyses.

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).

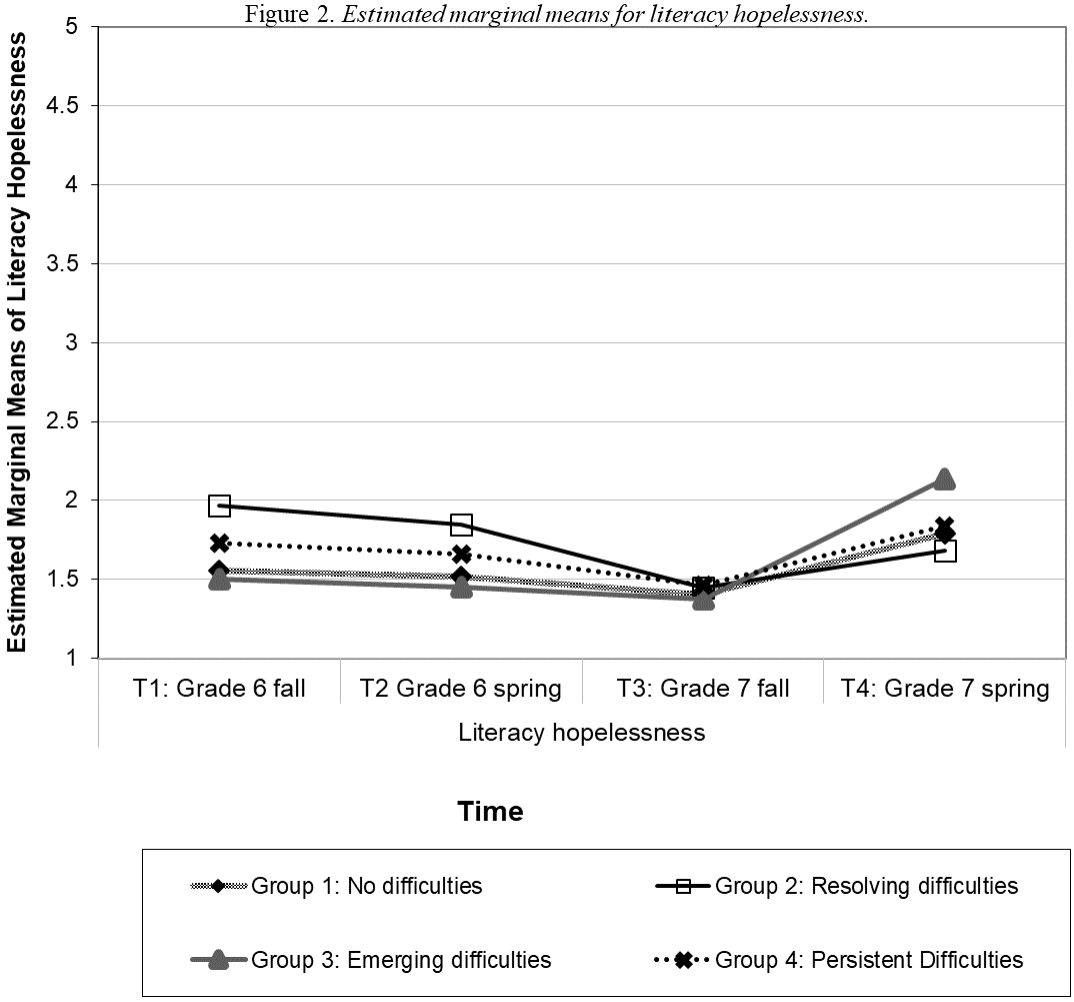
Figure 1. *Estimated marginal means for literacy anxiety.*



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 ($p = .045$).

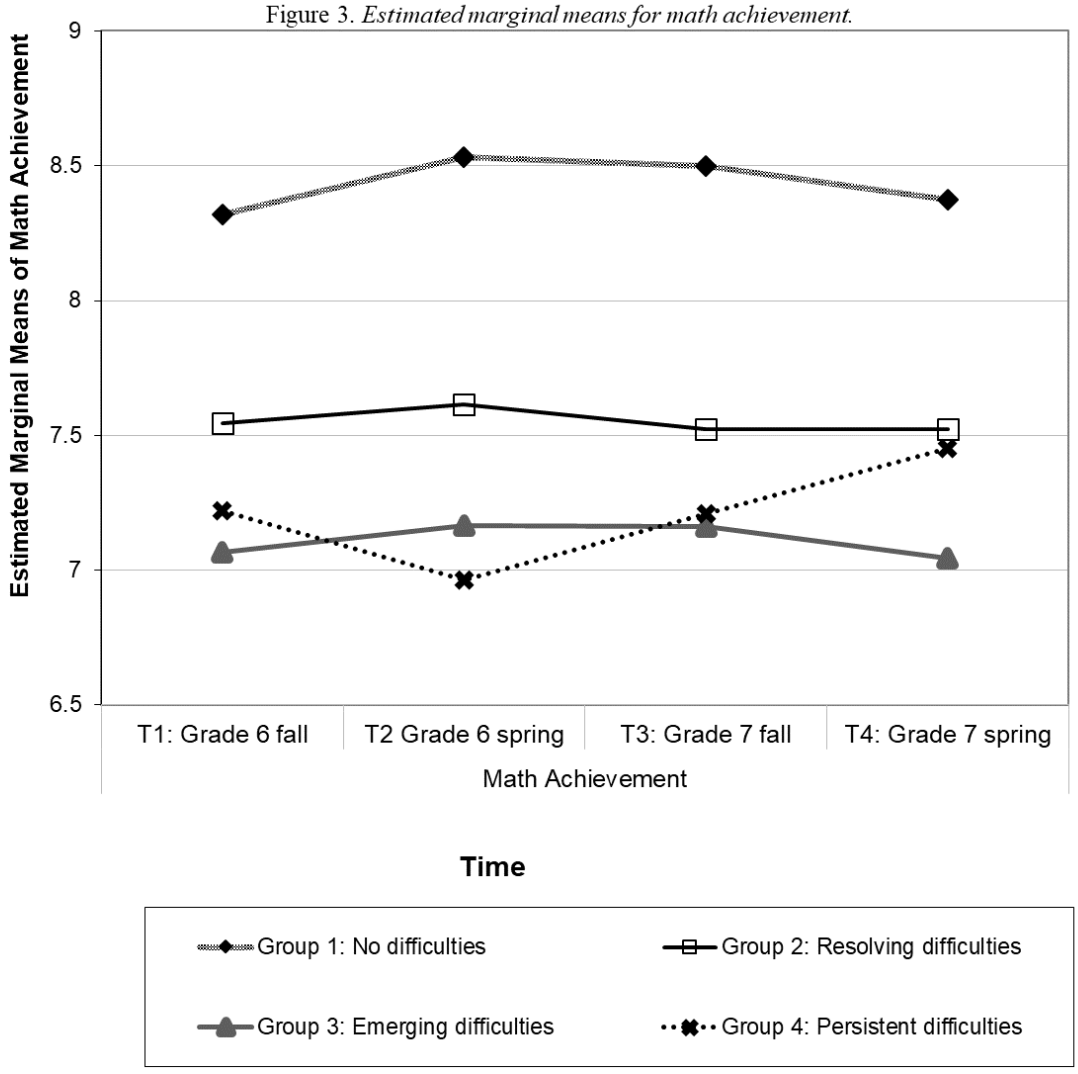
The results for *math hopelessness* showed no time x group interaction and no main effect of time. However, a main effect of MD groups was found. The results revealed that students with no MD reported less math-related hopelessness when compared to students with resolving MD ($p < .001$), students with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

THE ROLE OF TEACHER CLOSENESS IN EMOTIONS AND ACHIEVEMENT FOR ADOLESCENTS WITH AND WITHOUT LEARNING DIFFICULTIES

by

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