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**Title:** Implications of Overlapping Difficulties in Mathematics and Reading on Self-Concept and Academic Achievement

**Year:** 2017

**Version:**

**Please cite the original version:**

Holopainen, L., Taipale, A., & Savolainen, H. (2017). Implications of Overlapping Difficulties in Mathematics and Reading on Self-Concept and Academic Achievement. International Journal of Disability, Development and Education, 64(1), 88-103. https://doi.org/10.1080/1034912X.2016.1181257

# Implications of Overlapping Difficulties in Mathematics and Reading on Self-concept and Academic Achievement

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**Abstract**

In this longitudinal study, the relationship between adolescents' difficulty in mathematics and reading and the influence on academic self-concept and school grades was examined. The participants (N = 585; 299 girls, 286 boys) were ninth graders whose mathematics and reading skills were assessed at the end of comprehensive school at age 16 years. Five student profile groups were found using cluster analysis: best achievers, normal achievers, the reading difficulty group, the mathematical difficulty group, and the learning difficulty group. Post hoc tests revealed that the reading difficulty group and the learning difficulty group had a higher academic self-concept than the mathematical difficulty group. In school grades history, surprisingly, the normal achievers group and the reading difficulty group performed equally well across all school grades. Students in the mathematical difficulty group performed as poorly as the learning difficulty group. The results emphasize the prolonged and generalized effects of mathematical difficulty on students' academic careers.

Keywords: Academic achievement, academic self- concept, reading difficulties, mathematical difficulties.

## Introduction

In adolescence, when the demands in educational situations increase and expectations and learning requirements are higher, and in most cases, at the same time support decreases, students with reading and mathematical difficulties experience many challenges (Berninger, Nielsen, Abbott, Wijsman, & Raskind, 2008; Zeffiro & Eden, 2000). From the point of our study one essential feature of reading and mathematical difficulties is that they may also overlap (Light & DeFries, 1995). The most common learning difficulty is reading disability or reading difficulty (difficulties in decoding and reading comprehension), mathematical difficulties have been the focus of considerably less study than have reading difficulties (Räsänen & Ahonen, 1995). This relative neglect is unfortunate because mathematics skills are important for success in school and after school, where mathematics competence accounts for employment, income, and work productivity (Rivera-Batiz, 1992).

Students with learning difficulties demonstrate lower academic achievement than their peers without difficulties, and this generally worsens as they get older and as course content becomes more complex (Deshler et al., 2001). Learning difficulty negatively affects the lives of students in many ways; for example, students tend to be underachievers as they have to compensate for poor word reading skills with harder work that result in longer workdays and increased pressure, which, in turn, affects further educational choices (Undheim, 2009) and causes feelings of inferiority that may result for example as low academic self-concept (McNulty, 2003). Thomson and Morgan (1996) isolated two types of reactions at school for students with reading difficulties. The first is an “under”-reaction, in which the student withdraws and manifests extreme anxiety, for example, trembling and sweating when asked to read. These students have low academic self-concept and they generalize every aspect of their life as a failure. Low self-concept can also mean the development of a poor or negative self-image. Such beliefs can become a self-fulfilling prophecy of expecting to fail. Second, these individuals have “over”-reactions to stress, for example, being seen as successful in other areas, being the class clown, hiding their failure under a “couldn’t care less” attitude and manifesting silly behaviour. In this study, we investigate the longitudinal effects of reading and mathematical difficulties on academic self-concept and academic school achievement (Thomson & Morgan, 1996).

### *Difficulties in mathematics and reading*

Mathematical skills, arithmetic, algebra, and geometry, are built upon previous knowledge and sub-skills (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Chan, Au & Tang, 2013; Entwisle & Alexander, 1990; Fuchs et al., 2006). Arithmetical development is not a single process, involving the development of different components, basic-number knowledge, memory for arithmetic facts, counting, addition and subtraction, understanding of concepts, and the ability to follow procedures (Butterworth, 2005; Dowker, 1998). Algebra begins with a search for patterns that helps to bring order, cohesion, and predictability to seemingly unorganized situations and allows the user to do generalizations beyond the information directly available (Clements, 2004). Clements (2004) links numbers and operations, algebra, geometry, measurement, and data-analysis to one another. In this linking, numbers are used to quantify the properties of geometric objects. Operations are essential elements of measurement, and algebra is used to identify, describe, and extend a number as well as geometric patterns.

Difficulties in mathematics can include problems in one or even every above mentioned mathematical skills. In arithmetic, fluency and ease in basic calculation is very important skill for solving math problems (Calhoon, Emerson, Flores, & Houchins, 2007). Deficits in calculation fluency interfere student’s ability to participate in the discussion during lessons and in more complex algebraic concepts (Gersten, Jordan, & Flojo, 2005). Difficulties in learning fluent computational skills during the early grades of compulsory education will make learning advanced mathematics more difficult (Mabbott & Bisanz, 2008). Moreover, poor quantitative skills (for example calculation, numerical estimation, and measurement skills) negatively affect not only success in school, but also multiple areas of everyday life in adulthood (e.g. dealing with money, measurement skills). In this paper, difficulties in mathematics include all of these three areas of mathematics; arithmetic, algebra, and geometry skills. We know far less about the developmental trajectory of mathematical difficulties than reading difficulties (Watson & Gable, 2013), but scholars have shown that difficulties in mathematics represent continuance issues in one or several skills presented above.

Reading ability assumes adequate language comprehension and fluent word identification in order to acquire alphabetic and orthographic knowledge. This leads to mastery of the alphabetic code and increasing accuracy and fluency in decoding, word identification, spelling, and the construction of meaning from written text (Adams, 1994; Vellutino, Fletcher, Snowling, & Scanlon, 2004). On the other hand, in reading comprehension, the reader must be able to integrate the meaning of the sentences as they progress, to use contextual tips, and to reach conclusions based on general information (Catts, Adlof, Hogan, & Weismer, 2005; Gough, Hoover, & Peterson, 1996; Snowling, 2000).

Reading difficulties usually refer to difficulties in learning to read and spell but also, later on, to difficulties in fluent and accurate reading and spelling performance (Lyon, Shaywitz, & Shaywitz, 2003). Especially in consistent orthography as in German or in Finnish, problems with reading fluency seem to be quite stable, defining poor word reading and reading comprehension skills throughout compulsory education and persisting even into adulthood (Hakkarainen, Holopainen, & Savolainen, 2013; Landerl & Wimmer, 2008; Savolainen, Ahonen, Aro, & Holopainen, 2008). Further, in a Swedish study, even university students with dyslexia had phonological difficulties, which supported the results of persisting problems causing dyslexia (Wolff, 2009). Persons with problems in reading comprehension experience difficulties when they try to reach conclusions by joining the thoughts of the text together or they are unable to understand the structure of the story (Perfetti, Marron, & Foltz, 1996; Oakhill & Yuill, 1996; Stothard & Hulme, 1996). Therefore, at the secondary school level, students with reading difficulties often struggle in many areas, such as science, due in part to the mismatch between their reading level and the academic requirements (Seifert & Espin, 2012). These difficulties may significantly impede or slow down the acquisition of knowledge through reading, an essential function for academic study (Carroll & Iles, 2006).

***Overlapping difficulties in mathematics and reading***

Often a student has both difficulties in mathematics and reading (Donlan, 1998; Fletcher, 2005; Fuchs & Fuchs, 2003; Geary, 1993; Light & DeFries, 1995; Zeleke, 2004). Moreover, most students (about 80%) who have difficulties in reading also have difficulties in mathematics in the upper grades, even if the students' achievements in mathematics had been average at the beginning of school (Light & DeFries, 1995). This could be interpreted as the result of the same types of cognitive demand required in mathematics and reading. Both skills seem to require well-organized working memory and functioning of the phonological loop (Baddeley, Gathercole, & Papagno, 1998; Geary, 2004; Swanson, 2006). Vukovic and Lesauz (2013) also have stated that verbal ability is related to arithmetic skills indirectly through symbolic number skills, explaining overlapping difficulties in mathematics and reading. Previous research (Krawec et al., 2013) has also shown that students with learning difficulties (e.g., spelling problems) have also difficulty in academic tasks that demand the use of cognitive and meta-cognitive skills and also have limited ability to monitor, regulate, and correct their performance.

***Learning difficulties effect on academic self-concept***

Self-concept is an important component of psycho-social adjustment and emotional well-being. It has been widely reported that children and adults with learning difficulties have more negative and lower academic self-concept than their typically achieving peers (Alexander-Passe, 2006; Carroll & Iles, 2006; Chapman, 1988). Lack of confidence and increased levels of frustration and anxiety may affect school performance (Riddick, Farmer, & Sterling, 1997). Adolescents with low academic self-concept are more likely to develop negative coping styles that are often associated with poor motivation and low emotional and psychological well-being (Barrett, Webster, & Wallis, 1999; Bear, Minke, & Manning, 2002; Harter, 1999; Klein, 1995; Rosenberg, Schooler, Schoenbach, & Rosenberg, F., 1995; Wilgenbusch & Merrell, 1999; Weare, 2000; Zeleke, 2004; Zimmerman, Copeland, Shope, & Dielman, 1997).

In adolescence, increasing demands, expectations and requirements of learning and, in most cases, at the same time cessation of help and support, creates challenges for persons having difficulties in mathematics and/or reading (Zeffort & Eden, 2000). In previous studies (e.g. Bear, Kortering, & Braziel, 2006; Deshler et al., 2001; Scanlon & Mellard, 2002) it has been shown that students with learning difficulties demonstrate lower academic achievement than their peers, without learning difficulties. Over time, learning difficulties are also to do with secondary problems such as poor academic self-concept, and difficulties in maintaining a positive attitude, high motivation and interest in meeting demanding learning situations (Murray, Goldstein, Nourse & Edgar, 2000). Proper compensation strategies can help to overcome many of these learning challenges, but if teachers are not aware of the variety or degree of learning difficulties, choosing the level, amount and content of support given to students is difficult (Gerber, 2012).

### *Aims of this study*

The study presented here examines the academic achievement history (grades 4 to 9) of the students profiled based on their reading and mathematical skills at the end of basic education. We are also interested in the relationship between academic self-concept and the reading and mathematical profiles. The following research questions were set:

1. What kind of profile groups of mathematics and reading difficulties can we find at the end of comprehensive school?
2. How are these mathematic and reading profile groups connected with the academic self-concept at the end of comprehensive school?
3. What kind of academic achievement history (operationalized by average grades for mathematics and first language) do young people with different mathematics and reading profile groups have from grades 4 to 9?

## Materials and methods

### *Participants*

This study is part of the ongoing longitudinal study Staying on Track of Learning (Savolainen & Holopainen, 2008), which follows a group (N = 585; 299 girls, 286 boys) of adolescents from a mid-sized Finnish city. At the beginning of the data-gathering period in 2004, the participants were ninth graders (median age 16 years, mean age 15.7 years, SD .58 years), in five comprehensive schools, at 27 classes, and all participants received a general education and spoke Finnish as their mother language. The Finnish comprehensive school system comprises an elementary school (grades 1–6) and an upper level (grades 7–9). In every school there are part-time special education teachers helping students with learning problems (e.g. reading and mathematical difficulties) during the school lessons. The participation to this study has been voluntary and written consent was requested from students' parents for participation in the study.

### ***Procedure and measures***

Mathematical and reading skills were measured at two time points at the end of ninth grade in groups at the students' schools. Before the reading test was started a questionnaire with the questions for academic self-concept were presented. Mathematics tests were presented to students by their mathematics teachers during lessons, and reading tests were presented by the students' Finnish language (first language) or special-education teachers during first-language lessons. The mathematics test is common at Finnish schools, and the teachers had used it previously. For the reading test, the teachers were specially prepared through a training video made by the researchers. The reading assessment sessions lasted approximately 2 hours, and the mathematics assessment lasted for 45 minutes. The tests were presented in the same fixed order to all students.

*Mathematical skills*. Mathematical skills were assessed with a normative test, MAKEKO (Matematiikan keskeisen oppiaineksen kokeet luokille 1-9 [The tests for assessing the main content in mathematics at grades 1-9], which consists of 100 basic mathematical tasks (maximum score is 100, mean is 64.46, SD 19.25), measuring four dimensions (Ikäheimo, Putkonen, & Voutilainen, 2002). On the MAKEKO test, arithmetic skills were assessed with the sum scores of number concept and integers, calculation with integers, algorithms, the concept of percent, and the application of percentage (24 sub-problems). The reliability coefficient of the sum score for arithmetic was .62. Algebra skills were measured by the sum scores of the concept of potency, the calculation of potency, rules of potency, square root, addition of monomials, multiplication of monomials, multiplication of polynomials with monomials, addition of polynomials, subtraction of polynomials, multiplication of polynomials, solving equations by drawing conclusions, solving equations, proportion, application of proportions, decoding of the delineator, and the description of a straight line (57 sub-problems). The reliability coefficient of the sum score for algebra was .87. Geometry skills were measured by the sum scores of the calculation of area, describing a triangle, and the concept of scale (6 sub-problems). The reliability coefficient of the sum score for geometry was .74.

*Reading skills*. Reading skills were assessed by the Finnish dyslexia screening test for youth and adults, which is standardized for persons ages 15 and older (Holopainen, Kairaluoma, Nevala, Ahonen, & Aro, 2004). Reading test comprises three subtests: a reading comprehension test and two word reading tests. The reading comprehension test includes a four-page story, in which 52 words have been changed; the participants have to mark the changed words by underlining them. The changed words are in the same word class as the original, but will not conform to clauses or paragraphs, and can be inadequate in the context in many different ways, therefore the test requires an ability of multi-level reading comprehension: understanding the storyline, finding irrelevant and wrong expressions, and constructing interpretations between inappropriate content and misleading information. The reliability in the reading comprehension test was excellent (Cronbach's alpha .91). The test score was the total number (max 52) of correctly identified items (Holopainen et al., 2004). The raw score mean was 37.69 and SD 8.80.

Both word reading tests contain 100 words each. The first word reading task is to find misspellings; there is one mistake (one letter omitted or one wrong letter added) in each word. Participants find spelling errors and mark them with a vertical line. The time limit for this task is 3 minutes and 30 seconds. The second word reading task includes word chains in which the single words have to be recognized and separated from each other with a vertical line. Words have been written together in four-word clusters without spaces between them. The time limit for this task is 1 minute and 30 seconds. Because of the time limits, success in word reading tasks requires quick and accurate knowledge of words, understanding of correct spelling, recognition of word forms and meanings, and rich vocabulary. Reliability of word reading tests was examined with re-measurement correlation and discovered to be good (misspellings .83-86, word chains .77-84, p=.000). The test score was the total number (max 100/test) of items marked/separated correctly (Holopainen et al., 2004). In this study, two word reading tests were combined and used as a sum variable of decoding. The reliability of sum variable of word reading was good (Cronbach's alpha .83). The raw score mean of the sum was 68.53 and SD 17.79.

*Academic self-concept*. To measure academic self-concept, the Harter Self-perception Profile for Children (Harter, 1985) test was used. In this study, only the part related to scholastic competence was used, because in previous studies it has been shown that learning difficulties negatively affect to academic self-concept, not so much in general self-concept. The version used, translated into Finnish by Hotulainen (2003), was based on students' self-reports. When answering, students had first to select from structured alternative items (two descriptions) and then indicate whether the item they selected was true or not true for them. Higher scores indicated greater perceived competence, maximum score was 24. In this study, the coefficient of the sum score for academic self-concept was .73, which is acceptable reliability for this separate score. In the study by Hotulainen (2003), the coefficient of the sum score was .82. The raw score mean in this study was 16.43, SD 3.05.

*School achievement.* To measure school achievement, each school kept a register of subject scores given to students in grades 4 to 9. In this study, we used school grades for mathematics and first language for each grade (at the end of each grade). The grades in mathematics include assessments in arithmetic, algebra, and geometry, and the grades in first language include assessments in decoding, reading comprehension, literacy, grammatical rules, and verbal expression. The lowest grade is 4, and the highest is 10 in Finnish schools.

***Statistical analysis***

Mathematical and reading difficulties were examined using person-oriented K-means cluster analysis (SPSS v. 19). Cluster analysis allowed the participants of the study to be sorted into similar groups. The variables used in this classification were the standardized scores for arithmetic, algebra, geometry, decoding, and reading comprehension. Connections between mathematics and reading difficulties and academic self-concept were examined using Univariate analysis of variance. Connections between mathematical and reading difficulties and the school achievement histories of the students of the target group were also examined using univariate analysis of variance. School grades for mathematics and first language from the fourth to ninth grades were used. Effect sizes were measured with Cohen’s d and partial eta squared.

## Results

First, we wanted to find out if there were gender differences in the test variables. The results showed that there were no gender differences in the overall mathematics test scores when the students were tested in the ninth grade ($t(486)=.34$; $p=.74$; Cohen’s $d=.03$). However, girls were better than boys in reading comprehension ($t(525)=.85$; $p=.00$; Cohen’s $d=.51$) and decoding skills ($t(514)=3.68$; $p=.00$; Cohen’s $d=.32$). Regarding the analysis of variance between mathematical and reading skills, students who performed well in mathematical skills also performed well in reading comprehension skills ($F(2,436)=36.01$; $p=.00$) and decoding ($F(2,428)=25.17$; $p=.00$).

### *Profile groups of students with difficulties in mathematics and reading*

Second, in order to categorize the participants according to mathematics and reading difficulty, a K-means cluster analysis with mathematics and reading sub-skills were used for arithmetic, algebra and geometry, reading comprehension, and decoding. After many classification systems were considered, a five-group approach was selected as the best model because it differentiated the groups according to mathematics and reading sub-skills and included normal achievers and best achievers. In addition, the sizes of the profile groups were sufficient. The members of profile group 1 (n=98) had an average performance in mathematics and in reading, so this group was named normal achievers (NA). The members of profile group 2 (n=38) had overlapping difficulties in mathematics and reading and had the most difficulty in reading comprehension. Thus, this group was named the learning difficulty (LD) group. The members of profile group 3 (n=54) performed normally in reading but not in mathematics. This group was named the mathematical difficulty (MD) group. The members of profile group 4 (n=150) performed very well in mathematics and reading and were thus named the best achievers (BA). The members of profile group 5 (n=85) had difficulty in reading comprehension and decoding but not in mathematics. In fact, they were quite good at geometry. This group was named the reading difficulty (RD) group. In Table 1, the standardized means for all test variables in mathematics and reading across the five clusters is shown.

>Insert Table 1 about here<

### *Connections between academic self-concept and mathematic and reading profile groups*

In the following steps, we wanted to see whether difficulty in mathematics and reading was related to academic self-concept at the end of comprehensive school. Academic self-concept differed for students in the different clusters (F(4,389)=25.18; p=.00; partial eta squared=.21). Post hoc tests (Scheffe) revealed that the BA group had a significantly (p<.000) higher academic self-concept (grade average 18.27; standard deviation 2.64) than did students in any other group, including NA (16.09; 2.67), MD (14.35; 2.38), RD (16.30; 2.90), and LD (15.03; 3.20). Surprisingly, MD members had a significantly (p<.01) lower self-concept than the members in the NA group and in two other difficulty groups (RD, LD).

### *Academic achievement history for students in different mathematics and reading profile groups*

In the third research question, we wanted to know whether the mathematics and reading skills profile groups had different school achievement histories from grades 4 to 9 in two school subjects, namely, mathematics and first language, which are the main two compulsory subjects throughout the school career. In mathematics skills, BA group members performed significantly better than did the students of the other profile groups across all the school grades. The NA and RD group members performed equally well across fourth and fifth school grades, but the RD group members were better in grades 6–9. Students in the RD group performed also better than members in the LD and MD groups across all school grades, but students in the MD group got the same grades in mathematics as the students in the LD group (Table 2).

>Insert Table 2 about here <

In addition, in terms of first-language grades, the BA group members performed significantly better than did the students of the other profile groups across all school grades. In fourth grade, the NA group members were better only than the LD group, but in grades 5–9 they were also better than the MD group. Surprisingly, the RD group members performed as well as the NA group across school grades and better than the LD group from Grade 4 to Grade 9 and, surprisingly, were also better than the MD group members from grades 6 to 9. Students in the MD group received the same grades in first language as all other students except the BA group members in fourth grade and were significantly better than the LD group in grades 5–9 (Table 3). To make the trajectories for school achievement history in two subjects more definite, they are presented in Figures 1 and 2. As was described earlier, the Finnish comprehensive school system comprises an elementary school (grades 1–6) and an upper level (grades 7–9). In Figure 1 the change from elementary school to upper level is seen as a drop in the mathematic grades in all groups but especially in NA group. Moreover, the mathematic grades between the groups seem to be surprisingly stable throughout 5 years; best students have got good grades already at the fourth grade and students in LD group have got the lowest grades in mathematics already then. In first language grades the change from elementary school to upper level can also be seen. The biggest dropping down happens in MD group, but also students in NA, RD and LD groups achieve a little lower grades in upper levels than in lower levels.

> Insert Table 3 about here <

>Insert Figures 1 and 2 about here<

**Discussion**

The primary objective of this study was to examine what types of groups of mathematical and reading difficulty could be found at the end of comprehensive school (age 16), and how these profiles are connected to academic self-concept and school achievement. The purpose was to identify what kind of consequence different types of learning difficulties have at school in a longitudinal investigation. This information is essential when choosing the amount and content of support given to students at schools. We identified five groups of students based on their assessed mathematics and reading skills: best achievers, normal achievers, and three groups with difficulties, namely, students with reading difficulties, students with mathematical difficulties, and students with both reading and mathematical difficulties (we named this group students with learning difficulties). Profile-group membership had an effect on the students' academic self-concept. The most interesting result was that the members of the MD group had the lowest academic self-concept and that the LD group did not have a lower academic self-concept than students in the NA and RD groups. We also wanted to find out what kind of school achievement history in two subjects students with different difficulty profiles had from grades 4 to 9. True to form, the BA group members had the best grades in mathematics and first language across all school grades. In mathematics, the NA and the RD group members performed equally well across fourth and fifth grade, but surprisingly, the RD group was better in grades 6–9. Students in the RD group performed better than the LD group members across all school grades, but students in the MD group got the same grades in mathematics as the students in the LD group. The results for first-language grades were more surprising, because the RD group performed as well as the NA group across all school grades. After fifth grade, the RD group members got also better grades than the MD and LD group students; the LD students got the lowest grades in first language in grades 5–9. These results will be discussed separately.

The MD group had good reading skills measured on reading tests, but during the school years and especially from grades 7–9, these students got quite poor marks (similar to the LD group) in the first-language yearly assessments compared to the RD and NA groups. Keeping in mind that students in the MD group also reported the lowest academic self-confidence scores of all groups, this may indicate, as Carroll and Iles (2006) and Riddick et al. (1997) suggested, secondary effects of mathematical difficulties such as a lack of confidence and increased levels of frustration and anxiety that also affect school performance, which extend to subjects other than mathematics. Also Levi, Einav, Ziv, Raskind and Margalit (2014) demonstrated that hopeful thinking had a direct effect on grade expectations, which, in turn, predicted academic achievement. The low school performance in mathematics for this group is more logical because mathematical skills are organized hierarchically, as Aunola et al. (2004), Entwisle and Alexander (1990), Fuchs et al. (2006), and Lyytinen et al. (2000) have confirmed. This means that every new skill depends on a previous one, and because skill in mathematics constitutes a hierarchical system, difficulties in mathematics are cumulative. The role of mathematical skills or the lack is also noteworthy in everyday life. As McCloskey (2009) points out, mathematical difficulties cause problems in many areas of life, and make life management difficult.

The LD group showed the greatest difficulty in reading comprehension, but they also had difficulty in decoding and all measured mathematics sub-skills. Second, self-concept acts as an important predictor of academic achievement, as Elbaum and Vaughn (2003), House (1993), Zeleke (2004), and March (1990) have confirmed. Thomas and Gadbois (2007) observed that students' self-concept is related to their exam performance and tendency to self-handicap. Similarly, in our study, those who had difficulty in mathematics or mathematics and reading had a lower academic self-concept than the NA and BA groups.

Third, one possible explanation when trying to understand the poor performance of the LD group, alongside academic self-concept, is difficulty in reading comprehension. A lack of reading comprehension makes it difficult for the reader to join together ideas presented in the text and, therefore, to understand the structure of the story (Perfetti et al., 1996; Stothard & Hulme, 1996). Reading comprehension problems impede or slow down the acquisition of knowledge through reading—an essential function for academic study (Oakhill & Cain 2004). Another explanation is that mathematics and reading make the same types of cognitive demands. Both skills seem to require well-organized working memory and functioning of the phonological loop (Baddeley et al., 1998; Geary, 2004; Swanson, 2006).

Whereas, in reading, the student must first be able to read in order to understand what has been written, in mathematics the student must first understand the concepts of the field before being able to use procedures and solve problems. In an earlier study regarding the overlapping of mathematics and reading skills, girls had the strongest correlation between skills in reading comprehension and algebra and arithmetic, whereas for boys the strongest correlation was observed between all the mathematics and reading comprehension sub-skills. The connection between mathematics and reading skills culminates on the overlapping of reading comprehension and a conceptual knowledge of mathematics (Taipale, 2010).

The RD group had the greatest difficulty with decoding, fewer problems in reading comprehension, and average results in mathematics. The students' problems seemed mostly to be in fluent and accurate reading performance (Lyon et al., 2003). Interestingly, this group was quite good at geometry. We assumed that difficulties in reading (decoding and reading comprehension) would affect school achievement more, especially first-language grades, but found that the RD group performed as well as those whose first-language and mathematics skills were average. One explanation for this is that the level of reading comprehension in these profile groups is quite good, so perhaps the decoding problems in the RD group can be compensated for by adequate reading comprehension strategies. It is likely that their students' minor comprehension problems in reading had not decreased their reading experience or impeded the growth of their vocabulary (Church, Fessler, & Bender, 1998; Lyon et al., 2003).

**Limitations and practical implications**

There are some obvious limitations to our study. First, we used a cross-sectional analysis of variance to measure what kind of school achievement history young people in different learning difficulty groups have from grades 4 to 9. With a repeated-measures ANOVA, we could also have tested whether there were significant within-group trends in achievement. This was not possible because the groups would have become too small, a consequence of missing data across the measurements. However, even the cross-sectional analyses gave ample evidence for the strong effect that overlapping mathematical and reading skills have on school achievement. Second, we did not have data on the students' IQs, but it would have been very interesting to know what effects result from controlling for the students' IQs. However, the strength of the present study is that the sample represents an entire age group; i.e., the students have a wide range of IQs. And finally, although the sample size of this study was relatively large, the sample involves one age group in only one middle-sized city in Finland. The educational system has also to be taken into account, and the results of this study should be compared only with studies that are conducted in similar educational systems.

As practical implications, we emphasize that overlapping difficulties in mathematics and reading measured at the end of comprehensive school are clearly a risk for lower academic self-concept and that those difficulties have negative effects on school achievement across several school years. In this study the school achievement of the profile groups was followed from the fourth to ninth grade and one important finding was that already at fourth grade those students who had learning difficulties in reading and mathematics had the lowest grades in first language (Finnish) and students in MD and LD groups the lowest grades in mathematics. Therefore, it is not only very important to recognize learning problems as early as possible but also give enough recourses so that students can be provided with additional guidance and support in general education in order to avoid secondary consequences harming their educational career. This would be in accordance with the objectives of inclusive education.

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**Figure captions**

Figure 1. Means for participants' mathematics scores in the five cluster groups (NA=normal achievers, LD=learning difficulty, MD=mathematical difficulty, BA=best achievers, RD=reading difficulty) from Grade 4 to Grade 9.

Figure 2. Means for participants' first-language scores in the five cluster groups (NA=normal achievers, LD=learning difficulty, MD=mathematical difficulty, BA=best achievers, RD=reading difficulty) from Grade 4 to Grade 9.

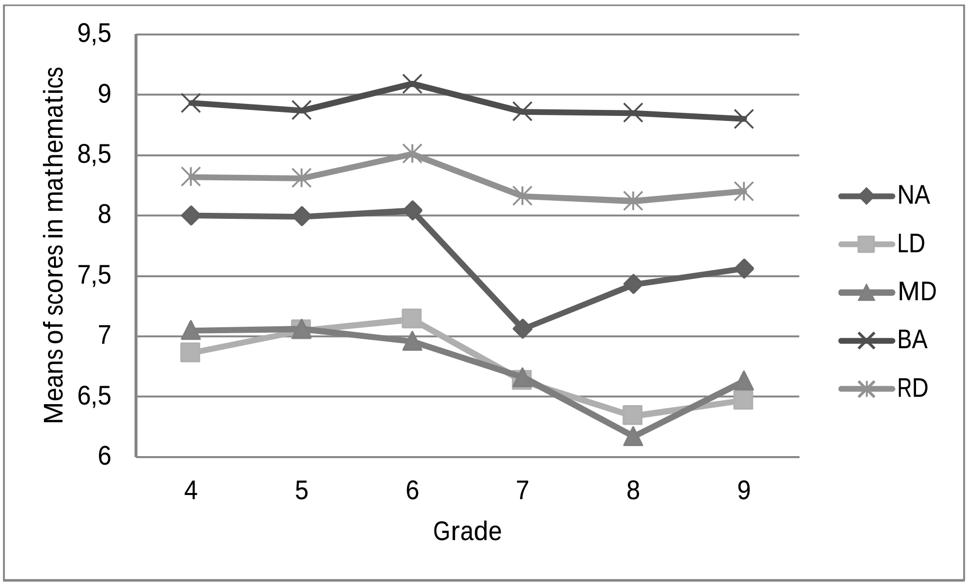


Figure 1

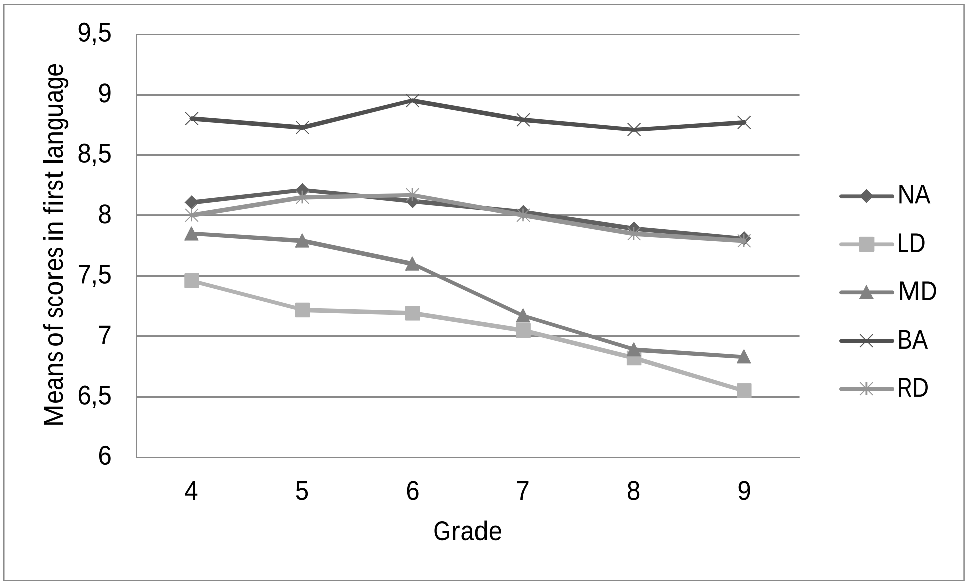


Figure 2

Table 1. Standardized means of the test variables in mathematics and reading across five clusters (NA=normal achievers, LD=learning difficulty, MD=mathematical difficulty, BA=best achievers, RD=reading difficulty).

| Tests | Clusters | | | | |
|---|---|---|---|---|---|
| | NA N=98 | MD & RD N=38 | MD N=54 | BA N=150 | RD N=85 |
| Reading comprehension | .21 | -2.23 | -.08 | .62 | -.03 |
| Decoding | .09 | -.81 | -.23 | .78 | -.93 |
| Arithmetic | -.16 | -.97 | -1.53 | .86 | .14 |
| Algebra | -.38 | -.90 | -1.39 | .90 | .27 |
| Geometry | -.45 | -.82 | -1.39 | .78 | .52 |

Table 2. Means, standard deviations, and post hoc comparisons of five cluster groups for mathematics scores in grades 4–9.

| | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|
| NA | 8.00(.93) [a,b,c] | 7.99(.86) [a,b,c] | 8.04(.88) [a,b,c,i] | 7.06(.88) [a,b,c,i] | 7.43(.93) [a,b,c,i] | 7.56(.89) [a,b,c,i] |
| LD | 6.86(.65) [a,d,e] | 7.05(.94) [a,d,e] | 7.14(.76) [a,d,e] | 6.63(.82) [a,d,e] | 6.34(1.07) [a,d,e] | 6.47(.95) [a,d,e] |
| MD | 7.05(.89) [b,f,g] | 7.06(.89) [b,f,g] | 6.96(.76) [b,f,g] | 6.66(.85) [b,f,g] | 6.17(1.01) [b,f,g] | 6.36(1.08) [b,f,g] |
| BA | 8.93(.73) [c,d,f,h] | 8.87(.75) [c,d,f,h] | 9.09(.67) [c,d,f,h] | 8.86(.80) [c,d,f,h] | 8.85(.90) [c,d,f,h] | 8.80(1.12) [c,d,f,h] |
| RD | 8.32(.89) [e,g,h] | 8.31(.84) [e,g,h] | 8.51(.91) [e,g,h,i] | 8.16(.86) [e,g,h,i] | 8.12(1.06) [e,g,h,i] | 8.20(1.06) [e,g,h,i] |
| F-tests | F[4,306]= 59.44; p=.00; eta$^2$ =.44 | F[4,416]= 69.10; p=.00; eta$^2$=.40 | F[4,413]= 98.44; p=.00; eta$^2$ =.49 | F[4,414]= 104.09; p=.00; eta$^2$ =.50 | F[4,418]= 108.04; p=.00; eta$^2$=.51 | F[4,417]= 79.70; p=.00; eta$^2$=.43 |

Note: F-tests between cluster groups (NA=normal achievers, LD=learning difficulty, MD=mathematical difficulty, BA=best achievers, RD=reading difficulty) in comprehensive school at grades 4–9. Superscripts [a,b,c...] indicate significant cluster group differences in the post hoc tests (Scheffe) as follows = NA/LD, b = NA/MD, c = NA/BA, d = LD/BA, e = LD/RD, f = MD/BA, g = MD/RD, h = BA/RD, i = NA/RD.

Table 3. Means, standard deviations, and post hoc comparisons of five cluster groups for first-language scores during grades 4–9.

| | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|
| NA | 8.11(.78)[a,b] | 8.21(.76) [a,b,f] | 8.18(.88) [a,b,f] | 8.03(.90) [a,b,f] | 7.89(1.03) [a,b,f] | 7.81(1.15) [a,b,f] |
| LD | 7.46(.84)[a,c] | 7.22(.79) [a,c,g,h] | 7.19(.71) [a,c,h] | 7.05(.84) [a,c,h] | 6.82(.95) [a,c,h] | 6.55(1.03) [a,c,h] |
| MD | 7.85(.86)[d] | 7.79(.74) [d,f,g] | 7.60(.95) [d,f,i,g] | 7.19(1.08) [d,f,i,g] | 6.89(1.17) [d,f,i,g] | 6.83(1.09) [d,f,i,g] |
| BA | 8.80(.70)[b,c,d,e] | 8.73(.68) [b,c,d,e] | 8.95(.64) [b,c,d,e] | 8.79(.76) [b,c,d,e] | 8.71(.77) [b,c,d,e] | 8.77(.73) [b,c,d,e] |
| RD | 8.00(.79)[e] | 8.15(.81) [e,h] | 8.17(.81) [e,h,i] | 8.00(.92) [e,h,i] | 7.85(.98) [e,h,i] | 7.79(1.05) [e,h,i] |
| F-tests | $F[4,307]= 25.52$; $p=.00$; $eta^2 =.25$ | $F[4,416]= 38.97$; $p=.00$; $eta^2=.27$ | $F[4,413]= 55.83$; $p=.00$; $eta^2 =.35$ | $F[4,414]= 51.77$; $p=.00$; $eta^2 =.33$ | $F[4,418]= 54.82$; $p=.00$; $eta^2=.34$ | $F[4,418]= 64.20$; $p=.00$; $eta^2=.38$ |

Note: F-tests between cluster groups (NA=normal achievers, LD=learning difficulty, MD=mathematical difficulty, BA=best achievers, RD=reading difficulty) in comprehensive school at grades 4–9. Superscripts [a,b,c...] indicate significant cluster group differences in the post hoc tests (Scheffe) as follows: a = NA/LD, b = NA/BA, c = LD/BA, d = MD/BA, e = BA/RD, f = NA/MD, g = LD/MD, h = LD/RD, i = MD/RD.