Children with learning difficulties in mathematics: Relating mathematics skills and reading comprehension

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The aim of this study is to examine the mathematics skills of fourth-grade children from Kosovo in relation to their background characteristics. Seventy-six children, out of 233 tested, who were identified with learning difficulties in mathematics were further assessed during fifth and sixth grades, in mathematics skills and reading comprehension. The findings showed that there were no gender differences in mathematics achievement, whereas children's urban or rural locations as well as their socio-economic status were observed to have a substantial impact on mathematics performance of children in the main sample, but not for those in the subsample. For children with learning difficulties in mathematics, the initial level of reading skills was a powerful determinant of their later mathematics performance and the initial level of mathematics skills was also similarly predictive of reading comprehension. The children's background characteristics did not add explanatory variance in performance outcomes over their previous mathematics and reading skills learned during the first years of primary school. The high association between mathematics performance and reading comprehension suggests that mathematics and reading problems may result from a similar cognitive background.

Introduction

Mathematics and reading skills are essential for successful functioning in all aspects of 21st century life (Hine et al., 2016; Joyce, Hine & Anderton, 2017). Seen from this perspective, it is very important that all children, including those with learning difficulties, acquire a solid foundation of basic academic skills across the core subject areas by the early grades. The International Mathematics, Science and Reading Literacy Study *TIMSS and PIRLS 2011* (Martin & Mullis, 2013) suggested that students who have not learned the basic fundamentals of mathematics and reading by the end of their fourth year of schooling are at risk for academic failure in the future and may lag far behind their peers as they continue in school. Thus, as Mullis (2013) pointed out, by achieving a certain degree of equity, students can continue in their schooling, building upon their basic foundation of knowledge and skills across the core curriculum areas. Furthermore, these skills are necessary beyond the school, in everyday real-life situations. For this reason, it is important to understand how many students lag behind and struggle with elementary concepts and skills across the core subject areas such as mathematics and reading (Duncan et al., 2007; Mullis, 2013).

Teaching and learning mathematics and reading skills are complex processes. As such, these processes present teachers and students with a range of challenging cognitive demands when planning, organising, monitoring, and evaluating activities. It is not surprising that in light of multiple skills involved in school performance, children's learning difficulties are less understood (Jordan, 2007), and the studies focusing on these issues are important. For example, researchers have suggested that basic reading proficiency is a strong predictor of mathematics achievement (Jordan, Kaplan, Olah & Locuniak, 2006; Jordan, Kaplan & Hanich, 2002), and early reading difficulties should be considered as a risk factor for mathematical difficulties (Leppanen, Niemi, Aunola & Nurmi, 2004). Despite this fact, according to Jordan (2007), reading difficulties appear to aggravate rather than cause mathematics difficulties. In their studies, Jordan, Kaplan, and Hanich (2002; 2003) found that difficulties in reading have a negative influence on children's development in general mathematics achievement, but difficulties in mathematics do not appear to affect the development of reading. This finding was also supported by the work of Landerl, Bevan and Butterworth (2004).

Other studies report that difficulties in reading and number fact retrieval are linked, and they share some common underlying deficits (Geary, 1993, 2004; Koponen, Aunola, Ahonen & Nurmi, 2007; Robinson, Menchetti & Torgesen, 2002; Simmons & Singleton, 2009; Vukovic, Lesaux & Siegel, 2010). Robinson and her associates (2002) formulated a theory that links weaknesses in learning and recalling number facts with the same phonological problem that impairs reading. In other words, children who have the most difficulty in recalling number facts may be those who do not process, encode and store such clearly and distinctly the information as an auditory-verbal image in long-term memory. It is also recognised that computational skills represent a major area of weaknesses for children with learning difficulties in mathematics (Jordan, Hanich & Kaplan, 2003; Salihu & Räsänen, 2018; Salihu, 2015). According to Jordan and her colleagues (Jordan et al., 2003), deficiencies in fact mastery and calculation fluency are defining features of mathematics difficulties, with or without reading difficulties. Hence, it is recommended that computational skills comprise and serve as an important part of any assessment because these skills are fundamental to success in all word problem-solving and practical application work (Shapiro & Elliott, 1999; Westwood, 2004).

In addition, to gain a deeper understanding of the development of mathematics and reading skills, it is important to acknowledge a multidimensionality of the process by taking into account those contributory factors influencing a child's ability to learn before and during formal school instruction. For example, the evidence from cross-cultural research studies such as the *TIMSS and PIRLS 2011* (Martin & Mullis, 2013; Mullis, Martin, Foy & Arora, 2012), indicated that the international variation in academic achievement suggests inclusion and evaluation of cultural influences in different countries, such as parental expectations and involvement, and the effectiveness of instructional approaches to curriculum and to classroom practice (Salihu & Räsänen, 2018; Salihu, Aro & Räsänen, 2017). The data collected from 34 countries have shown that socio-economic status indicated by parents' level of education and occupation or income substantially influenced the children's achievement in reading and mathematics in the fourth grade. Evidence also indicates that the difficulties in learning are strongly linked to children's socio-economic disadvantages. Sirin (2005) observed that children whose parents have a more prestigious occupation and greater income tend to have higher academic achievement, while children whose parents have a lower standing on such socio-economic status indicators tend to have lower learning outcomes, manifest a higher prevalence of behaviour problems, and leave school at the earliest opportunity (McLoyd, 1998; Sirin, 2005). Many children from lower socio-economic backgrounds lack the experiences and learning opportunities that are important for smooth entry into numeracy and literacy (Mwoma, 2017; Thornton, 2018).

Furthermore, once the child is in school, there is often less parental involvement in children's schoolwork, and the parents may hold lower expectations for their children's educational progress (Castro et al., 2015; Westwood, 2004). Evidence also indicates that family communication about school matters is associated with children's better academic performance and outcomes (Trautwein & Lüdtke, 2009). It seems that parents' function as role models, particularly in terms of home literacy activities, has a positive impact on the development of both literacy and numeracy skills. Studies have shown that a stronger emphasis on early literacy activities than on numeracy activities influenced both the levels of children's literacy and numeracy skills when entering school as well, as their achievement in the fourth grade (Anders et al., 2012; Gustafsson, Hansen & Rosen, 2013). As Anders and associates (Anders et al., 2012) have argued, this is because adequate language skills are a prerequisite for enhancing and promoting early mathematical thinking and communication.

Aim of the study

Drawn from theoretical explanations and previous empirical research evidence, the aim of this study was twofold: (1) to examine the mathematics skills in terms of children's background characteristics along with identifying those who struggle in mathematics learning, and (2) to investigate the relationship between mathematics and reading skills in children with learning difficulties in mathematics.

This work was an attempt to add to the ongoing discussion on issues mentioned above by providing research data from the Kosovo educational and social context.

Method

Participants

A total of 233 fourth-grade children from Kosovo (M = 116 months, SD = 6.93 months) participated in the present study. Of these, 132 were boys and 101 were girls. Four participating schools were randomly selected from two municipalities of Kosovo with average to low SES. In each school, all children in two classes were tested. Schools from urban and rural areas were included in this study in order to accurately represent the population. There were 131 children from urban areas and 102 children from rural areas.

Then, on the basis of poor performance in the RMAT (arithmetic test), a subsample of 80 children (46 boys and 34 girls) with learning difficulties in mathematics were selected from the main sample. They came from eight classes of two urban (n = 28) and two rural (n =

52) primary schools. Children with poor mathematics skills were identified by the use of the mathematics achievement RMAT test (Räsänen, 2004; Räsänen & Salihu, 2006). Based on the RMAT test score, all children who scored below the 35th percentile on national norms were included in the study. As suggested by prior research, there are two reasons for using this cut-off percentile. First, it increases the possibility of picking up in the screening those children who have persistent learning difficulties in mathematics (Geary et al., 2000; Hanich et al., 2001; Jordan et al., 2003; Räsänen, & Ahonen, 1995), and second, mathematics achievement based on RMAT score may mask children's specific deficits because the test contains different types of items (see Gersten, Jordan & Flojo, 2005; Gersten et al., 2011; Mazzocco, 2007; Mazzocco & Myers, 2003, for a complete discussion). In the subsample there were 63 children identified with low mathematics achievement (a cutoff criterion above the 15th percentile, but below the 35th percentile) and 13 children identified with limited mathematics ability (a cutoff criterion at or below the 15th percentile). All children attended general education classes, and none of them were receiving special educational services. For each child a specific number was assigned. During the follow-up, three children moved to other schools, and one, for personal reasons, discontinued participation in the study. All parents, except one, gave their written consent for participation in the study. As a result, 76 children were included in the follow-up analyses. Prior to its initiation, the study protocol was approved by the Ministry of Education, Science and Technology Committee.

The children's background information that was related to their parents' occupations was collected from the school records. Specific data for the parents' educational level were not available. Based on the occupational category, it was possible to distinguish each parent's occupation as belonging to one of the two categories: white-collar professions or blue-collar professions. A total of 27.0% of parents were working in white-collar professions (such as doctors, attorneys, economists, engineers, teachers, etc.), and 54.1% of parents were working in blue-collar professions (mostly part-time workers, such as repairing and building workers, plumbers, electricians, drivers, farm workers, sales clerks, etc.). In addition, 18.9% of parents' activities did not belong to either of the above-mentioned groups (e.g., housewives, students, pensioners, or unemployed).

Measures

Mathematics achievement

Each child's mathematics achievement was assessed in a group classroom situation with *RMAT - A Mathematical Achievement Test* for 9 to 12-year-olds (Räsänen, 2004; Räsänen & Salihu, 2006). The RMAT was used for all participants in this study to determine which children had learning difficulties in mathematics and required additional support (Salihu, Aro & Räsänen, 2017). RMAT is a time-restricted group test that enables screening of many children in a short time. RMAT items mainly consist of basic mathematics skills, such as arithmetic operations (e.g., $6000 - 627$; 204×12), fractions and decimals (e.g., $3/10$; 5×0.3), measurement (e.g., 9 l = ? dl), and algebra tasks (e.g., $x \div 20 = 8$). The Kosovo RMAT test (Räsänen & Salihu, 2006) is a translation of the Finnish RMAT test (Räsänen, 2004). In Kosovo, the test is used as a universal screening tool for identifying children with learning difficulties in mathematics. The time limit for the test was 10 minutes. It was developed as a one-dimensional test (Räsänen, 2004), so there is only one total score to interpret. One point is given for each correct answer. Consequently, the total maximum score for the test is 56 points.

The reliability and validity of the RMAT test have been shown to be sufficiently high in the Finnish (Räsänen, 2004) and Swedish (Räsänen, Linnanmäki, Haapamäki & Skagersten, 2008) populations of Finland, and the test has also proven to be valid and reliable for measuring the mathematics skills of Kosovar children (Salihu & Räsänen, 2018). As reported by Räsänen (2004), the Cronbach alpha reliability was .92 to .95 at ages 9 to 12; the correlation with the WRAT-R (Jastak & Wilkinson, 1984) was .547 to .659. The Cronbach alpha coeficient on this sample was .917. The RMAT test was used two more times with the group of children identified as having learning difficulties in mathematics with an interval of six months between the second and the third assessment. The Cronbach alpha reliabilities on this sample at two measurement points were .892 and .912.

Calculation skills

The *Mathematics Performance Test on Calculations*, MPT-C (Salihu, 2008) contains 25 items with one- and two-digit number combinations (addition, subtraction, multiplication, and division operations) and with four response options presented horizontally. It was administered in a group classroom situation. Children were given 20 minutes for task completion. The score was the number of correct answers. The Cronbach alpha on this sample was .889.

Reading comprehension

The children's reading comprehension was assessed by a short passage with five questions and four response options presented beneath in a worksheet. The task implied accuracy and fluency in reading. It was given in a group situation. Children had 5 minutes to respond. The score was the number of correct responses. The task was used three times within a year with an interval of 5 months between assessment points. The correlations between the summed scores at three measurement points ranged from .491 to .678.

Nonverbal intelligence

Children's general IQ was assessed using the *Raven's Standard Progressive Matrices* (SPMs; Raven, 1976) test. The SPM measures nonverbal reasoning with 60 items divided into five sets (A, B, C, D and E), each made up of 12 problems that progressively become more difficult. It was administered individually. The test administrator presented a sheet with alternative patterns and child selected from among six and eight choices, respectively. The score was the number of correct responses. The test is considered to be an efficient instrument for measuring the cognitive ability of subjects from childhood until adulthood (Raven, Raven & Court, 1998).

Procedure

The data collection was carried out in the middle of the school year among fourth-grade primary school children in two municipalities of Kosovo, a year and a half before the other data were collected (see Salihu & Räsänen, 2018, for more details). The RMAT test was administered in groups of 12–15 children in the classroom. It was administered using Albanian translation by the first author, with the help of the class teacher. Pencils and eraser were the only permissible equipment for the test, but children were allowed to count with their fingers or use a piece of paper for their workings. The children were instructed to solve as many of the problems as they could within the 10-minute time limit. After receiving the test instructions, the children were given the RMAT test booklets.

After the first assessment, the group of children identified by the RMAT test (RMAT 1) as low achievers in mathematics was assessed further, over the 2-year and 4-month follow-up period (see Salihu & Räsänen, 2018, for more details). The second assessment, at the end of fifth grade, consisted of a mathematics performance (MPT-Calculation) test, a reading comprehension task (Reading 1), and Raven's SPMs. Further, the RMAT and reading comprehension skills were assessed two more times at the beginning (RMAT 2, Reading 2) and in the middle of sixth grade (RMAT 3, Reading 3).

Data analysis

After checking the assumptions for parametric testing, a multivariate analysis of variance (MANOVA) was carried out to examine the impact of gender, location, and socio-economic background on children's academic skills (gender x location x parents' professional category). This analysis allowed us to assess the possible interactions, as well as the main effects of gender, location, and socio-economic background in the main sample and in the subsample.

Next, for the subsample, the relationship between children's performance on mathematics skills and their performance on reading comprehension and nonverbal reasoning was explored. For this set of analyses, correlation analyses were used. Finally, multiple regression analyses were performed between mathematics and reading performance as the dependent variables (RMAT 2, 3 and Reading comprehension 2, 3) and the initial reading (Reading comprehension 1) and mathematics (RMAT 1) skills as independent variables.

Results

To examine the impact of gender, location, and socio-economic background on children's mathematics achievement, multivariate analysis of variance (MANOVA) was carried out. The results showed that the interactions between these factors (gender x location x parents' occupation) did not reach significance ($p > .645$). The same pattern was observed for the subsample of children identified with learning difficulties in mathematics ($p > .280$).

There was a statistically non-significant effect of gender on children's mathematics achievement, $F(1, 221) = 3.32$, $p = .070$, $\eta^2 = .015$. A statistically significant difference in mathematics performance was found between children from urban areas and those from rural areas, $F(1, 221) = 15.50$, $p < .001$, $\eta^2 = .066$, the children from the rural areas scoring lower as compared to their peers from the urban areas (Table 1). The big difference in mathematics achievement was noticed particularly between girls from the urban areas (M = 26.55, SD = 5.98) and girls from the rural areas (M = 20.00, SD = 8.80).

Table 1: Descriptive information for children's mathematics achievement by gender, location, and parents' professional category

		Main sample			Subsample		
		n	*M*	*SD*	*n*	*M*	*SD*
Gender	Girls	101	23.89	7.91	32	14.69	6.36
	Boys	132	25.33	7.46	44	17.11	5.19
Location	Urban	131	26.92	6.37	25	16.32	5.78
	Rural	102	21.95	8.16	51	15.98	5.86
Parents' professional category	White-collar	63	28.24	6.76	10	17.20	6.61
	Blue-collar	126	23.29	7.73	51	15.69	5.46
	Other	44	23.70	7.28	15	16.73	6.61

The results showed that parents' professional category also had a significant effect on children's achievement score, indicating that children whose parents were in white-collar professions had better scores in mathematics compared with children whose parents were in blue-collar or other occupations, $F(2, 221) = 3.42$, $p = .034$, $\eta^2 = .030$ (see Table 1). Tukey tests revealed that children whose parents were in white-collar professions achieved better scores than children whose parents were in blue-collar professions (mean difference = 4.94, SE = 1.11) and those whose parents were in the other occupational category (mean difference = 4.53, SE = 1.41). However, no differences were observed in terms of achievement in RMAT between children whose parents belonged to blue-collar and other occupation categories (mean difference = 0.41, SE = 1.26).

For the subsample of children with learning difficulties in mathematics, findings showed that these children did not differ in mathematics performance (all $p > .05$) and reading comprehension (all $p > .05$) as a function of gender, location, and parental occupation over time (see Table 1). In Table 2 the mean scores for children's performance over time are displayed for all the scales.

Table 2: Performance outcomes of children with learning difficulties in mathematics by gender and location

Scale	All		Girls		Boys		Urban		Rural	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
RMAT 1	16.09	5.80	14.69	6.36	17.11	5.19	16.32	5.78	15.98	5.86
RMAT 2	23.47	7.08	22.91	6.73	23.89	7.38	23.84	7.18	23.29	7.10
RMAT 3	23.61	8.20	24.44	6.97	23.00	9.03	22.42	9.83	24.18	7.35
MPT-C	14.79	6.02	14.09	6.61	15.30	5.58	15.56	5.43	14.41	6.31
Reading 1	3.14	1.39	3.25	1.34	3.07	1.44	3.28	1.27	3.08	1.45
Reading 2	3.59	1.43	3.66	1.47	3.55	1.42	3.80	1.44	3.49	1.43
Reading 3	3.91	1.35	4.22	1.01	3.67	1.52	3.83	1.55	3.94	1.26
RPM	35.59	5.92	35.12	6.10	35.93	5.84	36.32	5.80	35.24	6.01

Note. RMAT = mathematics achievement test; MPT-C = Mathematics performance test on calculations; RPM = Raven's progressive matrices; 1, 2, 3 = assessment time point.

Another aspect of this study was to investigate the relationship between children's mathematics achievement, mathematical performance, reading comprehension, and their intellectual capacity. Correlations between the sum variables in Table 3 showed that mathematics achievement was highly associated with all mathematical performance outcomes, reading comprehension, and general intelligence.

Table 3: Correlations between children's mathematical performance, reading comprehension, and nonverbal reasoning

Variables	1	2	3	4	5	6	7	8
1. RMAT 1	-							
2. RMAT 2	.689**	-						
3. RMAT 3	.587**	.730**	-					
4. MPT-C	.704**	.820**	.742**	-				
5. Reading comprehension 1	.378**	.500**	.441**	.520**	-			
6. Reading comprehension 2	.506**	.435**	.412**	.454**	.657**	-		
7. Reading comprehension 3	.390**	.365**	.448**	.406**	.491**	.678**	-	
8. RPM	.338**	.388**	.348**	.343**	.419**	.361**	.251*	-

Note. RMAT = mathematics achievement test; MPT-C = Mathematics performance test on calculations; RPM = Raven's progressive matrices; 1, 2, 3 = assessment time point.
$^{**}p < 0.01$, $^{*}p < 0.05$.

Then, multiple regression analyses were performed between mathematics and reading performance as the dependent variables (RMAT 2, 3 and Reading comprehension 2, 3) and the initial reading and mathematics skills as independent variables, to determine the extent and the strength of relationships between these variables. Findings show that altogether, 54% (for RMAT 2), 40% (RMAT 3), 56% (MPT-C), 51% (Reading comprehension 2), and 29% (Reading comprehension 3) respectively of the variability in mathematics and reading performance was predicted by the initial level of children's reading comprehension ability and mathematics skills. As indicated by the squared semipartial correlations, the two predictors accounted for unique variance in RMAT 2 (25% and 29%), RMAT 3 (19% and 21%), MPT-C (19% and 36%), Reading comprehension 2 (26% and 25%), and Reading comprehension 3 (14% and 15%). The addition of the background variables did not appreciably add to the explanatory variance in mathematics and reading outcomes over the previous mathematics and reading skills. It is worth mentioning that despite the significant positive correlations between nonverbal intelligence and performance on mathematics and reading tasks, nonverbal reasoning did not contribute significantly to regression.

Discussion

This study examined the mathematics skills in terms of children's background characteristics along with identifying those children who struggle in mathematics learning. Specifically, the focus of our study was the investigation of the relationship between mathematics performance and reading comprehension in children with learning difficulties in mathematics.

The results showed there were no gender differences in mathematics achievement at the fourth grade for the main sample, as well as for the subsample of those children who were followed-up and identified as having learning difficulties in mathematics at the fifth and sixth grades. The finding is in line with previous studies that illustrated that there was no significant average effect of gender on achievement in mathematics for this age group (Gustafsson et al., 2013; Lachance & Mazzocco, 2006; Mullis et al., 2012; Salihu & Räsänen, 2018). In comparison, substantial effects on mathematics performance are observed for location, as well as for the parental occupation category. However, in all measures, these effects were found not to be significant on the performance of children with learning difficulties. Similar results were found by Gustafsson and associates (2013) who reported that the total effects of parental education were substantial for mathematics and reading. They also noted that although the quality of the students' home environment explained substantial variance in numeracy at the first assessment, there was no significant effect of home environment on the numeracy development after the first assessment, suggesting that other factors should be considered when assessing the children's basic academic skills (Duncan et al., 2007; Moser, West & Hughes, 2012; Salihu & Räsänen, 2018).

Martin and associates (2013) documented that school instruction is a powerful factor that has an effect on student achievement, over and above home influences. The instructional differences among countries not only influenced student achievement in the TIMSS content domains, but also in the cognitive domains (Martin et al., 2013). Bearing in mind this fact, as noted in the recent study (see Salihu & Räsänen, 2018), students attending schools in rural areas of Kosovo traditionally have had fewer opportunities for development of their abilities due to the lack of resources and non-equal distribution of means and equipment for learning and instruction in schools in those locations. The limited access to learning opportunities and support in turn has had a major impact on children's low mathematics achievement. Discrepant results of this study for the RMAT in terms of schools in urban and rural areas should be addressed by educational policymakers.

Indeed, the findings of our study also confirm that children's previous mathematics and reading skills learned at the fourth grade were highly predictive of their later performance on academic skills. High predictive correlations between RMAT and reading comprehension indicate that these skills may have at least some common cognitive grounds. Hence, it is likely that children with learning difficulties in mathematics could be at risk for developing associated reading difficulties as they progress through primary school, and vice versa. The research findings are in line with previous studies suggesting the contribution of reading skills to mathematics performance (Aunola et al., 2004; Geary et al., 2000; Larwin, 2010; Mazzocco & Myers, 2003; Mullis, Martin & Foy, 2013; Räsänen & Ahonen, 1995; Rutherford-Becker & Vanderwood, 2009) and contribution of mathematics skills to reading performance (Geary, 1993; Koponen et al., 2007; Koponen et al, 2016). Furthermore, the findings suggest that parallel assessment of both mathematics and reading skills is needed not only for the detection and identification of children who struggle in learning, but also for the purpose of planning and providing special instruction as a means of intervention in order to meet their learning needs and to restructure properly knowledge and skills in these two core subject areas (Bowles et al., 2016; Salihu, Aro, & Räsänen, 2017). This planning can go a long way towards overcoming difficulties and preventing school failure and drop-out in developing countries similar to Kosovo's circumstances of economic and social welfare deprivation.

Limitations

It is important to note, however, that the relatively small number of children in the subsample can be considered as a limitation of the study and should be considered in any attempts at generalising the findings (Salihu & Räsänen, 2018). Moreover, the measure we used for reading comprehension served as a brief control task for assessing children's reading comprehension and it is not a standardised one. To gain a deeper understanding of children's reading ability perhaps a more sophisticated standardised measure for assessing reading fluency and comprehension is needed (Salihu & Räsänen, 2018).

Conclusion and future direction

In sum, although developing fluency in mathematics computation and reading have been fundamental goals of education in every country, the promise has never been completely fulfilled (UNESCO, 2015). Still, a considerable number of children, particularly in the underdeveloped countries, have a lack of the basic academic skills. To reach the mentioned goals and prevent school failure, the psychological principles proposed by Griffin (2007) are of supreme importance for the meaningful and effective instruction. The kind of instruction that adequately matches the learning and instructional needs has the capacity to improve children's achievement and performance, despite their background characteristics. Thus, further research is needed to further clarify the interconnectedness of cognitive and non-cognitive factors that influence the development of mathematics skills and reading ability in children with learning difficulties.

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References

Anders, Y., Rossbach, H.-G., Weinert, S., Ebert, S., Kuger, S., Lehrl, S. & von Maurice, J. (2012). Home and preschool learning environments and their relations to the development of early numeracy skills. *Early Childhood Research Quarterly*, 27(2), 231-244. https://doi.org/10.1016/j.ecresq.2011.08.003

Aunola, K., Leskinen, E., Lerkkanen, M.-K. & Nurmi, J.-E. (2004). Developmental dynamics of math performance from preschool to grade 2. *Journal of Educational Psychology*, 96(4), 699 713. https://doi.org/10.1037/0022-0663.96.4.699

Bowles, T., Scull, J., Hattie, J., Clinton, J., Larkins, G., Cicconi, V., Kumar, D., & Arnup, J. L. (2016). Conducting psychological assessments in schools: Adapting for converging skills and expanding knowledge. *Issues in Educational Research*, 26(1), 10-28. http://www.iier.org.au/iier26/bowles.html

Castro, M., Exposito-Casas, E., Lopez-Martin, E., Lizasoain, L., Navarro-Asencio, E., & Luis Gaviria, J. (2015). Parental involvement on student academic achievement: A meta-analysis. *Educational Research Review*, 14, 33-46. https://doi.org/10.1016/j.edurev.2015.01.002

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K. & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, 43(6), 1428-1446. https://doi.org/10.1037/0012-1649.43.6.1428

Geary, D. C. (2004). Mathematics and learning disabilities *Journal of Learning Disabilities,* 37(1), 4-15. https://doi.org/10.1177/00222194040370010201

Geary, D. C., Hamson, C. O. & Hoard, M. K. (2000). Numerical and arithmetical cognition: A longitudinal study of process and concept deficits in children with learning disability. *Journal of Experimental Child Psychology*, 77(3), 236-263. https://doi.org/10.1006/jecp.2000.2561

Geary, D. C. (1993). Mathematical disabilities: Cognitive, neuropsychological, and genetic components. *Psychological Bulletin*, 114(2), 345-362. https://doi.org/10.1037/0033-2909.114.2.345

Gersten, R., Clarke, B. S., Haymond, K. & Jordan, N. C. (2011). *Screening for mathematics difficulties in K-3 students* (2nd ed.). Portsmouth, NH: RMC Research Corporation, Center on Instruction. https://files.eric.ed.gov/fulltext/ED524577.pdf

Gersten, R., Jordan, N. C. & Flojo, J. R. (2005). Early identification and interventions for students with mathematical difficulties. *Journal of Learning Disabilities*, 38(4), 293-304. https://doi.org/10.1177/00222194050380040301

Griffin, S. (2007). Early intervention for children at risk of developing mathematical learning difficulties. In D. B. Berch & M. M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 373-395). Baltimore, MD: Brookes Publishing. https://products.brookespublishing.com/Why-Is-Math-So-Hard-For-Some-Children-P378.aspx

Gustafsson, J.-E., Hansen, K. Y., & Rosén, M. (2013). Effects of home background on student achievement in reading, mathematics, and science at the fourth grade. In M. O. Martin and I. V. S. Mullis (Eds.), *TIMSS and PIRLS 2011: Relationships among reading, mathematics, and science achievement at the fourth grade–Implications for early learning.* (pp. 181-287). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. https://timssandpirls.bc.edu/timsspirls2011/downloads/TP11_Chapter_4.pdf

Hanich, L. B., Jordan, N. C., Kaplan, D. & Dick, J. (2001). Performance across different areas of mathematical cognition in children with learning difficulties. *Journal of Educational Psychology*, 93(3), 615-626. https://doi.org/10.1037/0022-0663.93.3.615

Hine, G., Reaburn, R., Anderson, J., Galligan, L., Carmichael, C., Cavanagh, M., Ngu, B. & White, B. (2016). *Teaching secondary mathematics.* Port Melbourne, VIC: Cambridge University Press.

Jastak, S. & Wilkinson, G. S. (1984). *The wide range achievement test: Revised.* Wilmington, DE: Jastak Associates.

Jordan, N. C. (2007). Do words count? Connections between mathematics and reading difficulties. In D. B. Berch & M. M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 107-120). Baltimore, MD: Brookes Publishing. https://products.brookespublishing.com/Why-Is-Math-So-Hard-For-Some-Children-P378.aspx

Jordan, N. C., Kaplan, D., Olah, L.N. & Locuniak, M. N. (2006). Number sense growth in kindergarten: A longitudinal investigation of children at risk for mathematics difficulties. *Child Development*, 77(1), 153-175. https://doi.org/10.1111/j.1467-8624.2006.00862.x

Jordan, N. C., Hanich, L. B. & Kaplan, D. (2003). A longitudinal study of mathematical competencies in children with specific mathematics difficulties versus children with co-morbid mathematics and reading difficulties. *Child Development*, 74(3), 834-850. https://doi.org/10.1111/1467-8624.00571

Jordan, N. C., Kaplan, D. & Hanich, L. B. (2002). Achievement growth in children with learning difficulties in mathematics: Findings of a two-year longitudinal study. *Journal of Educational Psychology*, 94(3), 586-597. https://doi.org/10.1037/0022-0663.94.3.586

Joyce, C., Hine, G. & Anderton, R. (2017). The association between secondary mathematics and first year university performance in health science. *Issues in Educational Research*, 27(4), 770-783. http://www.iier.org.au/iier27/joyce.pdf

Koponen, T., Salmi, P., Torppa, M., Eklund, K., Aro, T., Aro, M., Poikkeus, A.-M., Lerkkanen, M.-K. & Nurmi, J.-E. (2016). Counting and rapid naming predict the fluency of arithmetic and reading skills. *Contemporary Educational Psychology*, 44-45, 83-94. https://doi.org/10.1016/j.cedpsych.2016.02.004

Koponen, T., Aunola, K., Ahonen, T. & Nurmi, J.-E. (2007). Cognitive predictors of single-digit and procedural calculation skills and their covariation with reading skill. *Journal of Experimental Child Psychology*, 97(3), 220-241. https://doi.org/10.1016/j.jecp.2007.03.001

Lachance, J. A. & Mazzocco, M. M. M. (2006). A longitudinal analysis of sex differences in math and spatial skills in primary school age children. *Learning and Individual Differences*, 16(3), 195-216. https://doi.org/10.1016/j.lindif.2005.12.001

Landerl, K., Bevan, A. & Butterworth, B. (2004). Developmental dyscalculia and basic numerical capacities: A study of 8–9-year-old students. *Cognition,* 93(2)*,* 99-125. https://doi.org/10.1016/j.cognition.2003.11.004

Larwin, K. H. (2010). Reading is fundamental in predicting math achievement in 10th graders? *International Electronic Journal of Mathematics Education,* 5(3), 131-145. http://www.iejme.com/article/reading-is-fundamental-in-predicting-math-achievement-in-10th-graders

Leppanen, U., Niemi, P., Aunola, K. & Nurmi, J.-E. (2004). Development of reading skills among preschool and primary school pupils. *Reading Research Quarterly*, 39(1), 72-93. https://doi.org/10.1598/RRQ.39.1.5

Martin, M. O. & Mullis, I. V. S. (Eds) (2013). *TIMSS and PIRLS 2011: Relationships among reading, mathematics, and science achievement at the fourth grade – implications for early learning.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of

Education, Boston College. https://timssandpirls.bc.edu/timsspirls2011/international-database.html

Martin, M. O., Foy, P., Mullis, I. V. S. & O'Dwyer, L. M. (2013). Effective schools in reading, mathematics, and science at the fourth grade. In M. O. Martin & I. V. S. Mullis (Eds.), *TIMSS and PIRLS 2011: Relationships among reading, mathematics, and science achievement at the fourth grade – implications for early learning.* (pp. 109-278). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. https://timssandpirls.bc.edu/timsspirls2011/downloads/TP11_Chapter_3.pdf

Mazzocco, M. M. M. (2007). Defining and differentiating mathematical learning disabilities and difficulties. In D. B. Berch & M. M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 29-47). Baltimore, MD: Brookes Publishing. https://products.brookespublishing.com/Why-Is-Math-So-Hard-For-Some-Children-P378.aspx

Mazzocco, M. M. M. & Myers, G. F. (2003). Complexities in identifying and defining mathematics learning disability in the primary school-age years. *Annals of Dyslexia*, 53(1), 218-253. https://doi.org/10.1007/s11881-003-0011-7

McLoyd, V. C. (1998). Socioeconomic disatvantage and child development. *American Psychologist*, 53(2), 185-204. https://doi.org/10.1037/0003-066X.53.2.185

Moser, S. E., West, S. G. & Hughes, J. N. (2012). Trajectories of math and reading achievement in low-achieving children in elementary school: Effects of early and later retention in grade. *Journal of Educational Psychology,* 104(3), 603-621. https://doi.org/10.1037/a0027571

Mullis, I. V. S. (2013). Profiles of achievement across reading, mathematics, and science at the fourth grade. In M. O. Martin and I. V. S. Mullis (Eds.), *TIMSS and PIRLS 2011: Relationships among reading, mathematics, and science achievement at the fourth grade – implications for early learning.* (pp. 13-65). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. https://timssandpirls.bc.edu/timsspirls2011/downloads/TP11_Chapter_1.pdf

Mullis, I. V. S., Martin, M. O. & Foy, P. (2013). The impact of reading ability on TIMSS mathematics and science achievement at the fourth grade: An analysis by item reading demands. In M. O. Martin & I. V. S. Mullis (Eds.), *TIMSS and PIRLS 2011: Relationships among reading, mathematics, and science achievement at the fourth grade – implications for early learning.* (pp. 67-108). Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. https://timssandpirls.bc.edu/timsspirls2011/downloads/TP11_Chapter_2.pdf

Mullis, I. V. S., Martin, M. O., Foy, P. & Arora, A. (2012). *TIMSS 2011 International results in mathematics*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. https://timssandpirls.bc.edu/timss2011/international-results-mathematics.html

Mwoma, T. (2017). Children's reading ability in early primary schooling: Challenges for a Kenyan rural community. *Issues in Educational Research*, 27(2), 347-364. http://www.iier.org.au/iier27/mwoma.pdf

Raven, J., Raven, J. C. & Court, J. H. (1998). *Manual for standard progressive matrices: Including the parallel and plus versions*. San Antonio, TX: Harcourt.

Raven, J. C. (1976). *Standard progressive matrices: Sets A, B, C, D & E*. Oxford: Oxford Psychologists Press.

Räsänen, P., Linnanmäki, K., Haapamäki, C. & Skagersten, D. (2008). *RMAT - Test av räknefärdighet hos evelver i åldern 9-12 år* [A mathematical achievement test for ages 9-12 in Finnish-Swedish]. Jyväskylä: Niilo Mäki Institute. https://www.nmi.fi/fi/julkaisut/nmi-julkaisut/RasanenEtAl2009a

Räsänen, P. & Salihu, L. (2006). *RMAT - Test i arritshmërisë në matematikë për moshën 9-12 vjeçare* [A mathematical achievement test for 9–12-year-olds]. Jyväskylä: Niilo Mäki Institute.

Räsänen, P. (2004). *RMAT-laskutaidon testi 9-12-vuotiaille: Kasikirja* [A mathematical achievement test for 9-12-year-olds: Manual]. Jyväskylä: Niilo Mäki Institute.

Räsänen, P., & Ahonen, T. (1995). Arithmetic disabilities with and without reading difficulties: A comparison of arithmetic errors. *Developmental Neuropsychology*, 11(3), 275-295. https://doi.org/10.1080/87565649509540620

Robinson, C. S., Menchetti, B. M. & Torgesen, J. K. (2002). Toward a two-factor theory of one type of mathematics disabilities. *Learning Disabilities Research & Practice*, 17(2), 81-89. https://doi.org/10.1111/1540-5826.00035

Rutherford-Becker, K. J. & Vanderwood, M. L. (2009). Evaluation of the relationship between literacy and mathematics skills as assessed by curriculum-based measures. *The California School Psychologist,* 14(1), 23-34. https://doi.org/10.1007/BF03340948

Salihu, L. & Räsänen, P. (2018). Mathematics skills of Kosovar primary school children: A special view on children with mathematical learning difficulties. *International Electronic Journal of Elementary Education,* 10(4), 421-430. https://doi.org/10.26822/iejee.2018438132

Salihu, L., Aro, M. & Räsänen, P. (2017). Dynamic potential of feedback in self-regulated learning and motivation of children with mathematical learning difficulties. *Hrvatska Revija za Rehabilitacijska Istra ivanja,* 53(2), 111-129. https://hrcak.srce.hr/file/282808

Salihu, L. (2015). Academic skills of Kosovar children with mathematical learning difficulties. 16th Biennial Conference of the European Association for Research on Learning and Instruction - EARLI SIG 15 Special Educational Needs, 25-29 August 2015, Limassol, Cyprus.

Salihu, L. (2008). *Testi i performancës në matematikë - Kalkulimet (TPM-K)* [Mathematics performance test on calculations, MPT-C] (Unpublished test material). University of Prishtina, Kosovo.

Simmons, F. R. & Singleton, C. (2009). The mathematical strengths and weaknesses of children with dyslexia. *Journal of Research in Special Educational Needs*, 9(3), 154-163. https://doi.org/10.1111/j.1471-3802.2009.01128.x

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, 75(3), 417-445. https://doi.org/10.3102/00346543075003417

Shapiro, E. S. & Elliott, S. N. (1999). Curriculum-based assessment and other perfromance-based assessment strategies. In C. R. Reynolds & T. B. Gutkin (Eds.) *The handbook of school psychology* (pp. 383-408). New York, NY: Wiley.

Thornton, F. (2018). Counselors and special educators in rural schools working together to create a positive school community. *International Electronic Journal of Elementary Education,* 10(3), 385-389. https://doi.org/10.26822/iejee.2018336197

Trautwein, U. & Lüdtke, O. (2009). Predicting homework motivation and homework effort in six school subjects: The role of person and family characteristics, classroom factors, and school track. *Learning and Instruction,* 19(3), 243-258. https://doi.org/10.1016/j.learninstruc.2008.05.001

UNESCO (2015). *Rethinking education: Towards a global common good?* Paris: UNESCO. http://unesdoc.unesco.org/images/0023/002325/232555e.pdf

Vukovic, R. K., Lesaux, N. K. & Siegel, L. S. (2010). The mathematics skills of children with reading difficulties. *Learning and Individual Differences*, 20(6), 639-643. https://doi.org/10.1016/j.lindif.2010.08.004

Westwood, P. (2004). *Learning and learning difficulties: A handbook for teachers*. London: David Fulton Publishers.

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