

A CURRICULUM-ALIGNED SCREENING TOOL FOR IDENTIFYING MATHEMATICAL LEARNING DIFFICULTIES IN GRADE 3

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Abstract

This study focuses on the development and initial testing of a school-based mathematics screening tool intended to assess whether third-grade students have acquired the essential skills and knowledge required for a solid foundation in further mathematics learning and to identify children with mathematical learning difficulties. A quantitative empirical design was used to construct a curriculum-aligned assessment consisting of a written and oral component. Results indicate that approximately 5–8% of students demonstrated performance profiles consistent with MLD, with specific difficulties observed in multiplicative reasoning, unit conversion, and verbal description of geometric solids. The test was administered in five schools in Tallinn. A total of 251 students participated in the written assessment and 82 students in the oral assessment. Based on the analysis of the test results, it can be concluded that the test presented in this article offers an overview of students' attainment in mathematics. Furthermore, the results can be used by professionals working with children to plan and implement their work more effectively.

Keywords: *Mathematical learning difficulties, mathematics assessment, screening tool.*

1. Introduction

Mathematical difficulties can greatly hinder students' learning of the subject. While there is no exact statistics, it is suggested that around 25% of people struggle with mathematics (BDA, 2025). Other authors have proposed that approximately 5%–8% of children experience mathematical difficulties (Geary, 2004; Lyon, 1996; Reeve & Gray, 2015; Shalev & Gross-Tsur, 2001), yet these difficulties receive considerably less attention than writing and reading difficulties. These numbers indicate that there can be students in every grade and classroom needing extra support. Mathematical difficulties have an impact on the learning of all skills and topics in mathematics. Previous studies have found that these struggles are mostly caused by differences in cognitive processes (Huijsmans et al., 2022). In the next paragraphs, we will give an overview of how various areas of mathematics can be affected by these differences. Arithmetic skills refer to the ability to perform, understand, and accurately evaluate standard algorithms to solve a variety of tasks both mentally and in written form using different tools and strategies (Sharma, 2015). Arithmetic skills provide the foundation for learning higher level mathematics, beginning with algebra and geometry (Dowker, 2024; Sharma, 2015). In terms of arithmetic skills, students with mathematical learning difficulties differ from their peers, for example, in their ability to apply basic knowledge to solve simple computational and word problems (Dowker, 2024; Koç & Korkmaz, 2020). The use of basic knowledge does not develop efficiently in children with mathematical learning difficulties during the first stage of primary education (Shalev & Gross-Tsur, 2001). These children tend to rely on immature computation strategies and continue to make errors in counting (Stocker et al., 2018). The most pronounced difference between students with learning difficulties and their peers lies in the significantly slower rate at which necessary skills are acquired (Dowker, 2022, 2024; Geary, 2004, Rouselle & Noël, 2007). Many children with learning difficulties do not demonstrate readiness to shift from procedural problem-solving strategies to memory-based strategies, which suggests difficulties in storing relevant knowledge in long-term memory (Dowker, 2014). Several authors (Dowker, 2024; Geary, 2004; Rouselle & Noël, 2007) emphasize that students with mathematical learning difficulties perform less accurately and make larger errors than their peers when comparing Arabic numerals and given quantities. In addition to number sense and arithmetic, mathematical difficulties can also be apparent when solving word problems, or tasks related to geometry and measurement. Word problems present a multifaceted challenge that requires reading skill, text comprehension, understanding mathematical terms, composing arithmetic facts, and answering the problem with full sentences (Henderson, 2012). Geometry and measurement require visual-spatial thinking and accuracy, skills that can be challenging if the shortcomings of cognitive processes limit learning. In order for special educators, classroom teachers, and subject teachers to identify mathematical learning difficulties

as early as possible and to better plan and implement instruction, it is essential to have precise information about the skills that children have already acquired and the areas that present difficulties. The aim of this study was to develop an assessment instrument that evaluates the extent to which third-grade students have acquired the skills and knowledge necessary for a solid foundation for further learning in mathematics. The following research questions were established: 1) What are the strengths and weaknesses of grade 3 students in mathematics skills? 2) What are the mathematics skills of low performing and high performing students within oral assessment?

2. Method

2.1. Sample

The first sample for written assessment consisted of 251 students from grade 3 enrolled in five general education schools in the capital of the country (aged 9–10). Participation was voluntary, and schools and parents were informed about the purpose and procedure of the study prior to data collection via a signed consent form. Based on performance in the written assessment, a purposive subsample of 82 students was selected to participate in the oral assessment. Selection criteria for the oral assessment included A) students who scored 50% or less on the written test ($N = 16$), indicating potential risk for mathematical learning difficulties, and B) a comparison group of students with higher written test performance ($N = 66$), selected to ensure variability and to examine the added value of oral assessment across performance levels.

2.2. Data collection instrument and analysis

The data collection instrument was developed in alignment with national curriculum requirements for grade 3 mathematics and designed to be feasible for use in everyday school practice. The development process was informed by previous research on mathematical learning difficulties and by practical considerations relevant to classroom and support team contexts. The data collection instrument consisted of two parts: written and oral assessment. Both parts of the instrument assessed three core mathematical domains central to upper primary mathematics:

1. Arithmetic (calculation): including basic operations (addition, subtraction, multiplication, division), multi-step calculations, and understanding of relationships between operations.
2. Measurement and word problems: including length measurement, unit conversion, and application of arithmetic skills in contextualized problem-solving tasks.
3. Geometric figures and solids: including recognition, classification, and verbal description of two-dimensional shapes and three-dimensional solids.

While the written assessment of the instrument focused primarily on procedural accuracy and application, the oral part emphasized conceptual understanding, verbal reasoning, and the ability to explain mathematical ideas. Descriptive statistics indices were calculated to give an overview of the overall performance patterns, score distributions, and domain-specific results.

2.3. Data collection procedure

The written assessment was administered during regular school hours in classroom settings by the students' teachers or school staff, following standardized instructions. Students completed the written assessment within a fixed time frame of 45 minutes. The oral assessment was conducted individually in a quiet setting within the school environment. Each oral session followed a structured protocol and included tasks designed to elicit students' verbal explanations, reasoning strategies, and conceptual understanding. The two-stage assessment procedure was designed to minimize disruption to regular instruction while providing additional diagnostic insight into students who demonstrated weaker performance in the written assessment.

3. Results

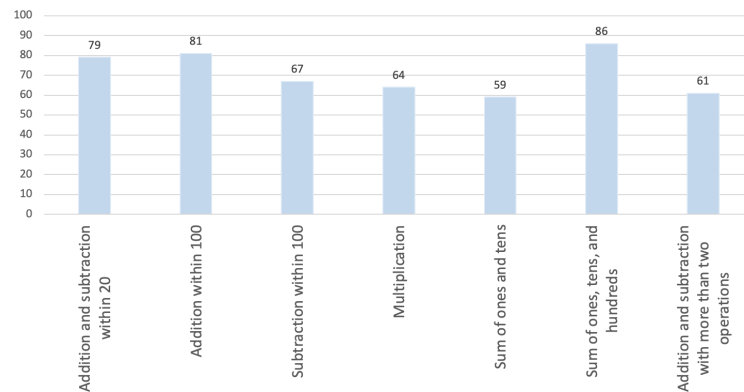
3.1. Strengths and weaknesses based on written assessment

The mean total score for the written assessment was approximately $M \approx 52$ ($SD = 10.45$; $\max = 67$). A majority of students (42%) scored from 75% to 89% of the maximum score, while the remaining students achieved either more (23%) or less (35%). 16 students, which is around 6% of the whole sample, scored less than 50% of the whole test. None of the students completed the written assessment with zero errors, while four students solved the tasks in the written assessment with only one error. The lowest score was 13 points.

3.1.1. Arithmetic skill. Arithmetic skill was assessed within multiple sub-skills. Students were most successful in representing a three-digit number in sum of ones, tens, and hundreds (maximum score of 3

points was achieved by 86% of the participants; Figure 1). Controversially, representing a two-digit number in sum of ones and tens was the least successful sub-skill with 59% of students scoring the maximum. In terms of calculations the skill of addition within 100 appeared to be the strongest, while multiplication stands out as the most difficult.

Figure 1. Percentage of students achieving maximum points of respective sub-skill.



3.1.2. Measurement, geometric figures, and word problems. The skills of measurement and identifying geometric figures present very varied results. Firstly, students were the most successful in identifying triangles among a set of geometric shapes with 88% scoring maximum (Figure 2) and 12% failing to do so. In the task assessing the measurement and labelling of a line segment, 78% of the students achieved the maximum score of 3 points, while 19% failed to complete the task successfully. It should be noted that 4% of the students did not attempt the task. Among other sub-skills presented in Figure 1, the task involving comparison of line segments presented overall difficulty with only 18% of students receiving a maximum score of 5 points. 40% of students got half of the task correct and 22% of students fully failed to complete it. 7% decided not to even try solving the task. Other skills that are not well acquired are conversions of metres to decimetres and decimetres to centimetres with 20% of students scoring zero. Assessing measurement in centimetres and correct labelling of side lengths of geometric shapes was successfully solved by 43% of students, while 7% failed to solve the task. The students were most successful in solving one-step word problem involving addition with 77% of participants achieving the maximum score (Figure 3). The least successful operation in the context of word problem was subtraction. While the overall success rate looks promising, it is important to bring out that 27% of students failed to solve a single-step word problem using division, 38% using subtraction, and 23% using addition.

Figure 2. Percentage of students achieving maximum points of respective sub-skill.

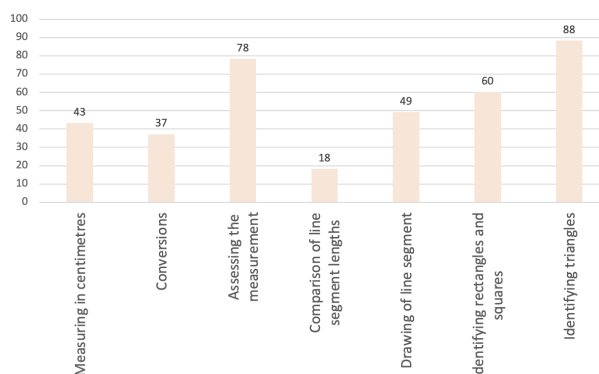
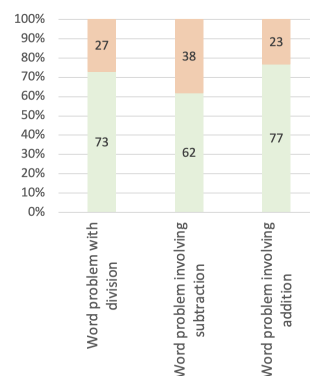
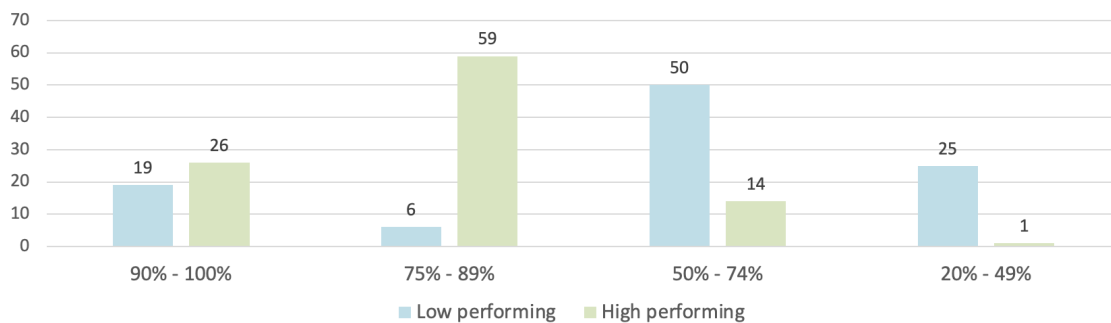


Figure 3. Percentage of students achieving maximum points (green columns) or failing to solve the task (orange columns) of respective word problem.



3.2. Oral assessment of low and high performing students

The oral assessment was administered to a purposive subsample of 82 students, including those identified as at risk based on written performance, as well as a comparison group of high performing students. The oral assessment confirmed the difficulties of students scoring less than 50% in the written assessment (low performing students). 99% of high performing students also got more than half correct in the oral assessment compared to 75% of low performing students.

Figure 4. Percentage of students falling into the respective percentage of the overall result of oral assessment.

The oral assessment also revealed important qualitative differences in students' mathematical understanding. While many students were able to produce correct answers in written form, the oral format exposed difficulties in verbal reasoning, explanation of strategies, and conceptual understanding. This was particularly evident in tasks involving geometric solids. Even students with relatively strong written performance often struggled to articulate properties of three-dimensional shapes accurately. These findings suggest that oral assessment provides critical information that may not be captured through written testing alone.

4. Discussion and practical implications

This study provided an overview of the strengths and weaknesses of grade 3 students in mathematics based on written assessment. It also emphasized the different performance of low and high performing students within oral assessment. The test was based on the basic mathematical skills and knowledge outlined in the 2011 National Curriculum for Basic Schools in Estonia, ensuring an accurate overview of the relevant topics in mathematics. The results of the study confirmed the fact presented in the introduction that mathematical learning difficulties occur in approximately 5%–8% of students (Geary, 2004; Lyon, 1996; Reeve & Gray, 2015; Shalev & Gross-Tsur, 2001). In the written test, 6% of the participants scored below 50% of the maximum possible score. The most challenging tasks in both the written and oral assessments were those related to the domains of geometry and measurement. In the written assessment, the lowest performance was observed in the task requiring students to compare the lengths of given and independently measured line segments. The results of the measurement and geometry tasks discussed above support the theoretical assumption that visually based spatial thinking, memory, and reasoning play a crucial role in mathematics, and that difficulties in these domains contribute to mathematical learning difficulties. The claim made by Vukovic and Siegel (2010) – that visuospatial processing based on visual perception is involved in the development of mathematical learning difficulties – is supported by the present findings. In contrast, Bugden and Ansari (2015) have argued that visually based perceptual difficulties occur only in children with severe mathematical learning difficulties. It is therefore worth noting that future research on mathematical learning difficulties should examine more closely how deficits in different cognitive functions affect the acquisition of geometry and measurement skills. Such knowledge would also be valuable for teachers and special educators in order to plan and organise instructional support for students more effectively. Surprisingly, the results of our study presented a rather good arithmetic skill among grade 3 students, with only multiplication showing the need for attention. However, it should be noted that multiplication is the least practiced skill in grade 3, while addition and subtraction are already covered through grades 1 and 2. The high percentage of accuracy can also be explained by a rather lengthy time frame for filling the written assessment. What is more, Chinn (2020) suggests to limit the time when measuring calculation skill – this way it is possible to distinguish the students who are more skilful, and have a certain automaticity and speed needed for solving more complex arithmetic tasks. A timed test does not, however, reveal calculation strategies and reasons for difficulty. To do so, written assessment is suggested to be combined with oral assessment.

4.1. Practical implications for teachers and support teams

The findings of this study have direct implications for classroom practice and for the work of school support teams. First, the screening tool offers teachers a structured and feasible method to identify students who may require additional support in mathematics at an early stage. If the instrument is aligned with curriculum content, it can be integrated into regular assessment practices without excessive time or resource demands. Second, the domain-specific results enable targeted instructional planning. Rather than relying on global performance indicators, teachers can use screening outcomes to focus on specific sub-skills, such as multiplicative reasoning, unit conversion, or spatial language related to geometric solids. This supports differentiated instruction and the design of tiered interventions tailored to students' actual learning needs (e.g., Malva et al., 2026). Third, oral assessment provides valuable information for

collaboration between classroom teachers, special education teachers, and other support specialists. Insights into students' verbal reasoning and conceptual understanding can inform decisions about instructional strategies, scaffolding, and the use of visual or manipulative supports. In this way, the screening tool functions not only as an identification instrument but also as a guide for pedagogical action.

4.2. Limitations and future directions

Several limitations should be acknowledged. The study was conducted using a convenience sample, which limits the generalizability of the findings. In addition, the absence of national norms restricts the ability to establish definitive cut-off scores for identifying students at risk of mathematical difficulties. The study also focused on descriptive analyses, consistent with its exploratory and practice-oriented aims, but limiting the opportunities for more profound findings focusing on the relationships of the variables or comparison of sample sub-groups. Future research should focus on extending psychometric evaluation, including reliability analyses and validation with larger and more diverse samples. Establishing normative data across different regions would strengthen the utility of the instrument and support its broader implementation. Further investigation into the predictive validity of the assessment, particularly its ability to identify students who benefit most from targeted interventions, would also be valuable.

4.3. Conclusion

In conclusion, this study demonstrates that a curriculum-aligned, school-based screening tool combining written and oral assessment can effectively support early identification of mathematics learning difficulties in grade 3. By providing teachers and support teams with practical, domain-specific information, the instrument contributes to more informed instructional planning and has the potential to improve educational outcomes for students at risk of persistent mathematics difficulties.

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