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Research Article

Inclusive mathematics teaching in primary school: Teacher competencies and textbook quality for students with dyscalculia

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ABSTRACT

This research focuses on examining the preparedness of future primary school teachers to recognize and support students with dyscalculia, as well as analyzing the suitability of mathematics textbooks within the context of inclusive education. Dyscalculia, as a specific learning difficulty in mathematics, often remains undetected within the educational system, despite curricular documents emphasizing the need for individualized approaches and support for students with learning challenges. The aim was to explore how future pre-service primary school teachers perceive their own competencies for working with this group of learners, the extent to which content related to dyscalculia is included in higher education curricula, and how well mathematics textbooks are adapted for students with learning difficulties. The methodological approach combined both quantitative and qualitative procedures. A survey was conducted among final-year students enrolled in pre-service primary school teachers education program, curriculum syllabi were analyzed, as well as mathematics textbooks for lower primary grades. The results show that students express a positive attitude toward inclusion but report insufficient knowledge and experience in the area of mathematical learning difficulties. Curricula generally do not include specific content related to dyscalculia, and the textbooks fail to offer systematic and diverse forms of support for students with difficulties. The findings indicate the need to strengthen pre-service primary school teachers' professional competencies through targeted education, better integration of theory and practice, and the development of educational materials tailored to the diverse needs of learners. The effective implementation of inclusive education goals requires systemic changes within the educational system to ensure equal access to quality mathematics education for all students.

Keywords: dyscalculia, students with learning difficulties, primary school teachers, mathematics instruction, mathematics textbooks, pre-service primary school teachers education

INTRODUCTION

Specific Learning Difficulties

Pursuant to the act on education in primary and secondary schools of the Republic of Croatia (2018), students with difficulties include three different groups:

(1) students with developmental disabilities,

(2) students with learning difficulties, and students with behavioral and emotional problems, and

(3) students with difficulties caused by educational, social, economic, cultural and linguistic factors.

While the developmental disabilities are most often easily noticeable in the early childhood phase, learning disabilities can be noticed only once a child starts formal education in school. Difficulties in learning refer to various obstacles in the learning process, which may include specific disabilities such as dyslexia, dysgraphia, and dyscalculia; general difficulties of an intellectual nature; or the influence of emotional, social, physical, and neurological factors. These disabilities are not related to low intelligence but rather to the way information is processed (American Psychiatric Association, 2013). Specific learning difficulties are defined as a special difficulty in one learning area in a child that is successful in other areas (Hudson, 2018, p. 12). Children with specific learning difficulties can achieve exceptional results when suitable teaching methods and strategies adjusted to their needs are applied (Lenček et al., 2007). Difficulties in learning may manifest at varying levels and affect numerous aspects of cognitive development. They may be reflected in language skills, such as listening, speaking, and comprehension; in reading, for example in word recognition and understanding; as well as in writing, including spelling, orthography, and written expression. They may also influence the learning of mathematics, such as arithmetic operations, problem-solving, and the understanding of mathematical concepts (Lerner & Johns, 2015). Dyscalculia, which is discussed in this paper, belongs to a group of specific learning disorders which are classified as neuro-developmental disorders of biological origin (Butterworth et al., 2011). The main feature of specific learning disorders is permanent difficulty in acquiring basic academic skills during the developmental period that is during formal education. Basic school skills include accurate and fluent reading, reading comprehension, writing and spelling accuracy, as well as arithmetic operations and logical reasoning in mathematics. Specific learning difficulties disturb typical learning process and cannot be prescribed to non-suitable teaching or lack of learning possibilities (Filipović Perić et al., 2023).

Children, whose specific learning difficulties are not recognized, are often seen in the wrong light, as irresponsible, lazy or unmotivated to meet school obligations due to their poor success in reaching set goals. Not being able to recognize their real difficulties, teachers often have a relationship characterized by lack of understanding with such students, which may lead to the loss of learning motivation (Galić-Jušić & Baričević, 2004). Apart from the mentioned, their intelligence and potential is often undermined, and there is a risk of finalizing their schooling with low self-respect and success that is poorer than the one they would have achieved if they had suitable support (Hudson, 2018). When a child notices a difference between their own skills and those of their peers in writing, reading, or arithmetic, they often develop a negative attitude toward themselves, which may lead to a decline in self-confidence. A lack of self-confidence reduces motivation, encourages avoidance of demanding tasks, and may trigger anxiety, fear, and shame (Ashcraft & Krause, 2007; Mallet et al., 2023). This is why it is important to provide the child with support, understanding, and an appropriate learning pace.

Students with specific difficulties in reading and writing often also display difficulties in mathematics; however, mathematical reasoning does not necessarily have to be impaired when the primary issue is dyslexia or dysgraphia. It is important to distinguish difficulties stemming from language disorders from those caused by dyscalculia in order to provide the student with appropriate support (Sharma, 2001).

What follows is an overview of dyslexia and dysgraphia, followed by a more detailed examination of dyscalculia.

Dyslexia and Dysgraphia

Dyslexia is a disorder characterized by specific difficulties in word encoding, associated with phonological processing. It most commonly manifests through difficulties in reading and writing, but it may also affect other language-related aspects (Bjelica et al., 2007, 2009). Children with dyslexia often have preserved mathematical abilities, but they may make errors when interpreting mathematical tasks due to language difficulties rather than a lack of understanding of mathematics. It is important to differentiate such errors from those related to dyscalculia. Among students with difficulties in learning mathematics, common issues include poorly developed mathematical vocabulary, challenges with working and short-term memory, and problems with remembering numerical sequences and recognizing mathematical symbols (Hudson, 2018).

Dysgraphia refers to difficulties in acquiring writing skills that manifest as persistent errors regardless of the student's knowledge of spelling (Bjelica et al., 2009). Children with dysgraphia often have illegible handwriting, copy slowly, and hold the pencil improperly, which further complicates writing (Hudson, 2018).

In mathematics, dysgraphia may cause distorted number formation, mirror writing of digits, incomplete shapes, and errors in performing procedures. A frequent mismatch occurs between written and spoken numbers, as well as difficulties in organizing numbers within place value charts, which may indicate problems with visual-motor coordination (Sharma, 2001).

Dyscalculia

Over time, numerous attempts have been made to define dyscalculia, with the aim of clarifying its neurological foundations and the various forms in which it may manifest. One of the earliest and most frequently cited definitions was offered by Košč (1974), who described dyscalculia as a disorder in the structure of mathematical abilities. According to his view, this disorder has a genetic basis and is linked to brain regions responsible for the development of age-appropriate mathematical skills, but it is not the result of general intellectual impairments. In the literature, dyscalculia is sometimes referred to as "number dyslexia" (Yoong & Ahmad, 2020), further emphasizing its specificity in comparison to other learning difficulties. Geary and Hoard (2005) expand the understanding of dyscalculia by distinguishing between two primary types. The first type relates to difficulties stemming from weaknesses in working memory, particularly in the verbal or spatial processing of numbers. The second type is associated with limitations in managing mathematical procedures and monitoring errors during problem-solving. Contemporary approaches describe primary developmental dyscalculia as a complex and heterogeneous disorder. This perspective assumes that difficulties in learning mathematics arise from a combination of issues at the behavioral, cognitive, neuropsychological, and neurological levels (Kaufman et al., 2013). On the other hand, the term secondary developmental dyscalculia is used when mathematical difficulties are a consequence of other disorders, such as attention disorders, and do not stem from a primary deficit in mathematical abilities. Sharma (2001) defines dyscalculia as a set of specific difficulties in learning mathematics, which may manifest in different areas of mathematics, though not necessarily in all of them. Students with these difficulties typically perform below expectations in mathematics, considering their chronological age. These challenges do not stem from inadequate teaching, sensory impairments, or reduced intellectual ability. Although research on dyscalculia is still developing, some authors believe the root cause lies in the specific organization of the brain (Emerson & Babtie, 2014). In addition to dyscalculia, the literature also mentions the term acalculia, which refers to the complete loss of the ability to understand and process mathematical content, essentially, a total absence of mathematical thinking.

Dyscalculia can appear in various forms, depending on the area of mathematical functioning in which the child experiences difficulties. Based on the literature (Butterworth, 2005; Kaufmann et al., 2013; Košč, 1974; Miundy et al., 2019; Sharma, 2001; Wilson, 2005), several basic types of this disorder can be distinguished. One form is verbal dyscalculia, which is characterized by difficulties in understanding and using mathematical language: children struggle to acquire terminology, do not understand instructions, and have difficulty verbally describing mathematical procedures and solutions. Practognostic dyscalculia refers to difficulties in handling concrete or represented objects that symbolize numbers and relationships, so children have problems learning basic operations (addition, subtraction) even when tasks are presented with physical objects. In lexical dyscalculia, the main difficulty lies in reading and recognizing numbers and mathematical symbols, while in graphic dyscalculia the primary issue is writing them correctly (messy notation, substitutions, or "mirror" writing of digits). Ideognostic dyscalculia involves difficulties in abstract understanding of mathematical concepts and rules, whereas operational dyscalculia refers to difficulties in performing basic arithmetic operations, often associated with limited working memory and attention (Butterworth, 2005; Geary, 2004; Košč, 1974). These various forms of dyscalculia underscore its complexity and the need for an individualized approach in diagnosing and supporting students with mathematical learning difficulties. **Table 1** shows a comparison between general difficulties in mathematics and dyscalculia.

Identification and Prevalence of Students with Dyscalculia

The identification of students with dyscalculia is crucial for providing adequate support and adjustments in education. Early recognition enables the creation of personalized learning strategies and ensures that students develop the necessary skills and self-confidence.

Table 1. Overview of general difficulties in mathematics and dyscalculia

	General difficulties in mathematics	Dyscalculia	Sources
Definition	Difficulties in learning mathematics due to a number of possible causes (e.g. poor instruction, lack of practice, anxiety).	Neurocognitive disorder specifically for numerical concepts and processing.	Dowker (2005) & Kaufmann (2008)
Frequency	15–25% of students have difficulties in mathematics in some period.	3-7% students have dyscalculia.	Shalev and Gross-Tsur (2001)
Cause	Circumstantial, pedagogical or emotional factors.	Neurobiological and genetic factors.	Butterworth (2005) & Geary (2004)
Identification	Can appear any time, often in relation to certain content.	Present from an early age, regardless of the teaching.	Landerl et al. (2004)
Characteristics	Confusion in steps, errors in tasks, lack of strategies.	Permanent misunderstanding of numerical relations, difficulties with counting, comparing amounts, working memory.	Mazzocco and Myers (2003) & Rubinsten and Henik (2009)
Effect on daily life	Can be compensated by learning and support.	Makes daily activities (time, money, measuring, amounts) more difficult.	Butterworth and Laurillard (2010)
Learning advancement	Students often advance with additional assistance.	Advancement is possible, but it is slow and it requires specific intervention.	Gersten et al. (2007)
Connection with other difficulties	Can be linked to anxiety and poor attention.	Often in combination with dyslexia, ADHD, visual and spatial difficulties.	Wilson et al. (2015)
Diagnosis	Recognized by a teacher or a pedagogic expert, dealt with by applying pedagogical methods.	Diagnosed by an expert (psychologist, rehabilitator) via tests and skills profiling.	Kaufmann (2008) & Geary (2004)

> It is essential to encourage further education in this area to facilitate the early detection of potential difficulties, accurate diagnosis, the implementation of appropriate therapeutic interventions, and, consequently, the introduction of an individualized approach within the regular curriculum for children who require it (Filipović Perić et al., 2023, p. 88).

Dyscalculia is often described as an "unexpected" condition, as it occurs in students with average or above-average intelligence and typical school development (Sans et al., 2017). What professionals emphasize in the context of identifying students with dyscalculia is that the lack of specificity in measurement instruments and appropriate diagnostic thresholds poses the greatest challenge in recognizing children with dyscalculia, especially in disadvantaged educational environments (Santos et al., 2022).

> The absence of standardized assessment tools as well as the lack of materials for working with children with dyscalculia, are some of the reasons why speech and language pathologists are less likely to engage in diagnosis and the implementation of therapeutic procedures (Filipović Perić et al., 2023, p. 88).

Research examining the relationship between gender and the prevalence of dyscalculia does not yield entirely consistent results. Most studies indicate that dyscalculia occurs equally in girls and boys (Devine et al., 2013; Karimi, 2011; Keong et al., 2016; Shalev et al., 2000). However, some authors report a slightly higher frequency of these difficulties among boys (Gifford & Rockliffe, 2008; Jovanović et al., 2013), which shows that the literature has not yet reached full agreement regarding gender differences. As for the overall prevalence of dyscalculia in the school population, the range of estimates in international research is fairly wide. Geary (2004) states that between 5% and 8% of students have pronounced difficulties in the area of mathematics, while Wadlington and Wadlington (2008) note that prevalence may approach the upper limit of that range. On the other hand, Peard (2010) estimates a much lower occurrence, between 1% and 2%. Additional studies estimate that dyscalculia appears in approximately 2.27% to 6.4% of students (Emerson, 2015; Estévez et al., 2008), which confirms that prevalence varies depending on diagnostic criteria and research methodology.

Typical Errors Made by Students with Dyscalculia

In the following section, we will outline some common errors, patterns of solving mathematical problems, and domains in which students with dyscalculia tend to perform poorly.

Sharma (2001) describes a range of typical errors in students with dyscalculia that appear in everyday mathematical tasks. Paraphrasic substitutions are common, where the student unintentionally replaces one number with another when reading, writing, or using a calculator, even though they understand the concept of number. Perseveration is also frequent that is, the automatic repetition of the same operation even when the task no longer requires it. Due to difficulties in visuospatial processing, mirror errors occur, such as reversals in the orientation of digits or incorrect placement of digits in multi-digit numbers (Shalev & von Aster, 2008). Students often perform calculations slowly and with uncertainty, and errors in written procedures frequently appear, for example, in written multiplication, where digits are "placed" in the wrong position. Additional difficulties include visual substitutions, such as confusing the plus sign with the minus sign, especially in the early stages of learning. Procedural errors are also common–omitting steps, following an algorithm incorrectly, or leaving out essential parts of the procedure (Geary, 2011). Moreover, many children with specific learning difficulties have weaker memory for numerical sequences, which makes it harder to memorize multiplication tables, telephone numbers, or the order of operations, further slowing down problem-solving.

The greatest amount of research about dyscalculia was focused on the field of mathematical arithmetic. Roulstone et al. (2024) showed that the effect can be equally informative in terms of identifying children with dyscalculia in all content domains, except arithmetic. They also established that multiple choice questions can help students with dyscalculia in achieving better results, which might be beneficial for the assessment of mathematical skills at children with dyscalculia in the educational context. Nonetheless, constructed-answer questions show greater sensitivity in recognizing students with dyscalculia, and they might be the most useful in diagnosis.

As for specific areas in mathematics, we have to mention the concept of *number sense*. Number sense is the innate ability to process approximate numbers (Hannagan et al., 2017). This ability includes approximate calculation, comparison, number decomposition, and arithmetic operations such as subtraction, which cannot be resolved solely based on basic mathematical facts (Karakonstantaki et al., 2017). Number sense is considered a key numerical skill that helps children learn basic mathematical concepts (Chinn & Ashcroft, 2016). Children with dyscalculia often have underdeveloped number sense, which leads to lower mathematical abilities compared to peers without such difficulties.

> Performance on basic number sense tasks provides key information for the differential diagnosis of developmental dyscalculia and can form the basis for early identification, as it does not directly reflect the outcomes of school-based learning and can be easily carried out with young children (Decarli et al., 2023, p. 19).

Furthermore, in tasks requiring children to perceive the numerosity of a pattern through counting or estimation, to retain that numerical representation in memory over a delayed period, and ultimately to compare the pattern with a target numerosity, children with dyscalculia are less accurate when dealing with larger numbers (greater than three). This suggests that numerosity perception is impaired in the estimation range (Decarli et al., 2023). Comprehensive studies indicate that children with dyscalculia show significantly slower progress in estimating the order and magnitude of numbers. Attout and Majerus (2015) particularly emphasize that there is a persistent weakness in working memory for number sequences, which impairs the ability to accurately assess the relative order of numerical values. Furthermore, Rousselle and Noël (2007) confirm this connection between working memory and difficulties in processing numerical content. Geary et al. (2008) and Landerl et al. (2009) further contribute to the picture, stating that children with dyscalculia are significantly less accurate when placing target numbers on a number line. In their experiments, students with mathematical difficulties showed greater deviation in determining the position of numbers than their peers without such difficulties, indicating specific problems with mental representations of numbers. Furthermore, slow access to numerical magnitudes hinders the use of effective strategies for solving arithmetic problems, such as choosing the larger addend in addition tasks (Vanbinst et al., 2012). Order estimation requires a combination of magnitude comparison and the retrieval of facts from memory. Weaker performance by students with dyscalculia has also been observed in number line tasks, which reflects an underdeveloped ability to associate numbers with space (Landerl et al., 2009) or an inefficient use of arithmetic strategies (e.g., using halves and quarters of the line as reference points) during problem-solving (Decarli et al., 2023).

According to Bjelica et al. (2009), children with dyscalculia often face severe difficulties while checking their results, which can be extremely frustrating and emotionally exhausting. In many cases, repeated check attempts do not lead to correct solution considering that a child gets different results at every attempt and does not have a clear idea as regards to which might be a correct one. This is why some children resist results check, believing it will not help. On the other hand, other children persistently repeat the same procedure until they obtain the same answer twice–this may include dozen attempts but does not guarantee accuracy.

Students with dyscalculia often choose solutions "by guessing," based on what seems correct, or they respond emotionally–they cross out results, erase tasks, crumple paper, or give up after the first unsuccessful attempt. Such behaviors reflect a high level of frustration and a sense of helplessness, which is why some students eventually insert random answers, even though they know they are not correct (Dowker, 2005). One reason students do not check their results is the lack of knowledge of different checking strategies, leaving them restricted to the procedure they have already used. Although a calculator can serve as support, its use requires additional cognitive load, which often exceeds the capacities of children with dyscalculia (Geary, 2011). Moreover, many children have an underdeveloped number sense, making it difficult for them to judge whether the obtained result is logical or approximately correct (Butterworth, 2005; Landerl et al., 2004).

Difficulties with numbers in individuals with dyscalculia persist in adulthood and affect not only school situations but also everyday activities. Research shows that adults with dyscalculia have difficulties solving practical numerical tasks, such as estimating time, measuring quantities, and managing simple financial transactions, while difficulties in estimating distance have not been confirmed. Individuals typically recognize their difficulties clearly, which are associated with negative emotions and may limit their academic and professional development (Caviola et al., 2019; Vigna et al., 2022).

Monitoring Students with Dyscalculia

Monitoring students with dyscalculia is crucial for understanding their needs and progress.

> In many instances, children with dyslexia demonstrate strong mathematical abilities, developed mathematical thinking, and therefore possess a good potential for understanding mathematical concepts. However, due to underdeveloped psychic functions, their ability to manipulate numerical symbols is reduced, meaning the process of understanding and memorizing these symbols is impaired. Consequently, the teacher has to be aware of the distinction between mathematics in general and arithmetic (Bjelica et al., 2009, p. 29).

Regular monitoring involves assessing their mathematical abilities through adapted tasks, tracking their reactions to implemented learning strategies, and recording progress in mastering basic mathematical concepts. Teachers and specialist staff have to collaborate to ensure that adjustments in teaching are effectively implemented. Providing adequate support is essential for successfully overcoming the challenges faced by students with dyscalculia (Kirk et al., 2006).

> The responsibility of these professionals is equal for every child (including those with specific difficulties who are included in the care, upbringing, and education system) and stems from the focus on achieving the highest possible educational and developmental quality for each individual. Such a level of achievement is possible only if we embrace the paradigm of continuous professional development for educators, aimed at enhancing their knowledge, motivation, and skills (Lenček et al., 2007, p. 115).

Furthermore, it is critical to provide continuous feedback to student and parents, emphasizing successes in order to foster self-confidence and motivation.

Furthermore, during assessment, it is important to focus on the solution accuracy, not the calculation orderliness or procedure steps, which might not be disorderly. Teacher with necessary competences may provide great support to a student by ensuring enough time to solve a task and by praising the student for each improvement (Posokhova, 2007). Roulstone et al. (2024) showed that small percentage of students with dyscalculia try to solve a task (or part of a task). They would rather leave it empty if they do not know how to solve it. By providing additional test tasks to children with dyscalculia and by encouraging them to try to answer each question, their success might be significantly improved. Children with dyscalculia often need more time to understand the set questions, and higher rate of empty answers may be the result of the time they spent doing previous question while the next one was already introduced (Landerl & Moll, 2010). This can force them to skip the question in order to keep up with the group if the questions are being read out loud.

Children often develop fear of mathematics. Such fear can appear after an unpleasant experience, and it can gradually grow when a child does not succeed in following teacher's explanations. This phenomenon, known as mathophobia, presents a specific form of difficulty in learning mathematics and becomes an increasing problem.

METHODOLOGY

Research Objective

The aim of this research was to empirically examine the level of competencies of future pre-service primary school teachers in recognizing and providing support to students with dyscalculia, as well as to analyze the extent to which current mathematics textbooks are adapted to the needs of students with such difficulties. The study was designed as a triangulation of procedures; it combines pre-service primary school teachers education students self-assessments, an analysis of higher education curricula, and a systematic evaluation of textbook content. In this way, a multi-level and methodologically grounded approach is achieved within the field of educational sciences—one that analytically examines, interprets, and theoretically grounds the state of practice, thereby contributing to a better understanding of teacher preparation and inclusive teaching materials in the field of mathematics education.

Accordingly, the following research questions were defined to guide the theoretical framework, methodology, and interpretation of findings:

1. How do final-year pre-service primary school teachers education students assess their own competencies for working with students who have dyscalculia?
2. To what extent are higher education syllabi and programs oriented towards preparing teachers for inclusive mathematics instruction?
3. To what extent can elements of support for students with dyscalculia be identified in current mathematics textbooks for primary education?

Research Instrument and Design

This research is based on a combination of quantitative and qualitative approach, enabling an insight into the complexity of dyscalculia from different perspectives: through self-assessment of the students studying at pre-service primary school teachers education studies, through the analysis of high education institutions official documents (studies) and through textbooks content analysis.

Quantitative data were collected through a pre-service primary school teachers education student survey using a questionnaire consisting of closed-ended questions and statements related to self-assessment of knowledge and competencies regarding the identification of and work with students with dyscalculia, attitudes towards the role of university education, and the perceived need for additional training. Participants rated the statements using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

A qualitative analysis was conducted on the content of the curricula and textbooks, whereby the textbook analysis was guided by predefined criteria (based on the work of Gersten et al., 2007, 2009) that enable a detailed examination of the materials in terms of their adaptation to students with mathematical difficulties (**Table 2**). After the authors, as experts in the field of mathematics, carried out a systematic analysis of the textbooks, the findings were additionally verified by an experienced primary school teacher and a university professor of pedagogy. The involvement of experts from both educational practice and academia ensured

Table 2. Criteria for the qualitative analysis of textbooks

Criteria	Description of what to analyze in the textbook
Clear structure of lesson	Does each lesson have a clear title, objectives, an introduction, tasks, and a summary?
Gradual introduction of new concepts	Is new content presented in small steps, with plenty of examples?
Use of visual representations	Does the textbook include tables, number lines, diagrams, or illustrations that support understanding?
Connection to real life	Are there tasks referring to everyday situations (e.g., shopping, time, measurement)?
Clear examples with explanations	Are examples explained step by step? Are verbal explanations provided alongside computational procedures?
Different levels of task difficulty	Is there a variety in task difficulty? Are there tasks for beginners and more advanced learners?
Repetition and practice	Is there sufficient repetition of key concepts and tasks of similar type?
Feedback/assessment	Does the textbook include self-check questions, quizzes, or "check your knowledge" sections?
Encouraging understanding, not just computation	Are questions such as "why," "explain," or "show in multiple ways" included?
Additional materials to support students with difficulties	Are there suggestions for teachers/parents, guidelines for differentiated instruction, or tasks with instructions or visuals to facilitate understanding?

Table 3. Descriptive overview of questionnaire results (arithmetic mean, standard deviation [SD], and mode)

Statement	Mean	SD	Mode
I can recognize the basic characteristics of dyscalculia.	3.68	1.06	3
I feel sufficiently competent to work with students who have dyscalculia.	2.96	1.10	3
My faculty has prepared me well for working with students with learning difficulties.	2.75	1.40	3
During my studies, we learned enough about dyscalculia.	2.64	1.37	3
I know how to adapt mathematics tasks for a student with dyscalculia.	2.75	1.14	3
I would like to receive additional training on this topic.	4.39	1.07	5
It is important in mathematics teaching to recognize and understand difficulties such as dyscalculia.	4.86	0.45	5
I feel worried when I think about having students with difficulties in learning mathematics.	3.39	1.07	3

methodological triangulation and increased the credibility of the interpretation of the results, thereby further securing the reliability and objectivity of the research.

Research Sample

In the Republic of Croatia, there are seven universities that offer primary teacher education programs, with a total enrollment capacity of 450 students. The study included 56 final-year students from four different higher education institutions, distributed as follows: 46.4%, 28.6%, 14.3%, and 10.7%. The sample represents a moderate proportion of the total population (12.38%). The survey was administered anonymously online and made available to students during their attendance at university classes. The selection of final-year students was intentional, as, by the time of completing the questionnaire, participants had completed all relevant mathematics, pedagogy, and teaching methodology courses, and were about to enter the teaching profession. The students who participated in the study voluntarily agreed to complete the questionnaire. Their attitudes, aspirations, and competencies offer a realistic representation of their readiness to meet the specific demands of contemporary mathematics instruction.

As for the textbooks used for qualitative analysis, three textbooks from different publishers were randomly selected for each of the first four grades of primary school.

RESULTS AND DISCUSSION

Questionnaire Descriptive Analysis

Some of the statements from the questionnaire will be presented below in order to get an insight into general situation (**Table 3**).

The results indicate that participants, in their self-assessments, relatively well recognize the basic characteristics of dyscalculia, yet at the same time evaluate their practical competencies for working with students with difficulties as insufficient. This gap between perceived theoretical knowledge and assessed practical readiness is consistent with previous findings showing that teachers often feel uncertain when applying knowledge in mathematics instruction (Dowker, 2005; Geary, 2004).

Participants also self-assess that their university education did not adequately prepare them for working with students with difficulties, a finding corroborated by international studies on the insufficient coverage of content related to mathematical difficulties in initial teacher education (Ní Ríordáin et al., 2017). Consequently, the low self-assessment of the ability to adapt mathematical tasks is expected and aligns with the literature emphasizing the importance of explicit strategies and differentiated instruction for students with difficulties (Gersten et al., 2009).

For further analysis, we selected five statements that operationalize knowledge and practical readiness, forming a composite competence scale (Cronbach's alpha = 0.91), which served to further examine the relationship between competence and other variables. To investigate the interrelations between the variables, Pearson's correlation coefficient was used. The results indicate a statistically significant negative correlation between perceived competence and the need for additional education ($r = -0.46$; $p < 0.05$), suggesting that participants who perceive themselves as less competent show a greater interest in professional development. A significant negative correlation was also observed between competence and concern ($r = -0.58$; $p < 0.01$), indicating that lower perceived preparedness is associated with a higher level of concern when thinking about working with students with learning difficulties. The correlation between the desire for additional education and concern was not statistically significant ($r = 0.15$; $p = 0.43$).

The analysis of the collected data clearly demonstrates a gap between the expressed awareness of the importance of recognizing learning difficulties and the self-assessed readiness to act in the classroom. Participants show a high level of motivation for further education, which represents an important resource for the implementation of professional development programs focused on working with students with dyscalculia.

Analysis of High Education Curricula

As part of the analysis of university curricula in the field of primary education, a qualitative mapping of courses addressing the topic of inclusive education and working with students with developmental difficulties was conducted. Seven different study programs in the Republic of Croatia were analyzed.

Three primary forms of the presence of inclusive content were identified: courses titled *inclusive pedagogy, inclusive education*, and *pedagogy of children with special needs*. The first two titles, present in some programs, refer to the contemporary discourse on inclusion and approaches based on student diversity (Booth & Ainscow, 2016), while the third retains elements of a traditional categorization of students with difficulties, focusing more on typology and the medical model than on integration into everyday practice. Although the presence of these courses indicates a degree of sensitivity in the programs toward the needs of inclusive education, it is important to emphasize that in almost all analyzed cases, this content is limited to a single compulsory course within the entire program. Considering the complexity of inclusive practice–which involves not only pedagogical challenges, but also administrative demands, collaboration with parents and expert teams, documentation adaptation, as well as the emotional and professional engagement of teachers–such limited educational preparation can be considered insufficient (European Agency, 2012; Florian & Black-Hawkins, 2011).

In addition to theoretical knowledge, future education professionals should have opportunities to directly observe and participate in the work of inclusive classrooms during their studies. Unfortunately, current programs rarely include structured practicum experiences in inclusive settings (in regular practice, this does not necessarily mean that they will be in such classrooms and observe students with various difficulties) which further limits the development of practical competencies. In real-life contexts, teachers often face multiple challenges–from uncertainty in recognizing learning difficulties and individualizing instruction to managing demanding documentation and collaborating with parents (European Agency for Special Needs and Inclusive Education, 2017; UNESCO, 2020).

Analysis of the Primary School Mathematics Textbooks

For the purpose of assessing the accessibility of textbook content for students with learning difficulties in mathematics, particularly those with dyscalculia, representative lessons from four primary school grades were analyzed. The selection was based on the developmental significance of the concepts, cognitive demands, and their connection to later mathematical content. For each of the four grades, two lessons were chosen–one in arithmetic and one in geometry–to ensure the analysis covered different types of mathematical knowledge. In the first grade, the lessons *point* as the first abstract geometric concept, foundational for spatial orientation (van Hiele, 1986), and *addition across ten*, a developmentally demanding topic requiring understanding of the decimal system and number sense (Butterworth, 2005; Dowker, 2005), were analyzed. In the second grade, the lessons *length*, key for understanding measurement and comparison of magnitudes (Clements & Sarama, 2009), and *multiplication*, a concept requiring comprehension of grouping and relationships between numbers, often challenging for students with dyscalculia (Geary, 2004; Mazzocco & Myers, 2003), were selected. In the third grade, *line*, which introduces students to the concept of unlimited geometric objects (van Hiele, 1986), and *written addition*, requiring coordination of working memory, place value, and algorithmic sequencing, particularly demanding for students with difficulties (Gersten et al., 2007), were analyzed. In the fourth grade, the *angle* lessons, crucial for later understanding of polygons, circles, and trigonometry, requiring well-developed visuospatial skills (Clements & Sarama, 2009), and *written multiplication of two two-digit numbers*, one of the most complex algorithms in primary education, requiring precision and deep understanding of number structure (Kaufmann, 2008), were chosen. These selected lessons represent developmentally key points in mathematical learning and topics in which difficulties most often occur (Dowker, 2005; Geary, 2004). Analyzing how they are presented in textbooks provides insight into the level of adaptation of the materials to diverse student needs, particularly regarding visual support, clarity of structure, and sequencing of tasks–elements crucial for students with learning difficulties in mathematics, including dyscalculia.

The following is an analysis of the first-grade lesson *Point* across three different primary school textbooks. In textbook 1, the lesson structure is clear, with an unambiguous title, but the tasks are not designed to support understanding of the concept of a point. The concept is presented both as the intersection of lines and as a spatial marker, but without clarification of whether it refers to a plane or a spatial concept. Although the content is introduced gradually, the visual representations are insufficiently structured, and the tasks lack a progression in difficulty. In textbook 2, the title "intersection of lines-point" narrows the mathematical concept and does not reflect the full breadth of the idea. The learning objective is not clearly stated, and the visual representations use too many different symbols, which can confuse students. The introduction attempts to relate the concept to real-life situations, but the tasks vary only by content, not by complexity. Textbook 3 offers a very concise lesson. The title is clear, but the content does not indicate a specific learning objective. The new concept is introduced without elaboration, and the tasks remain exclusively in a mathematical context, without connection to students' experiences. The exercises are uniform and do not promote conceptual understanding. Across all three textbooks, there is a lack of tasks designed to foster deeper understanding, and no additional materials are provided for students with difficulties, even though the literature emphasizes the importance of visual clarity, task progression, and conceptual activities for developing geometric concepts (Clements & Sarama, 2009; van Hiele, 1986).

The following is an analysis of the first-grade lesson *addition across ten* (e.g., 8 + 5) across three different textbooks. In textbook 1, the title "addition 7 + 5" suggests a focus on a single example rather than on the general procedure. The new content is presented through examples and illustrations that do not explain the strategy of crossing ten, and the number line is used inadequately. The lack of context, unclear explanations, and a small number of tasks hinder the development of conceptual understanding, which is particularly important for students at risk of mathematical difficulties (Dowker, 2005). In textbook 2, the title covers both addition and subtraction across ten, making it difficult to focus on the learning objective. The content is presented technically, without explaining the procedure or providing contextual examples. The tasks are monotonous, lack a progression in difficulty, and do not include questions that encourage understanding. This structure does not align with recommendations for differentiated instruction for students with difficulties in mathematics (Gersten et al., 2009). Textbook 3 offers a clear structure, visual support (images, tables, and colors), and a large number of graded tasks. It includes questions that promote thinking and explanation ("think and explain …") as well as tasks set in real-life contexts. This approach fosters the development of number sense and understanding of the strategy for crossing ten, which is crucial for further mathematical progress (Clements & Sarama, 2009; Van de Walle et al., 2018).

Although textbook 3 shows the greatest potential for conceptual understanding and differentiated support, none of the textbooks provide additional materials or clear adaptations for students with learning difficulties, which is important in the context of inclusive mathematics education (Butterworth, 2005).

The following is an analysis of the second-grade lesson *length*. The analysis reveals clear differences in the quality of the didactic approach among the three textbooks. Textbook 1 has a defined structure and a clearly stated objective, but the lesson introduces too many concepts (e.g., endpoints, markings, and belonging), which may hinder understanding for students with difficulties. New concepts are introduced gradually and supported with visual representations, but connections to real-life contexts are lacking. Tasks vary by content rather than by complexity, thus failing to promote conceptual understanding (Clements & Sarama, 2009). In textbook 2, the lesson focuses almost exclusively on the shortest segment between two points, without explaining the broader concept of length as a straight line. The visual representations are technical and monotonous, and drawing lengths is not explained. Connections with students' experiences are almost entirely absent, and the tasks are very simple, without progression in difficulty. Such an approach provides limited support for students at risk of mathematical difficulties (Gersten et al., 2009). Textbook 3 offers the highest-quality structure: content is introduced gradually, visual representations are clear, and concrete examples facilitate understanding of the concept of length and its drawing. The introductory context connects the content to students' everyday experiences, enhancing the functional use of knowledge. Tasks are varied and graded by difficulty, and questions prompting explanation of procedures foster deeper understanding, in line with recommendations for developing geometric thinking (van Hiele, 1986). However, none of the textbooks provide additional materials or support for students with difficulties, representing an important limitation in the context of inclusive teaching. Integration with other subject areas is also missing, even though interdisciplinary approaches are known to facilitate understanding of mathematical concepts (Clements & Sarama, 2009).

The following is an analysis of the second-grade *Multiplication* lesson. The analysis of three second-grade textbooks shows that all have a clear structure, but they differ in the level of support for deeper understanding of multiplication. Textbook 1 introduces new concepts gradually and provides a detailed, well-explained representative example, but visual aids (number line, counting frame) are used more as technical illustrations than as tools for conceptual understanding. Tasks vary in content but not in difficulty, and activities that promote analysis and conceptual understanding are lacking, which is important for developing a structural understanding of multiplication (Clark & Kamii, 1996). Textbook 2 also introduces content gradually, but the visual representations are simplified to routine procedures, limiting understanding. Although real-life contexts are present, tasks are not graded by complexity, and solutions are sometimes presented differently than in examples, which may cause confusion. There are no questions to check understanding or materials for students with learning difficulties, contrary to recommendations for differentiated instruction (Gersten et al., 2009). In textbook 3, the title "what is multiplication?" clearly directs students to the key concept, and illustrations and contextualized tasks facilitate understanding. However, the definition of the concept appears only at the bottom of the page, which may make it harder to identify essential information. Tasks are varied and graded, but the lesson still lacks systematically guided reflection on multiplication strategies, despite evidence that such questions significantly support conceptual learning (Clements & Sarama, 2009). No additional materials are provided for students with difficulties, although some tasks require representing the same calculation in different ways, which positively contributes to understanding the structure of multiplication. Overall, the textbooks meet basic didactic standards, but they differ in the level of support for understanding and connecting to real-life contexts. The lack of differentiated strategies and materials for students with learning difficulties remains a common limitation.

The following is an analysis of the third-grade lesson *line*. The review of three textbooks shows that the teaching of the concept of a line, which is abstract and requires careful didactic elaboration, varies considerably in quality. Textbook 1 offers a clear structure and gradually introduces new concepts, with visual representations accompanying the text. However, all lines are depicted horizontally, and the content is not connected to real-life contexts, making it harder for students who need concrete situations to understand abstract geometric ideas (van Hiele, 1986). Tasks are not graded by difficulty, and few encourage reflection, even though such tasks are crucial for developing geometric thinking (Clements & Sarama, 2009). Textbook 2 contains several methodological shortcomings. The title combines too many abstract concepts for students' first encounter with the concept of a line, and the lesson includes mathematically inaccurate formulations. The concepts of line, ray, and segment are neither clearly explained nor visually differentiated, and the tasks are unclear and confusing. The lack of context, explanatory tasks, and any materials for students with learning difficulties makes this textbook the least suitable. Textbook 3 demonstrates the highest level of didactic quality. The new concept is introduced gradually, connected to previously known content, and illustrations are clear and high-quality. The introductory example links the line to real-life situations, facilitating understanding. Tasks are varied and include explanations of procedures, comparisons, and reasoning–strategies shown to support the development of abstract geometric thinking (Clements & Sarama, 2009). The lesson concludes with a review, although specific adaptations for students with learning difficulties are still missing. In conclusion, textbook 3 provides the most suitable approach for teaching the concept of a line, while textbook 1 offers a solid structure but lacks sufficient depth and context. Textbook 2 has significant content and methodological deficiencies, making it unreliable as a resource for students' first encounter with this geometric concept.

The following is an analysis of the third-grade lesson *written addition*. Textbook 1 combines written addition and subtraction in the same lesson, which is not appropriate for students' first encounter with the written algorithm. The content is overloaded with text, and the new concept is explained through a single extensively verbalized example. Visual support is present (place value charts), but connections to prior knowledge are not emphasized. Tasks are varied, but some are insufficiently structured, and questions that promote understanding are missing. Review and knowledge checks appear only at the end of the unit. Textbook 2 follows a clear methodological structure and introduces the procedure through a real-life example, but the length of verbal explanations may hinder understanding for students with learning difficulties. Visual representations support the algorithm, and tasks are varied and graded. However, there are terminological inconsistencies ("number" instead of "sum") and a lack of tasks that encourage deeper reflection. Connections to earlier strategies, particularly mental calculation, are not clearly highlighted, and additional materials are not included. Textbook 3 offers the most comprehensive development of the lesson. Written addition is introduced gradually and visually clearly, with place value charts, illustrations, and contextual examples. Tasks are well-graded, and students are encouraged to explain procedures and represent the same calculation in different ways, which significantly enhances conceptual understanding of the algorithm. The lesson concludes with a summary and review, but here too, there are no specific adaptations for students with learning difficulties. Overall, although all three textbooks meet basic didactic criteria, the lack of differentiated materials and adaptations for students with difficulties represents a common issue. The literature emphasizes the importance of gradual modelling, visual support, and explicit linking written algorithms to previously acquired strategies as key factors for successful learning of written calculation (Gersten et al., 2009; Van de Walle et al., 2018).

The following is an analysis of the fourth-grade lesson *angle*. The concept of "angle" in fourth grade introduces a large number of new and abstract notions, which present a challenge for students, particularly those with learning difficulties in mathematics. Textbook 1 has a clear title and reviews prior knowledge, but one lesson combines too many new concepts (angle, notation, symbol ∠, arms, vertex, membership, and drawing), which may overload students. Illustrations accompany explanations, but there is a content-related issue in point labelling. Tasks are varied in content but not in difficulty, and contextualization is missing, making it harder to understand abstract geometric concepts (van Hiele, 1986). Textbook 2 is methodically structured and contains a large number of tasks, with new concepts introduced through problem solving. Visual representations are clear, but explanations are very brief, expecting students to infer new knowledge independently. Prompts for explanation and reflection are almost entirely absent, and feedback is not systematically planned. The presence of real-life contexts is limited to only two tasks. Textbook 3 provides the most balanced approach. New concepts are clearly defined and accompanied by high-quality illustrations. The introductory example connects the content to students' experiences, facilitating understanding. Tasks are varied and graded, with some requiring analysis and explanation of procedures, contributing to deeper understanding of geometry (Clements & Sarama, 2009). At the end of the unit, a concise review lesson is provided. In all three textbooks, additional materials or adapted tasks for students with learning difficulties are missing, even though it is well known that visual concretization, progression, and differentiation play a key role in learning abstract geometric concepts (van Hiele, 1986).

The following is an analysis of the fourth-grade lesson *written multiplication of two two-digit numbers*. Written multiplication represents one of the more complex algorithmic procedures in lower elementary grades, especially for students with learning difficulties. Textbook 1 titles the lesson with an example ("written multiplication 43 · 25"), which makes it harder for students to recognize the general learning goal. The procedure is explained exclusively verbally, without visual support, and tasks are few and thematically unconnected, limiting practice. Additionally, contextualization is lacking, and there are no elements to support conceptual understanding of the algorithm, which research shows is particularly problematic for students with learning difficulties (Gersten et al., 2009). Textbook 2 provides a clearer topic title ("written multiplication of two-digit numbers"), but the lesson's focus is more on reviewing known procedures than on systematically developing the new algorithm. New content is introduced quickly, without sufficient didactic support, and the diagrams are not linked to the written method. The lesson lacks prompts for explaining strategies or systematic comprehension checks, making it difficult for students to develop metacognition and deeper understanding of the process (Booth & Newton, 2012). Textbook 3 offers the most comprehensive and balanced approach: the lesson is extensive, the procedure builds on prior knowledge, and visual support–particularly the grid background–facilitates correct digit placement. Tasks are numerous, graded, and oriented toward understanding, including prompts for explanation, which contributes to conceptual learning. However, explicit materials for students with learning difficulties and systematic checks during the procedure are still missing. Overall, textbook 3 best supports understanding of written multiplication due to visual and gradual development as well as tasks that encourage reflective thinking. Textbook 1 and textbook 2 provide limited support, especially for students with difficulties, as they insufficiently explain the reasoning behind the procedure and do not provide differentiated materials, which are considered crucial in inclusive mathematics teaching (Kroesbergen & Van Luit, 2003).

Although one of the textbooks offers a digital version adapted for students with learning difficulties, such support is not included in the printed edition. Since students in primary grades usually do not have access to tablets, those who have difficulties–including students whose difficulties have not yet been recognized and who do not have a formally adapted or individualized program–effectively remain without intended support in practice.

The analysis of mathematics lessons from grade 1 to grade 4 shows that most textbooks, despite formally meeting basic didactic requirements, do not provide systematic support for students with learning difficulties. Tasks are most often procedural, without differentiation in difficulty and without activities that promote conceptual understanding. Visual and verbal explanations are often insufficient, and examples linked to real-life contexts appear rarely. This approach does not align with the principles of universal design for learning (UDL), according to which instructional materials should be accessible to all students through multiple forms of representation and engagement (CAST, 2018). Similar issues are highlighted in the literature. Research shows that digital and accessible textbooks can significantly improve learning outcomes for students with difficulties (Lewis et al., 2010), while visuospatial and kinesthetic materials are proven to support students at risk of dyscalculia (Baccaglini-Frank & Bartolini Bussi, 2016). Additionally, tasks that include explanation, pair work, and discussion of strategies improve understanding for students with difficulties (Mokotjo, 2024). Meta-analyses indicate that the most successful interventions involve structured teaching, clear steps, and gradually increasing complexity (Filiz & Güneş, 2023; Gersten et al., 2009), which most of the analyzed textbooks still fail to provide. In conclusion, the analysis of primary-grade mathematics textbooks shows that, although some lessons have didactic advantages, systematic support for students with difficulties remains underdeveloped. While individual lessons demonstrate pedagogical strengths, textbooks should integrate inclusive elements far more robustly in their printed versions, not only in digital supplements. Clearer learning objectives, consistently structured content, differentiated tasks, connections to students' experiences, and embedded support for children with difficulties–including those whose difficulties are not yet recognized–are necessary. These findings align with international research on textbook quality, which also warns of the lack of differentiation, visual structure, and multiple learning modalities necessary for inclusive practice (Baccaglini-Frank & Bartolini Bussi, 2016; Fan et al., 2013; Ok et al., 2017).

CONCLUSION AND IMPLICATIONS

The mathematics curriculum (Ministry of Science and Education, 2019) clearly defines the teacher's responsibility to adapt instruction to the individual needs of students and emphasizes the importance of differentiated approaches, the application of diverse teaching strategies, and the creation of conditions in which every student can feel competent, engaged, and autonomous. Within this framework, the obligation to recognize and support students with learning difficulties, including those with dyscalculia, is particularly highlighted. However, this normative requirement comes into tension with the findings of our study, which indicate that future primary school teachers often lack sufficient specific knowledge and practical competencies required to work with students who have difficulties in mathematics. Participants in the study had only a limited number of courses related to learning difficulties, and the area of mathematical difficulties was rarely addressed explicitly. This reveals a gap between curriculum expectations and the actual preparedness of future teachers, which constitutes one of the key starting points for the scientific contribution of this work.

The significance of these findings is further confirmed by the analysis of mathematics textbooks, which indicates a systematic absence of adapted materials for students with dyscalculia. Although some textbooks provide digital supplements for students with learning difficulties, such resources are not integrated into the printed editions most commonly used by students in schools. It should also be emphasized that a student may have difficulties even without a formally recognized need for an individualized program. This practice shows that formal inclusive principles are not consistently translated into the didactic materials available during regular instruction, which further complicates the implementation of the curriculum under real classroom conditions.

The scientific contribution of this work extends beyond national boundaries, as it highlights structural challenges present in many European education systems, particularly those struggling with the systematic empowerment of teachers for inclusive mathematics teaching. Although the research was conducted in the Croatian context, the identified mismatch between a curriculum that advocates individualization and inclusion and the empirical reality in which teachers remain insufficiently prepared is also recognized in international literature. Thus, the study gains broader relevance considering that it raises issues of general interest for European countries seeking to improve inclusive practices and outcomes in mathematics education.

The scientific value of this study lies in the integration of three analytical levels that are rarely examined together: self-assessments of future teachers, the requirements of official curriculum documents, and a systematic analysis of textbook materials. This holistic approach allows for a deeper understanding of the structural weaknesses of the education system–weaknesses that are not specific to Croatia but are also recognized more broadly in Europe, particularly where reform processes aim at inclusivity but have not yet ensured adequate implementation support.

The practical implications of this research are therefore significant not only for the Republic of Croatia but also beyond. Effective preparation of teachers to work with students with mathematical difficulties requires the alignment of higher education programs with the needs of the modern classroom, strengthening practice grounded in real teaching situations, and the development of didactic materials designed according to the principles of UDL. Such findings may be useful for all education systems seeking to enhance teacher professional competencies, provide targeted support for students with difficulties, and ensure that inclusive principles are effectively realized in daily instruction.

Given international trends in the development of inclusive education, the results of this study call for further comparative research and regional or European initiatives aimed at creating more systematic models of support for teachers. Future research should include deeper analyses of the effects of inclusive strategies in different cultural and institutional contexts, as well as comparisons of textbook and instructional material quality between countries with a well-established tradition of inclusion and those still in development.

In conclusion, the study demonstrates that highly ambitious inclusive goals can only be achieved if they are accompanied by long-term support for teachers, the development of high-quality materials, and systematic investment in the professionalization of teaching practice. With this contribution, the study offers a relevant and empirically grounded input to the European discussion on inclusion in mathematics education, providing insights that extend beyond local boundaries and have the potential to inform broader regional and international educational policies.

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