Children with Mathematics Learning Disabilities in Belgium

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Abstract
In Belgium, between 3% and 8% of the children in elementary schools have mathematics learning disabilities (MLD). Many of these children have less developed linguistic, procedural, and mental representation skills. Moreover, a majority of the children have been found to show inaccurate prediction and evaluation skills in Grade 3. MLD often become obvious in elementary school. Whereas some children are retained, others are referred to special education. During the last 10 years, the number of children in special education and the number of children with learning disabilities who are following a special guidance program in general education (inclusive education) have increased. Children in Belgium with MLD can get therapy for about 2 years. Nevertheless, many problems continue unresolved even in high school and adulthood.

From 1974 to 1997, only 28 articles on mathematics learning disabilities (MLD) were cited in PsycInfo, whereas 747 articles could be found on reading disabilities (Noel, 2000). Therefore, we agree with Ginsburg (1997) and Hanich, Jordan, Kaplan, and Dick (2001) that children with mathematics difficulties have been understudied, and their problems have been underestimated. We know that MLD can seriously limit a student’s educational opportunities (Rivera-Batiz, 1992). Moreover, the disabilities often persist into the college years (Miller & Mercer, 1997), and many of these children continue to function below the arithmetical level of a 13-year-old child (Cawley & Miller, 1989; Miller & Mercer, 1997).

In this article, first we give a general description of mathematics education in Belgium. Second, we describe children with MLD in our country. Third, we discuss the problems with mathematical problem solving in children of average intelligence, both with and without MLD, in Belgium. Finally, we inventory the instructional interventions and the accommodations implemented to help students with MLD in Belgium.

Mathematics Education in Belgium

General Education
Belgium is a small country in the heart of Europe with a population of nearly 11 million. Belgium has French-speaking and a Flemish-speaking communities, along with a small German-speaking community. This article relates mainly to the Flemish-speaking community, or Flanders, although some additional information is provided concerning the French-speaking community. The situation in the French and German-speaking parts is similar to that of the Flemish-speaking part.

In Belgium, most children start kindergarten when they are 2½ years old. They get 3½ years of kindergarten education. At the age of 6, the children go to primary school, where they learn to read, write, and do mathematics. Primary classes include roughly 20 to 30 children in a single classroom. Children spend about 7 hours at school every weekday, except Wednesday, which has early dismissal. There is no school on Wednesday afternoon. After primary school, students enter secondary education. This is followed either by vocational training or by college or university.

All Belgian children have to continue their education (and in most cases remain at school) at least until they are 18 years old. A small number of children are educated at home, because since 1914, there has been compulsory education in Belgium, but not compulsory schooling. There are three types of schools in Belgium: Catholic schools, schools organized by the federal government, and schools organized by the cities or provinces. There are no major differences between these three types of schools, although each operationalizes the obligatory central developmental aims (ontwikkelingsdoelen) of the kindergarten and the outcomes to be achieved at the end of elementary education (eindtermen) in a slightly different way with respect to the mathematics curriculum (wiskundeleerplan).

Schools are held accountable for student performance. Inspection is organized at a central level. As in most European countries, several systematic, full inspections of the schools as a whole are carried out in Belgium annually (Standaert, 2001). The CIPO (Context, Input, Process, Output) model
is used for this inspection, and a school’s performance is evaluated in four key areas. This evaluation determines the results of each school with respect to student performance (output) and the way in which these results have been achieved (process), taking into consideration the context in which the school is operating (e.g., demographic, juridical, and administrative data) and the input data (e.g., information about pupils, school staff, and material resources). In Flanders, the evaluation of the quality of teachers is left to the local school or its governing body, whereas the French-speaking community of Belgium has a central teacher assessment system (Standaert, 2001).

In the Flanders curriculum, 80% of the children must acquire 80% of the required minimum skills and knowledge by the end of their primary school education. Children who do not meet these minimum aims and who read or solve mathematics problems on the level of third graders without learning disabilities (LD) are referred to the B-classes of secondary education (Hellinckx & Ghesquière, 1999). If their lost ground is made up in the first year of secondary education, then these children can go back to the A-classes, where they follow a general course of studies aimed at preparing them for college or university. About 20% of the children with LD in special primary education go to one of the A-classes in secondary education (Hellinckx & Ghesquière, 1999). The other children follow a specialized course of vocational training.

General mathematics education in Flanders seems to be doing quite well for most children. The Program for International Student Assessment (PISA) recently compared the learning performance of students in 30 different countries all over Europe, Asia, and America. This project revealed that the 15-year-old Flemish students did best on mathematics (DeMeyer, De Vos, & Van de Poele, 2002). Flemish students obtained a second place on reading skills, just after students from Finland, and they scored third on science, after Korea and Japan. Especially children in families with a high socioeconomic status did well in this study. Children in families with a lower socioeconomic status had results comparable with those of their peers in the other countries. Moreover, students in the French-speaking part of Belgium did worse on mathematics, reading, and science than their Flemish-speaking peers in the same country (Bormans, 2002; Galle, 2001).

The mathematics curriculum in Belgium changed in 1998 (Commissie Wiskundeleerplan van het Gemeenschapsonderwijs, 1998; Vlaams Verbond van het Katholiek Basisonderwijs, 1999). The former mechanistic approach and even the structuralistic approach (with “new mathematics”) became history. Inspired by the example of the Netherlands (Freudenthal, 1991; Treffers, 1991), a more constructivistic realistic mathematics education (RME) was introduced, which emphasizes the importance of students becoming active learners who construct their own mathematics (Blöte, Van der Burg, & Klein, 2001). The main paradigm of RME is that the teaching of mathematics should build on the previous knowledge of children derived from their real-life experiences with numbers. Dialectical constructivists stress that the understanding of arithmetic develops through active knowledge construction, transformation, and discovery within an approach involving scaffolding and does not merely result from passive information acquisition (Cobb, Yackel & Wood, 1992; Muthukrishna & Borkowski, 1996). They assume that people actively construct their own knowledge by linking prior knowledge to new knowledge. The emphasis is on a more functional use of basic mathematics concepts and skills and on the use of schemata to assist abstract thinking. Moreover, mathematics has become a tool for solving all kinds of problems, for handling all kinds of tasks, and for communicating and working together through a more interactive teaching process. In the RME approach, children in small groups are given the opportunity to discover adequate strategies for themselves on a variety of tasks presented in meaningful and rich contexts (e.g., Milo, 2001; Van Luit, 1999; Verschaffel, 1999).

This conceptual change has had consequences for the content of mathematics education (Verschaffel, 1995). So-called structuralistic “new mathematics” (e.g., A∩B) has disappeared from the curriculum, and some number algorithms, formulas, and other domain-specific data (e.g., prime numbers, nine control on multiplications, theory of sets) have disappeared with them. In contrast, the accent is now on mental mathematics, on approximate arithmetic or number sense, on mathematics using the calculator (from Grade 4), and on problem solving and strategy use. However, there is still acknowledgment of the importance of older, established aims and contents, such as perfect mastery of number concepts. But in contrast with the traditional conception of mathematics learning as the passive and isolated absorption of knowledge and procedures, these concepts should be constructed actively by children, allowing for individual learning trajectories (Torbeys, Verschaffel, & Ghesquière, 2003).

RME focuses on adaptive expertise (Baroody & Dowker, 2003) and on having students create and discuss their own solution procedures and on using context problems to relate mathematics to real-life situations. RME has resulted in a higher level of flexibility and more conceptual understanding for average students without LD (e.g., Blöte et al., 2001). However, children with MLD have not done as well (e.g., Woodward & Baxter, 1997). Several handbooks (e.g., Pluspunt, 2002) and teaching methods based on the RME approach that have been used for Flemish children with MLD have resulted in confused children who are unable to solve math problems. This is presumably because RME places substantial demands on metacognitive skills, which may not be adequately developed in children with MLD (De-
in Belgium were being educated in 2000–2001, 10,049 (+ 59.86%) of the children in Type 8 schools, whereas in years. In 1990–1991, there were 6,015 primary school children. For Type 8 school children, and 3.65% of the secondary school children. For Type 8 (7–14 years) with reading, spelling, or mathematics learning disabilities, Type 8 special primary education has been set up. For children with LD, no special education program has as yet been set up either in kindergarten or in secondary schools. In the 1970s, about 3% of school-age children went to special schools (Types 1 through 8). However, by the end of the 1990s, 78.65% of the total number of children in special primary education (Mardulier, 2001). However, there seems to be a large gender difference in the choice of general versus special education. In 2000–2001 in Flanders, boys went more often to special schools than girls.

In general, the budget for special primary and secondary education is about 414 million euro, which means that 9% of the total education budget is spent on the 3.9% of the students, who are receiving this kind of education (Mardulier, 2001). With this extra budget, special education is able to work with smaller classes (about 10 children in a class) using specially trained teachers and a team of other specialists (speech–language therapists, occupational therapists, ergonomic therapists, psychologists, and sometimes psychiatrists or other physicians) to assist in the education of these children.

At the present time in Flanders, there is a strong movement in favor of inclusive education (Broekaert & Van Hove, 1995; Kennes, 2001; Lebeer, 2003; Van Hove & Roets, 2000; Wuyts, 1996). Some of its proponents are even insisting on the abolition of special education for children with LD. This inclusive approach to education is aimed at restructuring the schools in order to meet the needs of the students who are at risk and at promoting the value of diversity within the human community. The guiding principle is that schools should accommodate all children, regardless of their physical, intellectual, social, emotional, linguistic, or other characteristics. In this spirit, the care coordinator (zorgcoördinator) has an important task in general education from September 2003 on.

An integrated education (Geïntegreerd onderwijs; GON) experiment was started in 1980 on Flemish children who had a physical or sensory disability (Types 4, 6, and 7). In 1983, it was generalized to all types of special education, and in 1986, it was put into law. School boards of general education schools now have the possibility of cooperating with schools for special education where students with learning or other disabilities are being educated. As a result, it is becoming possible for some children with disabilities to remain in general education for 1 or 2 years or, in the case of a severe disability, for an unlimited time. The general education school then receives pedagogical–didactic or therapeutic assistance from a school for special education. The school for special education receives an integration allowance to assist the general education school in educating children with disabilities. Although the percentage of children in special education has increased, the number of GON students has also increased in 10 years. In 1994–1995, there were 36 children in Type 8 with a GON status, whereas in 2000–2001, there were already 190 children in the GON education system (Mardulier, 2001; Wuyts, 1996).

To summarize, general mathematics education in Flanders seems to be doing quite well for most children. Although there is a strong movement in favor of inclusive and integrated education, separate special schools exist for children with LD.

**MLD in Flanders**

**General and Special Education**

In Flanders, most learning disabilities are not detected until primary school, when reading disabilities often become obvious. Likewise, many children with MLD in primary school did not encounter severe difficulties with preliminary mathematics learning in kindergarten, although in some cases, inefficient counting and not remembering number names was already present as a marker (Grégoire, Van Nieuwenhoven, & Noel, 2003). Nevertheless, most children with MLD in Belgium are detected in Grade 1, when they have to master addition and subtraction, and, in some cases, even later (in Grade 3), when they have to learn
to quickly retrieve the multiplication tables or to select and apply various problem-solving strategies in addition to the basic mathematical operations.

In secondary education, college, or university, students with MLD encounter numerous problems with mathematics and physics and very few teachers who understand their learning problems. This often results in low self-concept and even in behavioral problems. About 40% to 80% of students with LD develop behavioral problems (Thiery, 2001). Parents are confronted with a very tumultuous period in the life of these youngsters, up to suicidal behavior in some of them.

**Definition of LD in Flanders**

Although various authors agree that an operational definition of LD is meaningful (e.g., Kavale & Forness, 2000; Swanson, 2000), most studies are rather vague when it comes to characterizing the children who fit in their category of children with learning disabilities. Several authors use different terms for a deficit in mathematical problem solving, such as mathematics learning difficulties, mathematics learning problems, mathematics learning disorder, mathematics learning disability, mathematics learning retardation, mathematics learning deficiency, or dyscalculia (e.g., American Psychiatric Association, 1994; Dumont, 1994; Fletcher & Morris, 1986; Hellinckx & Ghesquière, 1999; Rourke & Conway, 1997; Thiery, 2001). Teaching difficulties must be noticed by the teacher for them to be defined as a mathematics learning problem.

The three criteria (severeness, discrepancy, and resistance) may seem very clear parameters for ascertaining whether an individual child belongs to the group of children with MLD. However, in clinical practice, the diagnosis also depends on the tests chosen to measure the severeness criterion. The choice of these mathematics tests was found to be crucial in a study of 85 children in Flanders. No single test was found to be able to detect all 37 children with MLD (Desoete & Roeyers, 2000). It might be interesting to combine the assessment of those aspects within one test (e.g., Grégoire, 1997) and to investigate if such a test would detect all children with MLD. Such studies are currently being prepared (Grégoire et al., 2003).

**Prevalence of MLD in Flanders**

In October 2001, a prevalence study was conducted among general education second-, third-, and fourth-grade students in Flanders (N = 3,978; see Table 1).

In second grade, 2.27% of the children (2.11% boys and 2.42% girls) were found to have MLD according to a test of domain-specific mathematics knowledge and a test of math word problems—was needed to prevent the choice of test from determining the diagnosis. The domain-specific test in combination with the test of math word problems was able to detect 27 out of the 37 children. The domain-specific test combined with the test of number facts was able to identify 34 out of the 37 children with MLD. Only the combination of a test of domain-specific knowledge, a test of number facts, and a test of math word problems was found to be able to detect all 37 children with MLD (Desoete & Roeyers, 2000).
edge and skills. Furthermore, in the fourth grade, 6.59% of the children (6.99% boys and 6.22% girls) had MLD in Flanders (see Table 1). MLD diagnoses were based on number fact retrieval and domain-specific knowledge in 2.88% and 4.47% of the cases, respectively.

About 25.47% of the second graders had MLP according to the teacher and a mathematics test battery (−1 SD below norm); MLP = mathematics learning problems (−1 SD below norm); AMA = adequate mathematics abilities (less than −1 SD below norm); NF = based on number facts, DS = based on domain-specific test.

Table 1: Prevalence of Mathematics Learning Disabilities in Flanders by Grade, Gender, and Diagnostic Test

<table>
<thead>
<tr>
<th>Diagnosis/Test</th>
<th>Grade 2 Boys</th>
<th>Grade 2 Girls</th>
<th>Grade 3 Boys</th>
<th>Grade 3 Girls</th>
<th>Grade 4 Boys</th>
<th>Grade 4 Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLD</td>
<td>2.11</td>
<td>2.42</td>
<td>7.15</td>
<td>8.32</td>
<td>6.99</td>
<td>6.22</td>
</tr>
<tr>
<td>Total</td>
<td>2.11</td>
<td>2.42</td>
<td>7.15</td>
<td>8.32</td>
<td>6.99</td>
<td>6.22</td>
</tr>
<tr>
<td>NF</td>
<td>1.21</td>
<td>1.81</td>
<td>4.43</td>
<td>4.39</td>
<td>3.26</td>
<td>2.52</td>
</tr>
<tr>
<td>Total</td>
<td>1.21</td>
<td>1.81</td>
<td>4.43</td>
<td>4.39</td>
<td>3.26</td>
<td>2.52</td>
</tr>
<tr>
<td>DS</td>
<td>0.91</td>
<td>0.91</td>
<td>3.29</td>
<td>4.24</td>
<td>4.66</td>
<td>4.29</td>
</tr>
<tr>
<td>Total</td>
<td>0.91</td>
<td>0.91</td>
<td>3.29</td>
<td>4.24</td>
<td>4.66</td>
<td>4.29</td>
</tr>
<tr>
<td>MLP</td>
<td>23.27</td>
<td>23.67</td>
<td>27.79</td>
<td>23.15</td>
<td>24.89</td>
<td>25.90</td>
</tr>
<tr>
<td>Total</td>
<td>23.27</td>
<td>23.67</td>
<td>27.79</td>
<td>23.15</td>
<td>24.89</td>
<td>25.90</td>
</tr>
<tr>
<td>NF</td>
<td>19.33</td>
<td>14.37</td>
<td>16.16</td>
<td>16.01</td>
<td>14.91</td>
<td>10.96</td>
</tr>
<tr>
<td>Total</td>
<td>19.33</td>
<td>14.37</td>
<td>16.16</td>
<td>16.01</td>
<td>14.91</td>
<td>10.96</td>
</tr>
<tr>
<td>DS</td>
<td>11.78</td>
<td>13.31</td>
<td>11.73</td>
<td>13.81</td>
<td>10.87</td>
<td>15.26</td>
</tr>
<tr>
<td>Total</td>
<td>11.78</td>
<td>13.31</td>
<td>11.73</td>
<td>13.81</td>
<td>10.87</td>
<td>15.26</td>
</tr>
<tr>
<td>AMA</td>
<td>79.46</td>
<td>83.81</td>
<td>79.39</td>
<td>79.59</td>
<td>81.83</td>
<td>86.66</td>
</tr>
<tr>
<td>Total</td>
<td>79.46</td>
<td>83.81</td>
<td>79.39</td>
<td>79.59</td>
<td>81.83</td>
<td>86.66</td>
</tr>
<tr>
<td>NF</td>
<td>87.31</td>
<td>85.93</td>
<td>84.98</td>
<td>81.95</td>
<td>84.47</td>
<td>80.44</td>
</tr>
<tr>
<td>Total</td>
<td>87.31</td>
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<td>84.47</td>
<td>80.44</td>
</tr>
</tbody>
</table>

Note. MLD = mathematics learning disabilities (−2 SD below norm); MLP = mathematics learning problems (−1 SD below norm); AMA = adequate mathematics abilities (less than −1 SD below norm); NF = based on number facts, DS = based on domain-specific test.

Mathematics Problems in Children With and Without LD

In the last decade, substantial progress has been made in characterizing the cognitive and metacognitive skills that are important for success in mathematical problem solving (Boekaerts, 1999; Geary, 1993; Grégoire & Van Nieuwenhoven, 1999; Hacker, Dunlosky, & Graesser, 1998; Lucangeli & Cornoldi, 1998; Wong, 1996). On the basis of this research and of an analysis of 150 math protocols of third graders in our study, a conceptual model of mathematical problem solving was developed (De Clercq, Desoete, & Roeyers, 2000; DeSoete, 2002; Desoete, Roeyers, & De Clercq, 2002a, 2002b; see Figure 1). A variety of studies based on different theoretical approaches have provided information regarding the cognitive skills that are important for young children in learning how to solve mathematical problems. Numerical comprehension and production skills are the cognitive skills that are necessary for the reading, writing, and comprehension of numbers composed of one or more digits (e.g., read 5 or 14; McCloskey & Macaruso, 1995; Van Borsel, 1998). Problems with these cognitive skills lead to mistakes such as 15 + 9 = 18 (confusion between 5 and 2 and 9 and 6). Operation symbol comprehension and production skills are cognitive skills that enable the reading, writing, and comprehension of operation symbols (such as +, −, ×, ÷, <, >; e.g., Veenman, 1998). Problems with these cognitive skills lead to mistakes such as 15 × 9 = 24. Number system comprehension and production skills are the cognitive skills dealing with number system knowledge and the position of decades and units (e.g., Veenman, 1998). Children having problems with these skills often make mistakes with the place of a number on a number line and do not know how many decades and units there are, for example, in 15. Procedural skills are domain-specific cognitive skills involved in calculating and solving mathematics tasks in number problem formats (e.g., 15 + 9 = __ or 81 − 5 = __; e.g., McCloskey & Macaruso, 1995; Noel, 2000; Veenman, 1998). Problems with these cognitive skills lead to mistakes such as 15 + 9 = 105 or 114. Language comprehension skills are cognitive conceptual skills that enable children to understand and solve one-sentence word problems (e.g. 9 more than 15 is __). Language plays a central role according to several authors (e.g., Campbell, 1998; McCloskey & Macaruso, 1995). Veenman (1998) stressed the importance of general conceptual knowledge in mathematics. Van Borsel (1998) went even further and defended MLD as a special kind of language disorder. We would not go so far. However, we can see that if children do not know what “more” means, then word problems such as “9 more than 15 is what?” cannot be solved correctly. Mental representation skills are cognitive skills that enable an adequate mental representation of the problem or task (e.g., Geary, 1993; Montague, 1997; Ver-
meer, 1997; Verschaffel, 1999). A mental representation is required in most word problems, because the simple translation of key words in a problem (e.g., “more”) into calculation procedures (e.g., “addition”) without representation leads to blind calculation or number crunching. This superficial approach leads to errors, such as answering “24” to questions such as “15 is 9 more than __,” “27 is 3 less than __,” and “48 is half of __.” Contextual comprehension skills are cognitive skills that enable the solving of tasks in word problems consisting of more than one sentence (e.g., “Bert has 14 Digimon™ [Akiyoshi Hongo] cards. Griet has 5 Digimon cards more than Bert. How many cards does Griet have?”). In children with MLD, problems involving these tasks (cognitive complexity) were found to be related to problems with working memory (and cognitive overload) and knowledge base and expertise (Baddeley, 1999; Logie & Gilhooly, 1998; McCloskey & Macaruso, 1995). Relevance skills are cognitive skills enabling the solving of word problems with irrelevant information included in the assignment (e.g., “Bert has 14 Digimon™ [Nintendo] cards and 3 Digimon cards. Griet has 5 Pokémon™ cards and 3 Digimon cards. Bert has 5 Pokémon cards more than Bert. How many Pokémon cards does Griet have?”). Children can have difficulty ignoring and not using information (e.g., “3 Digimon cards”) in an assignment. Children with MLD often think that all the numbers have to be used in order to solve a mathematical problem, and will therefore answer “22.”

Number sense skills are the ninth category of cognitive skills. These skills enable the solving of tasks such as “the answer to 5 more than 14 is nearest to __. Choose between 5, 10, 15, 70 and 50.” The ability to estimate without calculating the exact answer is called number sense. In clinical practice, almost all children with MLD have problems with number sense tasks (e.g., Sowder, 1992). In our study, significant partial correlations were found between all cognitive skills except between linguistic and procedural skills, linguistic and operational symbol comprehension skills, linguistic and relevance and number sense skills, and mental representation and relevance and number sense skills (Desoete, Roeyers, & Buyssse, 2000).

It is nowadays widely accepted that metacognition also influences mathematical problem solving (Brown, 1987; Carr & Jessup, 1995; Desoete, Roeyers, & De Clercq, 2003a; Hacker et al., 1998; Lucangeli, Cornoldi, & Tellarini, 1998; Veenman, Kerseboom, & Imthorn, 2000; Verschaffel, 1999). In recent studies, however, the term metacognition has come to be used in multiple and nearly unrelated senses to refer to a wide range of phenomena (Borkowski, 1992; Carr & Biddlecomb, 1998; Schoenfeld, 1992; Wong, 1996). Metacognitive knowledge has been described as knowledge and deeper understanding of one’s own cognitive skills and products (Flavell, 1976, 1979). Within metacognitive knowledge, Cross and Paris (1988) and Jacobs and Paris (1987) distinguished between declarative knowledge, procedural knowledge, and conditional knowledge. Metacognitive skills relate to the voluntary control that people have over their own cognitive skills (Veenman, in press). The number of metacognitive skills being distinguished varies from 3 to 10 (Desoete, 2001). Substantial data have been accumulated on 4 metacognitive skills: prediction, planning, monitoring, and evaluation (Lucangeli & Cornoldi, 1997; Lucangeli et al., 1998). Simons (1996) described this third metacognitive component (metacognitive beliefs) as the broader general ideas and theories (e.g., self-concept, self-efficacy, motivation, attribution, and conceptions of intelligence and learning; see Figure 1) that people have about their own and other people’s cognition (McCombs, 1989; Vermeier, 1997; Wong, 1996). A principal components analysis of metacognition revealed three metacognitive components that explained 66% to 67% of the common variance (Desoete, Roeyers, & Buyssse, 2001). Prediction and evaluation were found to be interrelated as one of these components. As both these metacognitive skills were measured either before or after the solving of exercises, we labeled this metacognitive component off-line (measured) metacognition. In 165 third graders, we were able to differentiate between different mathematics ability groups on the basis of the off-line metacognitive component (Desoete, Roeyers, & Buyssse, 2001).

Recent studies have underlined the importance of several cognitive and metacognitive skills for the purpose of distinguishing between children with MLD, children with MLP, and children with age-appropriate mathematics performance in Flanders (Desoete, 2003; Desoete & Roeyers, 2002).

In terms of cognition, several children with combined domain-specific and automatization MLD were found
to have less developed language comprehension skills (Desoete & Roeyers, 2001). Moreover, several children with domain-specific MLD were found to have less developed mental representation skills. However, children with merely automatization MLD (and age-appropriate domain-specific mathematics knowledge and skills) did not fail on mental representation tasks, and some even had higher scores than peers without MLD (Desoete & Roeyers, 2001). These findings support the idea that some children with specific MLD use blind calculation techniques depending on a simple translation of key words in an instruction. Finally, several children with domain-specific MLD had problems with procedural skills, using several erroneous procedures (Desoete & Roeyers, 2001; Van Lehn, 1990).

In terms of metacognition, a majority of children with MLD were found to have less accurate prediction skills than their peers without LD. Younger children outperformed all children with MLD in the area of prediction skills on tasks designed for first-grade students (so-called easy tasks). Furthermore, children with specific MLD had less accurate prediction skills relating to number system knowledge and procedural calculation. Also, children with combined MLD and reading disabilities were found to have less accurate prediction skills in word problems involving language-related and mental representation tasks. Moreover, a majority of the children with MLD had less accurate evaluation skills than their peers without LD. Furthermore, children with MLD had problems especially in estimating their chances of success on the easy tasks. Finally, children with MLD scored worse in the evaluation of number knowledge and procedural calculation than did younger children who were their equals in the area of mathematical problem solving (Desoete, 2003; Desoete & Roeyers, 2002; Desoete, Roeyers, & De Clercq, 2001).

Studies at the group level certainly revealed interesting information. There is, however, a certain risk of misinterpreting these studies, because they cannot be automatically applied to individual children. Not all children with MLD were found to have the same inadequate cognitive or metacognitive skills. For example, children with a mathematics automatization disability did not fail on linguistic, procedural, or mental representation tasks (Desoete & Roeyers, 2001). Moreover, only a small majority of the third graders with MLD had inaccurate off-line metacognitive skills. Furthermore, a minority of the children without learning problems also had a severe deficit (~2 SD) on off-line metacognitive skills (Desoete, 2001).

Taking all these findings together, what we see is a broad spectrum of MLD that manifest themselves in a great variety of individual cognitive and metacognitive profiles in young children. It might, therefore, be important to assess cognitive and off-line metacognitive skills in children with MLD. Certainly procedural, linguistic, mental representation, prediction, and evaluation skills have to be tested in order to detect whether these skills are appropriately developed. Moreover, a general protocol of cognitive or metacognitive intervention for all children with MLD might represent overconsumption of therapeutic resources because not all individual children were found to have below-average performance on tasks depending on these skills. This leads us to the final section, namely the inventory of the instructional interventions and accommodations implemented to help students with MLD in Belgium.

Instruction for Children with MLD in Belgium

When problems with mathematics are detected, the teacher or parent can ask the advice of the school psychologist. In most cases, problems with mathematics are regarded as problems to be solved within the classroom and within the school system. The school psychologist and the care coordinator (zorgcoördinator) then look at exercises done in the classroom and, if necessary, give an additional mathematics test. Special groups may be formed within the classroom for several hours during the week in order to differentiate between fast and slow learners (broader care or zorgverbreding). In addition, STICORDI (Stimulating, Compensating, Relativating, and Dispensating) measures can be agreed upon in some kind of pedagogical charter. When broader care is insufficient, then bringing in a remedial teacher (taakleerkracht) is the usual next step. Here the children are given special exercises in a special classroom for 6 months (on an individual basis or in small groups) in an attempt to remedy their problems.

After 6 months to 1 year, children with resistant, severe problems with mathematics in primary school often move to one of the rehabilitation centers or centers specialized in handling educational problems to get a more elaborate assessment. After an interview with the parents, the child, the teacher, and sometimes the school psychologist, and after an elaborate series of tests, interviews, and observations, the diagnosis and label of LD is often given.

Some of the children with LD are also advised to repeat a year in general education. In Flanders, 10% of all sixth graders have repeated 1 or more years of primary school (Hellinckx & Ghensquier, 1999). In other cases, children are referred to special education (Type 8), although, as previously mentioned, there is a strong movement toward inclusive education.

In Flanders, young children of average intelligence up to the age of 15 who have a learning disability, a score lower than Percentile 4 on a mathematics test, and a need for a multidisciplinary approach, can follow a course of therapy for 2 years (two or three times a week) in a rehabilitation center. Moreover, there are some situations in which psychologists and educators, and in some cases also remedial teachers and care coordinators, set up a special thera-
peutic program for these children. This program sometimes fits within the general education system, although for many children, it is provided by psychologists and other specialists outside the school. In other cases, when a specific isolated mathematics retardation of 1 year (for 7- to 9-year-olds) or 2 years (for 9- to 14-year-olds) is found, a multidisciplinary therapy is advised, and the children go to private mathematics therapists (in Flanders, often specialized speech–language therapists or specialized physiotherapists).

The different approaches taken to therapy for children with MLD in Flanders can vary greatly. However, most therapists apply a rather cognitive/metacognitive and task-analytical therapy based on the learning of algorithms and heuristics. The instruction principles are isolation (orientation, demonstration, practice, shortening, control, working faster, knowing when and where to use the principles), integration, and generalization (Ruijsse-naars, 2001). This is frequently combined with stimulating a realistic sense of self-esteem in young children and a correct identification of their successes and failures in school performance. Often, therapists also use self-instructional techniques, for example to teach children how to handle word problems (“read the instructions,” “see if you understand all the words,” “make a diagram or drawing of the situation,” etc.). A minority of therapists in Flanders use a more psychomotor approach to dealing with mathematical problems in young children. However, in many cases, a combination of therapeutic approaches is used from a more eclectic perspective. The form that the course of therapy actually assumes depends to a great extent on the assessment of the problems of the individual child.

Summary

Flemish students seem to do quite well on mathematics compared with youngsters in other countries. However, between 3% and 8% of students in Flanders have MLD in primary school. Moreover, MLD seems to be very persistent, leading to residual problems with mathematics in adolescence and even in adulthood.

We have argued that although many authors agree that an operational definition of LD is meaningful, most studies are rather vague when it comes to objectively defining the characteristics on the basis of which they identify children with learning disabilities. Overlapping concepts and terms are frequently used to deal with a wide range of phenomena relating to children who have difficulties with mathematical problem solving. In an effort to be more explicit, we have adopted three criteria (discrepancy criterion, severity criterion, and resistance criterion) for ascertaining whether an individual child belongs to the group of children with MLD.

Moreover, we have stressed the need for care in the assessment and diagnosis of children with MLD. More specifically, we have referred to the importance of using a combination of mathematical tests for young children, including at least one test of number facts and one test of domain-specific mathematics knowledge or word problems, in order to avoid basing an entire diagnosis on a single test. Furthermore, we have found that teachers’ judgments seem to be an absolute requirement for confirming the test results. Our research revealed the importance of also testing the reading skills of children with MLD in order to differentiate children with a specific mathematics learning disability from children with combined LD. Furthermore, quite a number of children with MLD were found to have less developed linguistic, procedural, and mental representation skills, and a majority of the children with MLD were found to have inaccurate off-line metacognitive skills. It may be advisable also to assess the cognitive and metacognitive skills of young children with MLD.

We further clarified that in Belgium, most young children with LD remain in general education in kindergarten. Once the children are in primary school, the learning disabilities often become obvious. With the new mathematics curriculum and the realistic approach (RME), additional research is certainly needed to determine their effect on children with MLD. Once the problems with mathematics are detected, the school psychologist is consulted. This psychologist often suggests a differentiated approach (broader care) or remedial teaching for 6 months. If this is not sufficient, a more elaborate assessment is carried out, and a therapy plan is established. This therapy is partially financed by the government for a period of 2 years. After this period, in theory, the MLD should be remedied. However, in practice, children in secondary or higher education with MLD encounter even more difficulties, which may lead to a very low self-concept and to behavior problems. These findings indicate that more in-depth research is certainly needed on the prevention and early detection of signals indicating potential MLD in preschool children. Moreover, studies on adolescents and even adults with MLD would be useful in order to gain more insight into the emotional and behavioral impact of their disabilities.

The findings from recent studies also provided evidence that educational interventions for students with LD can produce positive effects of respectable magnitude (Desoete & Roevers, 2003; Desoete, Roeyers, Buysse, & De Clercq, 2002; Efklides, Papadaki, Papantoniou, & Kiosseoglou, 1997; Masui & De Corte, 1999; Swanson, Hoskyn, & Lee, 1999). However, a number of problems that students with MLD encounter continue to make themselves felt into adulthood. In Belgium, most therapists were found to apply a rather cognitive/metacognitive therapy, based on the learning of algorithms and heuristics. This approach was often found to be combined with efforts to remedy the emotional aspects of the learning disability. In most cases, a combination of therapeutic approaches is used for an
individual child, depending on the assessment results.

It is important to keep in mind that we have restricted most of our studies to third graders with MLD in Flanders. Therefore, on several aspects, further research can be recommended. On the one hand, cognition and off-line metacognition needs to be studied in younger and older children and in children with below-average or above-average intelligence. Moreover, individual studies of children with MLD are clearly needed to help us translate the findings at the group level into remedial measures specifically suited to individual children. We believe that the research data derived from such studies would improve our understanding of individuals with MLD.

In conclusion, we have found that MLD can be very persistent. We have also found that a well-elaborated assessment and intervention procedure is of key importance, because there appears to be a broad spectrum of MLD that come to expression in a broad range of highly individual cognitive and metacognitive profiles in young children.

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REFERENCES


met een verstandelijke handicap [From care to support: Recent developments in the services provided to persons with a mental disability] (pp. 41–52). Houten, the Netherlands: Bohn Stafleu Van Loghum.


