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Metacognitive Functioning in Students with Learning Disabilities or Difficulties: A Systematic Literature Review

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Abstract. Dealing with the particularities of learners with learning disabilities or difficulties requires an understanding of the metacognitive functioning of these subjects. The aim of this work is to summarise the studies dealing with metacognitive functioning in students with learning disabilities or difficulties. For this reason, this research applied the systematic literature review method with the PRISMA (preferred reporting items for systematic reviews and meta-analysis) protocol. The research stages included identification, selection, eligibility and inclusion, so that studies must be indexed by Scopus between 2018 and 2023 and focus on metacognition in learners with learning disabilities or difficulties, the selection was carried out in two phases; an assessment of titles and abstracts, followed by a full analysis of the texts. The results reveal significant metacognitive disparities between students with learning disabilities and their typically developing peers. They use more surface strategies and fewer self-regulatory strategies, attach less importance to mastery, and avoid performance for fear of failure. They also have difficulty organising information, which affects their motivation. Interventions including cognitive and metacognitive strategies, techniques such as virtual reality and specific teaching improve learners' ability to detect errors, self-regulate and develop essential skills in mathematics, reading and other areas. Future research should further explore these interventions to better understand their impact, taking into account aspects such as motivation and using rigorous methodological tools.

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1. Introduction

The concept of metacognition, initiated by Flavell in 1976, has been the subject of a vast field of research (Flavell, 1979, 2002). It has been examined in its various dimensions at different ages of life (Cornoldi et al., 2015; Rosdiana et al., 2023; Urban, 2023) and in different sectors such as school learning (Bala et al., 2023; Branigan & Donaldson, 2020). Lingel and his colleagues (2019) have defined metacognition as knowledge of cognitive tasks and the cognitive strategies that enable these tasks to be carried out successfully, including the executive skills associated with monitoring and self-regulating one's own cognitive activities; in other words, it involves awareness and control of learning. There is also considerable evidence in the educational context that the development of metacognition is an effective intervention for students whose abilities are in or below the 'normal' range (Veenman, 2012). For example, when a student is revising for an exam, if they are able to make a more accurate assessment of their knowledge they will be able to use more efficient revision strategies – this will subsequently help them to develop their memory for the exam.

Learning disabilities are one of the most commonly detected developmental disorders in children and adolescents. Referring to the American Psychiatric Association's (APA) Diagnostic and Statistical Manual of Mental Disorders (APA, 2019), a specific learning disability gives rise to difficulties in learning academic skills, such as reading, writing and learning mathematics. In general, the percentage of language disorders is between five and 15% in children attending school, regardless of language or culture (APA, 2019).

According to Dirgantoro (2019), learning difficulties (mathematics, for example) can occur at any level of education. Sometimes these difficulties can be observed when students are unable to solve a problem (Wasida & Hartono, 2018). Other studies have confirmed that pupils with learning difficulties have a significantly lower level of metacognitive awareness than their peers without difficulties (Padeliadu et al., 2002). The role of different metacognitive components in the functioning of our mind is essential. These components enable us to activate execution and control strategies in order to improve our learning and problem-solving processes (Schneider & Lockl, 2002).

For students with learning disabilities, the functioning of metacognition also appears to be different (Tops et al., 2020); this evolutionary gap seems to have an impact on all dimensions of metacognition, whether it concerns metacognitive monitoring, learning to read or learning to write. This includes the ability to evaluate and regulate one's own performance (i.e. knowledge of performance and adjustment of how one does things) (Baten & Desoete, 2019; Girli & Öztürk, 2017), in addition to metacognitive knowledge (knowledge about cognitive functioning) (Antshel & Nastasi, 2008).

In terms of reading and comprehension, those with learning disabilities tend to use less complex surface processing strategies that are not adapted to their

chronological level of development, which may prove inefficient and maladaptive (Botsas, 2012). In contrast, good readers, generally those who do not experience learning difficulties, possess a wide range of well-developed strategies. Thanks to their ability to use these strategies adaptively, they achieve successful comprehension efficiently (Fuchs et al., 2003).

Metacognitive functioning is an essential aspect of learning, particularly for learners with learning disabilities or difficulties. Metacognition, which encompasses the awareness and regulation of one's own cognitive processes, is crucial to the development of autonomous and effective learning. Recent studies have shown that students with learning disabilities such as dyslexia, dyscalculia or attention deficit hyperactivity disorder (ADHD) have difficulty with metacognitive control, such as organising material, monitoring and planning, which adversely affects the various skills involved in performing the act (Khan & Lal, 2023). These deficits can manifest themselves in difficulties in planning, organising and controlling their own learning, which can adversely affect their academic performance (Cerezo et al., 2020). A study of learning strategies and metacognition in students with learning disabilities found that students who received explicit instruction in metacognitive strategies improved their ability to identify and use relevant information (Tewolde et al., 2016). Furthermore, research indicates that when students experience difficulties with reading comprehension due to low metacognitive awareness, their academic performance can be poor. This lack of success can reduce their motivation to participate in reading and learning activities, as repeated failures can lead to feelings of frustration and helplessness (Lazarus & Anwalimhobor, 2023).

Educational interventions aimed at improving the metacognitive functioning of learners with special needs often focus on teaching specific strategies that help to regulate learning. For example, one study found that using metacognitive strategies during note-taking can help learners with learning disabilities to better organise and interpret information (Boyle et al., 2016). These interventions can include techniques such as self-questioning, pre-planning and systematic revision, which are essential for enhancing metacognitive awareness and self-regulation. Research also suggests that integrating these strategies into the curriculum can help close the achievement gap between students with learning disabilities and their peers (L.-C Wang et al., 2021).

The assessment of metacognitive skills in learners with learning difficulties is an evolving field, with multimodal protocols that combine online and offline methods for more accurate assessment (Cerezo et al., 2020). These assessments provide a better understanding of metacognitive processes and enable interventions to be adapted accordingly. For example, the use of technologies such as human-machine interaction recording offers new insights into how learners regulate their learning in real time. These innovative approaches are essential for developing personalised interventions that take into account the specific needs of each learner, thereby improving their academic success and general well-being (Anache & Resende, 2016).

Through a methodical review of a wide range of literature, this systematic review aims to analyse in depth the differences in metacognition between learners with

learning disabilities or difficulties and those without, to measure the effectiveness of metacognitive training and to identify concerns for future research in this area. Emphasis is placed on the importance of understanding specific cognitive mechanisms and adapting evidence-based teaching practices to improve outcomes for these subjects. This research aims to enrich theoretical knowledge on cognitive differences and develop effective teaching strategies in favour of inclusion. It will also provide empirical data to design appropriate interventions and guide new studies while strengthening equity and pedagogical innovation in this field.

From this point of view, metacognition plays an essential role in the learning process of understanding and interpreting certain aspects of mental functioning in learners with special needs. Consequently, this study attempts to find descriptions of articles related to the functioning of metacognition in learners with learning difficulties or disabilities. The researchers therefore pose the following central question: What is the current literature on metacognitive functioning in learners with learning disabilities or difficulties? The specific research questions of the study are as follows: 1)What difference is there between learners with learning disabilities or difficulties and those without difficulties/disabilities in terms of metacognitive functioning? 2)What are the results of metacognitive interventions for learners with learning disabilities or difficulties? 3)To what extent should metacognition be the subject of more advanced research for the benefit of learners with learning disabilities or difficulties?

2. Research method

2.1. Research strategy

We developed and followed a standard systematic literature review protocol and the methodology of systematic reviews of scientific literature from the PRISMA 2020 recommendations (Page et al., 2021) was applied. We searched the following databases on 5 October 2023: Scopus, PubMed and Google Scholar. Our search equation was: (metacognition AND learning disorders) OR (metacognition AND learning difficulties) OR (learning strategies AND learning difficulties) OR (learning strategies AND learning disorders). We obtained 314 results from the Scopus database, 119 from Google Scholar and 43 from PubMed.

2.2. Inclusion and exclusion criteria

As mentioned in Table 1, the selection had to include all articles indexed by Scopus only dealing with the subject of metacognition in learners with learning disabilities or difficulties. The publications must have been published between 2018 and 2023 and written in French or English. In addition to excluding papers dealing with patients with psychological trauma or illness, we also excluded papers dealing with individuals outside the field of learning. The search stages with the PRISMA flowchart are described in Figure 1.

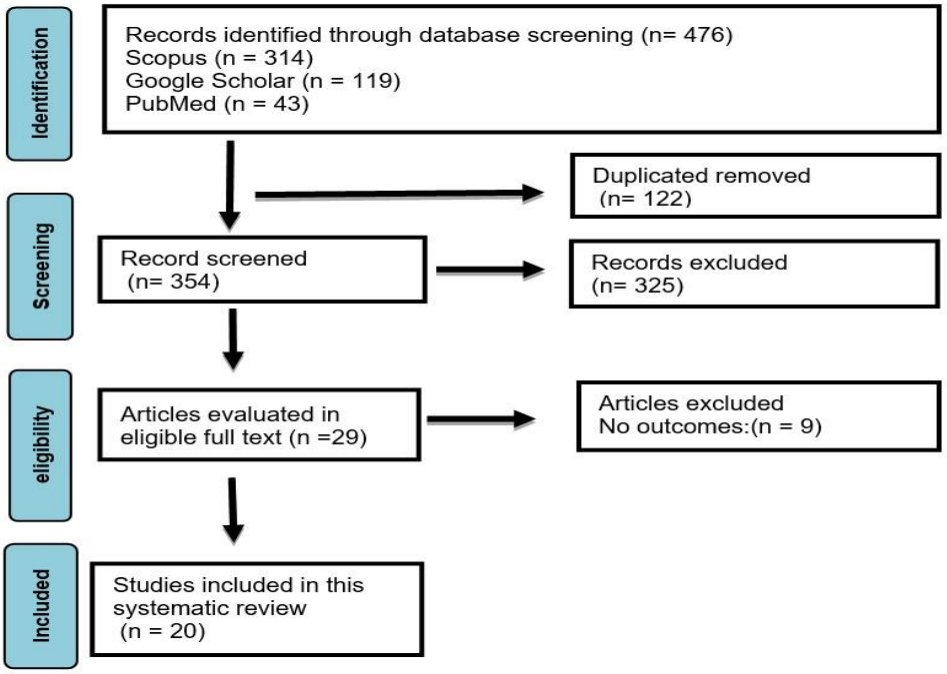

Figure 1. The PRISMA diagram

Table 1. Inclusion and Exclusion Criteria

Aspects	Inclusion	Exclusion
Article category	1. Quantitative, qualitative or mixed-method research 2. Systematic literature reviews 3. Articles undergone peer review and published in peer-reviewed journals 4. Relevance of the topics 5. Every article was written in English or French 6. The coverage of publishing years: 2018–2023	1. Articles of conference proceedings 2. Articles without pertain to the topics 3. Opinion articles 4. Out-of-date articles 5. Articles dealing with patients suffering from trauma or psychological illnesses 6. Articles dealing with individuals outside the field of learning
Themes of research	1. Metacognition 2. Learning disorders 3. learning difficulties 4. Learning strategies	Papers that were not aligned with these themes: 1. Metacognition 2. Learning disorders 3. learning difficulties 4. Learning strategies

2.3. Selection and analysis of publications

All publications were collected between 10 and 25 September 2023 from recognised academic databases such as Scopus, PubMed and Google Scholar. These sources were selected for their in-depth review of the scientific literature relevant to our field of research. Once collected, the references were exported to Zotero, a bibliographic management tool, in order to organise and structure our

publications library efficiently. We began by excluding duplicates using Zotero's automatic detection function, but an additional manual check was carried out to ensure that no repeated publications had escaped the first sorting stage.

As the research questions oriented us towards a qualitative research approach (content analysis), the selection of the remaining publications was then undertaken in two phases. Initially, a preliminary assessment based on a review of titles and abstracts facilitated excluding unrelated articles. At this stage, we took into account factors such as relevance to the research questions, the characteristics of the sample examined (including or excluding apprentices with learning difficulties or disabilities), and the types of methodology used. A second, more in-depth selection phase was then carried out on the full texts of the articles, applying our predefined inclusion and exclusion criteria. These criteria included publication date (studies published between 2018 and 2023), language of publication (articles written in English or French) and methodological rigour.

At the same time, an additional literature survey was carried out up to 10 October 2023 to identify any additional publications that might enrich our analysis. This survey identified eight additional articles that met the initial selection criteria. These articles were examined in depth, but their content did not provide any new or significant information likely to complement our work. They were therefore discarded and not included in our final bibliography as they were deemed redundant with the studies already selected.

At each stage of the process, the relevant data were organised and classified according to the central theme, the methodology used and the main research findings. This rigorous process ensured that only the most relevant and methodologically sound publications were selected for inclusion in our systematic review. The method, description and results of the selected studies are detailed in Table 2.

Table 2. Systematic review results

Names of the authors	Elements of methodology	Study description	Study findings
(Forrest, 2022)	a) Qualitative b) Interview c) Population: Successful learners and others with learning difficulties	A comparative study of the self-regulated learning strategies employed by successful International Baccalaureate Diploma Programme learners and others with learning difficulties.	The results show that there are only small differences in the number and nature of strategies implemented by students in each category, however, there is a significant difference in the quality of the strategies. Furthermore, the researchers suggest that these differences are related to the epistemic awareness shown by the students during this research, which suggests that it can play an important role in self-regulated learning.
(Özmen & Özkubat, 2021)	a) Quantitative b) Questionnaire c) Population:	This study aimed to evaluate the impacts of cognitive strategies and	The study identified a set of factors predicting performance in mathematical problem solving, namely metacognitive strategies and

	Students with learning disabilities and those without learning disabilities in mathematics	metacognitive functions on students with learning disabilities and those without learning disabilities in mathematics.	experiences of learners with learning disabilities, metacognitive strategies and knowledge of low achievers and metacognitive strategies of average achievers. This research also found a significant correlation between the problem-solving performance of students with learning disabilities and their metacognitive experiences and strategies.
(Kampylafka et al., 2023)	a) Quantitative b) Questionnaire c) Population: Apprentices with and without learning disabilities or reading comprehension difficulties	This research researched the orientations and structures of classroom objectives and their correlation with self-regulated learning strategies in apprentices with and without learning disabilities or reading comprehension difficulties.	The results show that learners with learning disabilities and reading comprehension difficulties obtained lower scores for mastery and higher scores for performance avoidance than their peers without difficulties. In addition, pupils with learning and comprehension difficulties had low mastery scores and avoided learning situations for fear of unsatisfactory performance and exposure of their deficits, and they generally perceived the classroom context as performance oriented.
(Polo-Blanco & González López, 2021)	a) Qualitative b) Interview/ observation c) Population: Three primary-school children (two boys and one girl) with learning difficulties, one of them diagnosed with autism spectrum disorder	This article looked at the effect of explicit teaching of addition strategies and the difficulties encountered during this intervention.	During learning, the three participants encountered obstacles relating to the comparison of quantities, so the results show that the participants succeeded in acquiring the minimal addition strategy and transferring it to problems divided into two sequences. In addition, the microgenetic approach showed favourable results for observing the nature of the strategies used by subjects on the autism spectrum.
(Mastrothanais et al., 2018)	a) Quantitative b) Questionnaire c) Population: Learners with and without specific learning difficulties	This article presented a study of the use of metacognitive strategies by pupils with and without specific learning difficulties.	Pupils in both years 5 and 6 showed a number of similarities in their preference for using cognitive knowledge. The differentiation that appears in the rates was mainly quantitative and refers to the number and frequency of strategies used, not qualitative, meaning that both groups faced difficulties in regulating cognition as a high-level cognitive process.

(Maras et al., 2019)	a) Quantitative b) Questionnaire c) Population: Learners with autism spectrum disorder	This study examined the effect of computer-based metacognitive support (the "Maths Challenge") on learners with autism spectrum disorder in the school context, especially in mathematics.	The metacognitive support concerning the accuracy of responses, reminders of objectives and strategic support enabled both the autistic learners and the typically developing learners to detect their errors. They also showed reduced cohesion between their intentions before and after the test. In short, the support provided by the 'Feedback' condition significantly improved the performance of both groups.
(Zheng et al., 2021)	a) Mixed-method b) Non-verbal intelligence test/ metacognition ability test c)Population: Students with attention deficit hyperactivity disorder (ADHD)	This study's objective was to evaluate how a metacognitive regulation intervention affects the learning of astronomy and the motivation of students with ADHD.	This research showed that students in the experimental group made considerable progress in terms of scientific skills, learning motivation and metacognition compared with the control group. These results mean that metacognitive regulation intervention is a beneficial approach for favouring the acquisition of scientific knowledge in students with ADHD.
(Cancino & Tomicic, 2023)	a) Mixed-method b) Interview/ content analysis c) Population: Students on the autism spectrum	An exploratory study of how Chilean elementary school students on the autism spectrum perceive their metacognitive awareness and how they develop foreign language reading strategies.	The results of the study show that the participants had an average level of awareness of metacognition, with a remarkable frequency of problem-solving strategies. In addition, these learners encountered difficulties mainly related to a tendency to focus on details, concentration problems, avoidance of multitasking processes and an unwillingness to seek help to promote understanding.
(A. Y. Wang et al., 2019)	a) Quantitative b) Questionnaire c) Population: Students at risk of difficulties in mathematics	The purpose of the research was to evaluate the effectiveness of an intervention focusing on fractions, with or without an integrated self-regulation component, in third-grade students at risk of experiencing difficulties in mathematics.	The results indicate that students who received an intervention showed a positive response to the intervention at all levels of problem-solving skills. In contrast, the control group's response to the fraction intervention depended on the students' pre-existing problem-solving skills.

(Karabulut et al., 2020)	a)Quantitative b)Systematic literature review c)Population: Students with special needs	The purpose of this study was to examine research using "Solve It!" strategies. This was done through a review of previous studies and digital databases, journals and references of pertinent research.	The research found that the "Solve It!" programme showed favourable results in teaching mathematical problem-solving skills to learners with particular needs.
(Bonti et al., 2021)	a)Qualitative b)Observation c) Population: Adolescents with disorders (Specific language impairment [SLI] and Specific learning disability [SLD])	The aim of this research was to provide guidance on how to diagnose and intervene appropriately during adolescence when the two disorders (SLI and SLD) manifest themselves in different and overlapping ways.	The study showed that the SLI group had considerably more difficulty than the SLD group in their overall cognitive-mental profile and a large proportion of linguistic measures. Regarding the metacognitive, metalinguistic and metamnemonic strategies, analysis of the results revealed similarities between the two categories (SLI and SLD); in brief, the adolescents with SLD succeeded in overcoming their difficulties compared with the group of subjects with SLI.
(Geurten & Lemaire, 2023)	a)Qualitative b)Tasks c) Population: Children with specific learning disabilities	This study sought to determine whether metacognitive development in children with specific learning disabilities shifts from a specific domain to a general domain.	The children with SLD and the children in the control group had values above chance when it came to determining whether they had chosen the right strategy for a given item, whether in arithmetic or memory. Moreover, the children with SLD showed less precision than the children in the control group when formulating their judgement. In addition, metacognition was limited by the content of the task in the SLD group.
(Lucangeli et al., 2019)	a)Mixed-method b) Questionnaire/ standardised tests c) Population: Primary and secondary school learners with atypical mathematical development.	This study's objective was to examine the effect of an established metacognitive and cognitive intervention to develop learners' arithmetic skills in addition to self-regulation and control functions in primary and secondary school pupils with atypical	The results of the post-test analysis demonstrate that the intervention group improved their precision in writing calculations and number transcriptions. Moreover, psychoeducational interventions that enhance metacognitive and mathematical realisations via examination of errors can play an important role in improving both self-regulation skills and control and success in mathematics in apprentices with atypical mathematical development.

		mathematical development.	
(Tops et al., 2020)	a)Quantitative b)Questionnaire c) Population: First-year undergraduate dyslexic students/ students without learning disabilities	This study evaluated whether first-year undergraduate dyslexic students (N = 100) differed from their comrades without learning disabilities (N = 100) in their use of strategies in their studies.	The results show that knowledge of assessment strategies was low among dyslexic learners. In addition, a predominance of "fear of failure" was observed among dyslexic learners. Further analysis revealed group (X gender) interactions on several variables, including motivation, time organisation and dread of failure; also, female pupils scored higher than male students.
(Mitsea et al., 2023)	a) Qualitative b) Systematic literature review(PRISMA methodology) c) Population: People with special educational needs and disabilities	This systematic review's objective was to assess the efficacy of virtual reality games in subjects with neurodevelopment-al disorders, cognitive disorders and learning difficulties.	The results of this study show that virtual reality technologies (VRG) can play a part in improving motivation and the metacognitive and emotional skills necessary for the integration, achievement, independent living and personal well-being required by people with special educational needs. Moreover, the VRGs offered participants favourable experiences, enabling them to acquire motivational, self-regulating, self-motivating and adaptive attitudes.
(Baten & Desoete, 2019)	a) Quantitative b) Questionnaire c) Population: Students with learning disabilities in mathematics	This research process assessed the effect of metacognitive accuracy, postdiction, and independent and controlled motivation in the field of mathematics among learners.	The study shows a positive correlation between the subjects' metacognitive postdiction abilities and their processing speed in mathematics. Furthermore, it was observed that controlled motivation was adversely associated with rapidity and precision for the research involving learners with and without mathematical disabilities. Learners with learning disabilities in mathematics differed from their peers without disabilities in postdiction accuracy and autonomous motivation, in contrast to controlled motivation.
(Kuracki & Dłużniewska, 2023)	a)Descriptive-analytical b) Questionnaire c) Population: Dyslexic learners	The aim of this research was to detect the correlation between sources of stress during the examination and the use of reading strategies in dyslexic learners	The study found positive relationships between stress sources and lecture strategies and significant correlations between lecture strategies, educational intervention and reading willingness. The nature and origin of stress significantly impacted lecture strategies; motivation played a mediating role here.

		regarding motivation and support interventions in the academic context.	
(Drigas et al., 2022)	a)Qualitative b) Observation c) Population: People with learning disabilities and various disorders	The aim of the study was to investigate the effectiveness of brain rewiring techniques implemented in virtual reality (VR) environments as an innovative intervention for people with learning disabilities and various disorders.	The results show that virtual reality is fertile ground for therapeutic metacognitive techniques. In addition, experimental research has revealed beneficial effects on learning disabilities, cognitive impairment, autism and ADHD. VR brain-wiring techniques have been shown to be effective metacognitive strategies for people suffering from a variety of disorders.
(Tsampouris & Sampedro Requena, 2022)	a)Quantitative b)Questionnaire c)Population: Learners with ADHD in secondary schools	This study aimed to analyse how the logical and mathematical thinking of pupils with ADHD in secondary schools in Heraklion (Crete) is related to their metacognitive awareness and their willingness to learn.	When pupils know that teachers and their parents are focusing on the main learning process, suitable strategies can be proposed to give them the opportunity to solve school tasks independently. This explains why there was a link between pupils' academic results and their willingness to learn.
(L.-C. Wang et al., 2021)	a)Quantitative b)Questionnaire c)Population: Chinese adolescents with and without reading and writing difficulties or disorders	The present study examined the role of metacognition in the relationship between test anxiety and reading and writing difficulties in Chinese adolescents with and without reading and writing difficulties or disorders.	The results show that test anxiety in young Chinese learners was related to difficulties in learning to read and write; however, it only affected high-functioning learners and typically developing learners with SLI. For learners without disorders, the effect of anxiety on literacy difficulties was indirect but occurred via metacognition.

3. Results and discussion

3.1. What difference is there between students with learning disabilities or difficulties and those without difficulties/disabilities in terms of metacognitive functioning?

According to the results of the literature review, the metacognitive functioning of subjects with learning disabilities differs from typical students on several levels. During learning situations, they display more surface strategies and fewer adaptive self-regulation strategies, and they do not place greater emphasis on mastery. In addition, they tend to avoid performing for fear of poor performance and exposing their deficits (Kampylafka et al., 2023), which put them at a disadvantage compared to their typical peers (Boyle et al., 2016). Similarly, results have shown a relationship between the academic results in problem processing of schoolchildren with learning disabilities and the metacognitive strategies and experiences they employ (Özmen & Özkubat, 2021). Concerning the difficulty of the situation and more specifically in mathematics, pupils with learning disabilities find it difficult to organise the information in their minds because multi-step problems are a source of additional confusion; this has a negative impact on their motivation to learn as the learner who thinks they cannot do it does not try (Karabulut et al., 2020). In the same vein, metacognition is limited by the content of the task for individuals with SLI, in other words, initiating metacognitive intervention in one area and expecting progress in another will be more difficult for children with SLI (Geurten & Lemaire, 2023). It should be noted that adolescents with SLI seem to lack more metacognitive strategies than adolescents with SLI (Bonti et al., 2021). During assessment situations, individuals with specific learning disabilities, including high-functioning and typically functioning students, experience a direct effect of test anxiety on literacy difficulties without mediation by other factors (L.-C. Wang et al., 2021).

More precisely, other research has shown little gaps in the metacognitive abilities of dyslexic students compared to their typical peers (Tops et al., 2020) as well as the impact of exam stress on reading strategies (Kuracki & Dłużniewska, 2023), showing that the origin of the stress can be treated as an element initiating the metacognitive processes monitoring the choice of suitable strategies. These deficits manifested themselves in difficulties in planning, organising and monitoring their learning, which could adversely affect their academic performance (Gupta & Sharma, 2017). In the case of autism spectrum disorder, learning to read shows a lower level of awareness of metacognition, with a dominance of problem-solving strategies in these subjects (Cancino & Tomicic, 2023). This metacognitive gap adversely influences students' motivation to engage in their learning and avoid learning tasks for fear of poor performance (Baten & Desoete, 2019; Kampylafka et al., 2023).

Students with learning difficulties mainly use cognitive awareness strategies and less cognitive regulation strategies (Mastrothanais et al., 2018). These results were subsequently confirmed by more advanced research which shows that there was no great difference in the number and nature of the strategies used by the subjects, but there was a significant difference in the quality of the strategies used (Forrest, 2022; Kampylafka et al., 2023).

3.2. What are the results of metacognitive interventions for learners with learning disabilities or difficulties?

Metacognitive interventions aimed at learning cognitive and metacognitive strategies had a positive impact on the subjects' metacognitive functioning and performance, with differences in effects due to the nature of the disorder, the training and the supporting discipline. For learners with autism, metacognitive support enabled them to detect their errors in addition to a reduced cohesion between their intentions before and after the test with a significant improvement in their performance (Maras et al., 2019). Similarly for subjects with learning disabilities, integrating strategies into the curriculum (Gomaa, 2016), teaching calculation strategies (Polo-Blanco & González López, 2021) or reading (Lazarus & Anwalimhobor, 2023) and metacognitive reflection on the choice of task-specific strategies enabled learners to make significant progress in number transcription, mental and written calculation (Lucangeli et al., 2019) and better organise and interpret information (Boyle et al., 2016). The metacognitive intervention based on VR activities with people suffering from neurodevelopmental disorders improved their metacapacities (Drigas et al., 2022). These advances have affected the capacity to be self-aware, to make aware and voluntary choices, to demonstrate flexibility in behaviour and to self-regulate thoughts, emotions and actions, which led to better social interactions and a sense of belonging for them (Mitsea et al., 2023). At the operational level in mathematics, for example, the use of concrete manipulatives during teaching is beneficial in improving learners' metacognitive skills (Polo-Blanco & González López, 2021).

For people with moderate intellectual disabilities, research has revealed techniques that can improve metacognitive skills in those with learning difficulties and various disorders. These methods include brain rewiring, clinical hypnosis, neurolinguistic programming, subliminal training, rapid learning, mindfulness and breathing training, all implemented in VR environments (Drigas et al., 2022). People with ADHD also showed favourable results in the development of metacognition, motivation to learn scientific knowledge and the development of scientific skills, and this study also indicated that the interactive group learning format (García-Redondo et al., 2019) is an appropriate method for improving the metacognitive awareness of students with ADHD (Tsampouris & Sampedro Requena, 2022). There is less research on learners with learning difficulties, but in this study, teaching with self-regulation in mathematics yielded more favourable results in the study group versus the reference group (A. Y. Wang et al., 2019).

3.3. To what extent should metacognition be the subject of further research for the benefit of learners with learning disabilities or difficulties?

Many of the studies discussed in this article have emphasised the importance of metacognitive interventions with learners with learning difficulties or disabilities for future research. Thus, since the problem-solving activities applied in the classes neglected the metacognitive aspect of the teaching and assessment processes, it is recommended to implement problem-solving interventions based on metacognitive functions with different metacognitive tasks (Baten & Desoete, 2019) to develop the problem-solving performance of students with and without learning difficulties – this can be done by creating a strategy teaching environment

in which learners play an active role and self-assess instead of directly teaching concepts and strategies (Özmen & Özkubat, 2021). In more detail, further research with a larger sample size (Baten & Desoete, 2019) and a wider age range will provide further insight into the use of metacognitive knowledge and regulation strategies across all ages while shedding light on how strategy transfer will be cultivated for subjects with particular learning difficulties (Mastrothanais et al., 2018). Similarly, future studies can test the effect of each of the elements of the subcategories of metacognition (Zheng et al., 2021), cognitive and metacognitive strategies, and examine the effects of each of these variables on the problem-solving performance of students with special needs – something that may give rise to professional development programmes on the problem-solving stages (Karabulut et al., 2020). Another training avenue highlighted the practical utility of VR brain rewiring techniques for therapists, educators, parents and individuals, enabling them to apply these techniques in a variety of contexts such as home, school or work in order to improve meta-capabilities and overall performance (Drigas et al., 2022).

Another aspect closely related to students' metacognitive skills has been the subject of several recommendations for future research; motivation during learning is undoubtedly an essential parameter. From this perspective, scientists have stressed the importance of motivation (individual and contextual) in choosing a personal aim or being in a context that favours particular objectives for the self-regulated learning of subjects with learning difficulties and the identification of students' motivational profiles. The implementation of primary and secondary prevention programmes is important in order to train self-regulated learners (Kampylafka et al., 2023). Based on these results and others, it is recommended that teachers take autonomous motivation into account when teaching mathematics (Baten & Desoete, 2019). Indeed, more student achievement variables should be included as parameters to examine the effect of intervention on these learning factors (Zheng et al., 2021).

With regard to the assessment of students' metacognitive skills, it was recommended that future studies should combine two measurement tools, namely assessment scales and behavioural observation, as methodological tools in order to make the research more rigorous (Kampylafka et al., 2023). In the same vein, another study advocated another measurement and evaluation tool such as think-aloud protocols which could lead to more explicit results (Baten & Desoete, 2019). In addition, the involvement of other stakeholders in the research, in particular teachers and tutors of students with learning disabilities, could help in better understanding the subjects, in particular, their diversity and the psychological and cognitive factors influencing their difficulties (L.-C. Wang et al., 2021).

4. Implications and Recommendations

With this in mind, several practical and research recommendations are provided. A set of studies recommended integrating metacognitive and self-regulation strategies into teaching in order to improve cognitive skills, especially among students with special needs (SLD, ADHD, ASD). Interventions should be tailored to cognitive profiles and focus on problem solving, motivation and error analysis.

Collaborative teaching and the use of adapted tools, such as manipulatives, are essential to promote deeper learning. Virtual environments and mastery-based objectives also support self-regulated learning and social development. Thus, given that the metacognitive aspect of teaching and assessment processes is neglected in the problem-solving activities used in schools, it is recommended for future research to implement problem-solving interventions based on metacognitive functions, with different metacognitive tasks to develop the problem-solving performance of students with and without learning disabilities. Many of the studies reviewed in this article highlighted the importance of metacognitive interventions for learners with learning difficulties or disabilities, which should be investigated further.

5. Conclusion

Overall, this systematic literature review comprehensively examined available studies on metacognition in students with learning disabilities or difficulties. To this end, articles from Scopus-indexed journals were analysed. Using a systematic review, this study synthesised 20 articles evaluated by the researchers in order to extract the conclusions that correspond to the objectives of this article. This study showed that in terms of metacognitive functioning, learners with learning disabilities use more superficial strategies than their typical peers and that they tend to avoid performance situations for fear of poor performance and exposing their deficits, in mathematics for example. Pupils with learning disabilities experience specific difficulties due to the complexity of multi-stage problems, which negatively affects their motivation. Students with learning difficulties tend to use mainly cognitive awareness strategies rather than cognitive regulation strategies. The implementation of metacognitive interventions aimed at learning cognitive and metacognitive strategies has a positive impact on subjects' metacognitive functioning and performance, with differences in effect due to the nature of the disorder, training and supporting discipline. For learners with autism, metacognitive support enabled them to detect their errors with a significant improvement in their performance, while for subjects with learning difficulties, teaching calculation strategies and metacognitive reflection on the choice of task-specific strategies enabled learners to make significant progress. In conclusion, this systematic review has highlighted the specific features of the metacognitive functioning of learners with learning disabilities or difficulties in the field of school learning, which may guide other researchers and practitioners in the education and care of people with special needs.

Limitation

This study had certain limitations, as it focused solely on articles relating to metacognition in learners with learning difficulties or disabilities. The search method employed, i.e. the pertinence of the inclusion and exclusion criteria and the database search processes may also have introduced other limitations. Despite a thoughtful design, the authors mainly included articles that were considered special, and the systematic literature review was limited to peer-reviewed articles in English.

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