The affective domain in mathematics in children with dyscalculia: A systematic review

O domínio afetivo na matemática em crianças com discalculia: Uma revisão sistemática

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Abstract. The affective domain is a key element to consider in the teaching and learning of mathematics. Most of the research on the mathematical affective profile of students has been carried out with students who do not exhibit specific learning difficulties, while considerably less attention has been given to students with dyscalculia. The main aim of this study is to find out what has been researched about the affective domain in mathematics of students with dyscalculia. A systematic review was carried out in different bibliographical sources and twenty-four publications were reviewed. Two clear groups were found: one group formed by research on math anxiety, this being the main theme, and the other by studies examining different constructs related to the affective domain, including emotions, without explicit reference to math anxiety. The results lead us to conclude that the study of aspects related to the affective profile of students with dyscalculia has been very limited and focused mainly on math anxiety. More studies are considered necessary to understand and describe all the elements from the affective domain (beliefs, emotions, and attitudes) that are relevant in the case of children with dyscalculia, which, if they are of a negative nature, can influence and aggravate the difficulties experienced by these students in the learning of mathematics.
Keywords: dyscalculia; learning disability; affective domain; affect; systematic review.

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Resumo. O domínio afetivo é um elemento-chave a ter em conta no ensino e aprendizagem da matemática. A maior parte da investigação sobre o perfil afetivo matemático dos estudantes foi realizada com estudantes que não apresentam dificuldades de aprendizagem específicas, enquanto consideravelmente menos atenção tem sido dada a estudantes com discalculia. O principal objetivo deste estudo é descobrir o que tem sido pesquisado sobre o domínio afetivo em matemática dos estudantes com discalculia. Foi efetuada uma revisão sistemática em diferentes fontes bibliográficas e foram revistas vinte e quatro publicações. Foram encontrados dois grupos claros: um grupo formado por investigação sobre a ansiedade matemática, sendo este o tema principal, e o outro por estudos que examinaram diferentes construções relacionadas com o domínio afetivo. Os resultados levam-nos a concluir que o estudo dos aspetos relacionados com o perfil afetivo dos estudantes com discalculia tem sido muito limitado e centrado principalmente na ansiedade matemática. Considera-se que são necessários mais estudos para compreender e descrever todos os elementos do domínio afetivo (crenças, emoções e atitudes) que são relevantes no caso da discalculia infantil, que, se forem de natureza negativa, podem influenciar e agravar as dificuldades experimentadas por estes estudantes na aprendizagem da matemática.
Palavras-chave: discalculia; deficiência de aprendizagem; domínio afetivo; afeto; revisão sistemática.

Introduction

Just as mental abilities or language develop as a consequence of children's experience and maturation, so does emotional development progress in the same way (Brett et al., 2018). Therefore, it is important to take into account healthy emotional growth from an early age, both at school and in the family and social environments.

Traditionally, the poor popularity that mathematics has had has considerably hindered its learning and teaching, flourishing a set of barriers towards this discipline. The beliefs, attitudes and emotions of teachers and students condition the way in which they approach mathematical objects in a learning space. The awareness of this challenge is considered essential to investigate the affective aspects they manifest and to have the possibility to modify them in order to overcome the existing barriers (De la Oliva, 2020).

In the field of Mathematics Education, research into mathematics learning disabilities has expanded over the last ten years (Deruaz et al., 2020). Nevertheless, in this type of research the affective dimension has been largely overshadowed by the cognitive dimension (Espina et al., 2022). However, for about half a century, studies have been carried out which show that the affective domain is a very important element to be considered in the teaching and learning of mathematics. Some of the reasons pointed out by Gómez-Chacón (2000a) are the great impact that aspects of the affective domain can have on how students learn and use mathematics, the influence of affect on self-concept and on how the social reality of the classroom is structured, the interactions with the cognitive system and the fact that it can constitute an obstacle to meaningful learning. Most of the research on the

mathematical affective profile of students has been carried out with students without specific learning difficulties in mathematics. But what has been studied about the affective domain in students with math learning disabilities (MLD) or dyscalculia? The main aim of this study is to find out what has been researched about the affective profile of students with dyscalculia. To achieve this goal, a systematic review was carried out by combining terms related to dyscalculia with aspects of the affective domain. In addition, a bibliometric analysis was beforehand carried out, specifically by means of a word co-occurrence analysis, using VOSviewer software, in order to identify and visualize the main research lines and topics addressed in the scientific literature on this combination.

Theoretical framework

Dimensions of the affective domain in mathematics

Among the definitions of affective domain presented in the literature we will highlight two. On the one hand, McLeod (1992, p. 576), who used the term to refer to "a wide range of beliefs, feelings, and moods that are generally regarded as going beyond the domain of cognition and include beliefs, attitudes and emotions as specific components". On the other hand, the affective domain as one of the three domains of learning, together with the cognitive and psychomotor domains, identified within the hierarchy of educational objectives that are part of the taxonomy proposed by Benjamin Bloom (Krathwohl et al., 1973). This domain includes beliefs, appreciation, attitudes, emotions, feelings, tastes and preferences, and values, thus describing learning objectives that emphasize a tone of feeling, emotion or degree of acceptance or rejection.

Multiple categorizations of the affective domain have emerged, with the seminal one in Mathematics Education, as proposed by McLeod (1992), being the focus of this research. This author considers three basic components of the affective domain: beliefs, attitudes, and emotions. These components are interrelated and mainly differ in terms of intensity and stability. Thus, emotions are the ones with the greatest intensity, the least stable and with the least cognitive involvement; beliefs are the ones with the greatest stability, the least intense and with the most cognitive involvement; and attitudes are somewhere in between. Subsequently, various authors have made different contributions, extending McLeod´s proposal. Three examples of this are the work by DeBellis and Goldin (2006), who also added values, the work by Goldin et al. (2016) who considered motivation and identity both concerning students and teachers, and the one by Gómez-Chacón (2000a), who incorporates the social factor from the affective point of view.

Beliefs

In general, beliefs are mental states that can be true or false and causally relevant or effective with respect to the desires, actions, and other beliefs of the subject (Defez, 2005). They constitute a basis for knowledge, are considered personal truths and represent constructions that the individual carries out in his or her training process to understand his or her world, nature, or functioning (Furinghetti & Pehkonen, 2002; Martínez-Padrón, 2005). Specifically, mathematical beliefs are, in the words of Gil et al. (2005, p. 18), "one of the components of the individual's implicit subjective knowledge (based on experience) about mathematics and its teaching and learning".

Among mathematical beliefs, it is possible to distinguish two major categories of beliefs in students (Bermejo, 1996). Beliefs about mathematics itself and students' beliefs in relation to mathematics. However, other authors (Blanco et al., 2010; McLeod, 1992) recognize other beliefs by adding beliefs about the teaching and learning of mathematics, related to how students believe mathematics should be learned, and beliefs raised by the social context, since the value given to mathematics from the environment determines their view of mathematics. Returning to the main beliefs, the first group, beliefs about mathematics itself, involves little affective component and may come from different contexts (e.g., school, family, classroom). Students tend to have the belief that mathematics is important, abstract, difficult, and rule-based, among others. The second group, students' beliefs in relation to mathematics, is more affect-dependent and is related to beliefs about oneself as a learner, about one's own ability towards mathematics. These include beliefs about self-concept, confidence and causal attribution of school success and failure (Hidalgo et al., 2015).

Attitudes

Attitude, defined by Hart (1989) and assumed by Gómez-Chacón (2000b), is an evaluative predisposition (positive or negative) that establishes personal intentions and influences behavior. If attitudes are linked to mathematics, they can manifest themselves as favorable or unfavorable evaluative judgements towards this subject, determining the personal intentions of individuals and influencing their actions and behavior in relation to mathematics (Martínez-Padrón, 2008). According to Martínez-Padrón (2003, as cited in Martínez-Padrón, 2008), negative, positive, and neutral attitudes can be distinguished. Negative attitudes may be linked to student failure due to rejection of the subject and the processes connected to it. Positive attitudes may lead students to "fall in love" with mathematics, allowing the construction of situations of affection, recognition or esteem towards processes that favor successful mathematics classes. Finally, neutral attitudes are materialized by a lack of commitment and lead to a lack of attention, interest, and concern for mathematics.

Attitudes can be classified into two categories: mathematical attitudes and attitudes towards mathematics (Vila & Callejo, 2004). Mathematical attitudes refer to the handling of

general cognitive abilities relevant to mathematical work. And attitudes towards mathematics are related to the valuation, interest, liking and appreciation of this discipline. These attitudes may refer to attitudes towards mathematics as a subject, towards certain parts of mathematics, towards mathematics and mathematicians, towards teaching methods or interest in scientific mathematical work.

From the perspective of Castro (2002, as cited in De la Oliva, 2020), attitudes are acquired, involve a high affective and emotional charge, and constitute stable learning, so they can be fostered, modified, and learned. This last feature translates into the possibility of achieving changes in attitudes towards mathematics by means of motivating elements that allow students to carry out a possible re-evaluation of their attitudes towards mathematics. In addition, the analysis made by Di Martino and Zan (2011) underline the narrow interplay between negative emotional disposition towards mathematics and students' beliefs about success in mathematics and about self.

Emotions

Emotions, according to Gómez-Chacón (2000b), are "organized responses beyond the boundary of psychological systems, including the physiological, cognitive, motivational and experiential systems. They arise in response to an event, internal or external, that has a load of meaning for the subject" (p. 25). They appear intensely and, unlike mood, in a short period of time. Moreover, they are the complex result of learning, social influence, and interpretation. In particular, recently, in the field of Mathematics Education, special attention is being paid to epistemic emotions (Gómez-Chacón, & Barbero, 2020; Muis et al., 2018), i.e., those that arise when we focus on knowledge and knowing.

Research focusing on emotions is scarce compared to the other descriptors of the affective domain, with the exception of anxiety. It seems that limited theoretical frameworks and methodologies for their study have contributed to their narrowed research tradition. From the discipline of Psychology, there are three types of evidence to which we can turn to learn about people's emotions (language, behavioral observation, and physiological evidence), but all of them have limitations. In language, there is the difficulty of expressing in words what we feel; in behavioral observation, this may be the result of different emotions, or the same emotion may present different behaviors; and in physiological evidence, the difficulty lies in its biological nature (García-González & Martínez-Sierra, 2018; Gil et al., 2005).

In the mathematics classroom, we would be talking about emotions when students become exasperated, frustrated, or show nervousness, phobia, panic, or pleasure for such a class, as emotions are associated with sadness, anger, hatred, fear, pleasure, love, surprise, frustration, displeasure, disgust, shame, or anxiety (Martínez-Padrón, 2014).

Characterizing dyscalculia

Currently, there is not a widely accepted definition of dyscalculia, but over time, research in the fields of Psychology, Neurology and Education, among others, has added and modified characteristics of dyscalculia in accordance with the advances that have been made. The different definitions that have appeared have several features in common, which will be mentioned below. The first feature is the consideration that dyscalculia is a learning disorder that persistently affects the acquisition of mathematical skills (Castaldi et al., 2020; Torresi, 2018), especially those related to number sense, counting and calculation (Meier et al., 2021). It is found within the wide range of the math learning difficulties, implying a high level of severity. It is a disorder that significantly influences both children's academic performance and everyday tasks related to mathematics (Alay et al., 2020).

Its multifactorial origin determines that this disorder can be caused by neurobiological, genetic, and environmental factors (Kaufmann & von Aster, 2012). Its neurological origin shows that the different deficits in mathematical skills are produced by persistent alterations in various brain areas (Butterworth et al., 2011) and by structural differences in the volume of grey and white matter (McCaskey et al., 2020). Regarding its (possible) genetic and environmental origin, it is indicated that dyscalculia tends to be a hereditary disorder (Shalev et al., 2001) and may be due to environmental conditions such as premature birth or alcohol intake during pregnancy (Gallego, 2015).

Dyscalculia is often "unexpected", occurring in students with normal intelligence levels and appropriate scholastic development (Sans et al., 2017). It is heterogeneous in nature, as there is great variability within and between individuals, it can occur comorbidly with other learning disorders or difficulties (e.g., dyslexia, ADHD, or language disorder) and it has an estimated prevalence of between 2.27% and 6.4% of the school population (Emerson, 2015; Estévez et al., 2008).

Methodological process

Bibliometric analysis of word co-occurrence

On 16 August 2022, a first thematic search was carried out by searching in the Web of Science (WoS) database for studies published between 1900 and 2022 (contemplating all the time period offered by the database). The combination of different terms related to affectivity and the elements that constitute the affective domain with various terms referring to dyscalculia were introduced. The choice of terms related to affectivity has been motivated by being related with the three constructs more widely used as elements of the affective domain together with other usually considered in research associated to math anxiety. Concerning the terms related to dyscalculia these have been considered as they are commonly used in the scientific literature on this topic. Each of the terms related to

affectivity has been combined with each of those related to dyscalculia using the Boolean Operators *AND* and *OR* as shown in Figure 1.

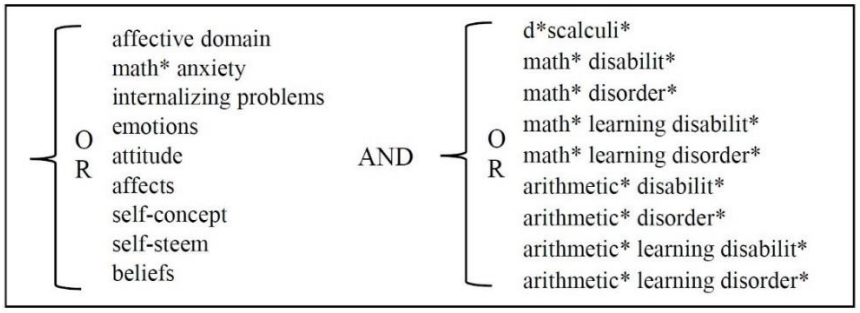

Figure 1. Descriptors used in the search

A total of 102 documents were obtained and the data from these documents were transferred to the VOSviewer program. A bibliometric analysis of word co-occurrence was carried out and a total of 9 words were identified that met the criterion of appearing at least 10 times in the total number of publications obtained. Figure 2 shows the network visualization map resulting from the analysis carried out.

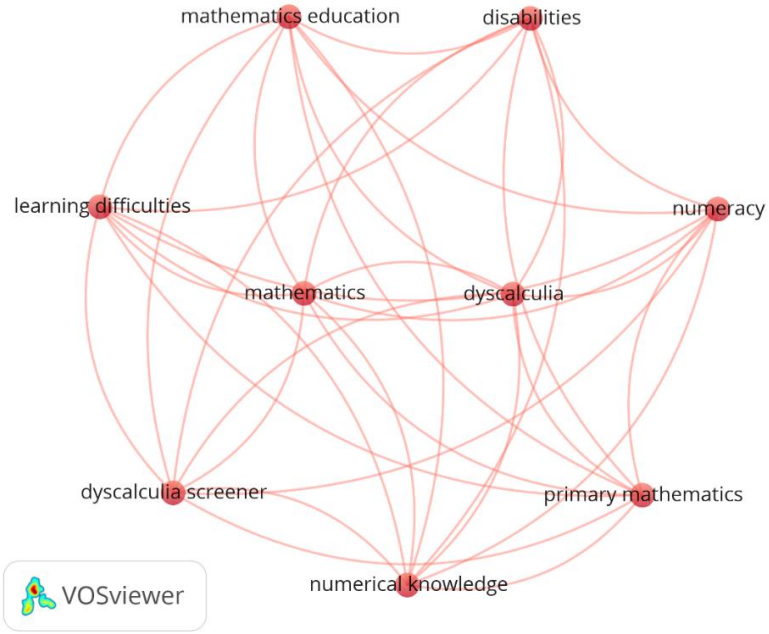

Figure 2. Network map visualization of word co-occurrence analysis in WoS (First search)

Analyzing the map generated, only one thematic group or cluster (red) can be observed. This group of words does not allow us to identify any theme or research line related to any aspect of the affective domain, but only shows words related to dyscalculia and mathematics education. For this reason, another search was carried out, but this time replacing the terms related to dyscalculia with terms related to math learning difficulties (math* difficult*,

math* learning difficult*). Although dyscalculia is not the same as math learning difficulties, as it is only part of the most severe group of these difficulties, it was decided to investigate this combination.

This time, a total of 85 documents were obtained and 16 words appeared at least 10 times in the publications found. Analyzing the network visualization map generated by the VOSviewer program (Figure 3), two clusters (red and green) can be seen. The red cluster, as before, shows words related to mathematics education in general and the green cluster shows, among the words related to dyscalculia, the word "maths anxiety". This last fact allows us to identify a thematic line linked to math anxiety.

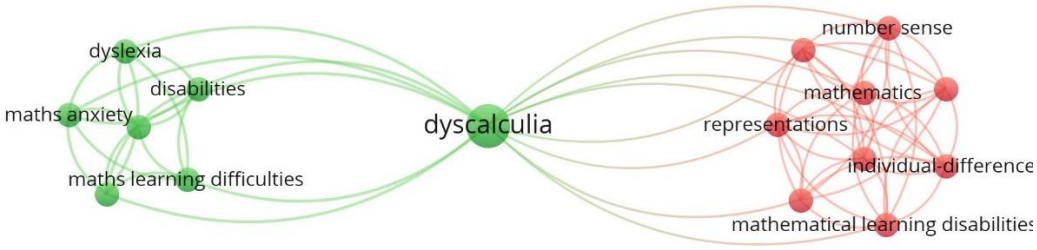

Figure 3. Network map visualization of word co-occurrence analysis in WoS (Second search)

Systematic review

This systematic review has been carried out by adopting the phases proposed by García-Peñalvo (2017), as well as the indications for reporting a review provided by PRISMA 2020 declaration (Page et al., 2021). The steps followed and mentioned above are set out in detail below.

a) Formulation of the objective

The aim of this review, as stated above, is to find out what research has been done on the affective profile of students with dyscalculia in all scientific fields (e.g., Education, Psychology, Pedagogy, Math Education). In this review, it is expected that there will be a scarce presence of evaluations of an affective nature, since in a bibliometric analysis on the term dyscalculia carried out by the authors prior to this study (Espina et al., 2022), it can be observed a predominance of studies focused solely on the cognitive profile of students with this disorder.

b) Definition of inclusion and exclusion criteria

- We have included studies that evaluate some characteristic of the affective profile presented by children with dyscalculia (emotions, beliefs, attitudes, self-esteem, motivation, anxiety, ...).
- We have included studies whose publication dates are within all the time periods offered by the databases.

- We have included studies in any language.
- We have only included publications of a scientific nature and not those with a merely informative nature.
- We have excluded studies that only talk about the affective characteristics of students with dyscalculia by referring to another research.
- We have excluded studies that have been carried out with adults, covering only school age (3-16 years old).

c) Selection of databases

The databases and documentary sources that have been consulted are the following: WoS, Scopus, Psychology Database, Dialnet, TESEO (Doctoral Theses Database), and OATD (Open Access Theses and Dissertations). The search was carried out in an attempt to cover a wide variety of bibliographic sources (without attending to any specific scientific field), from the largest and most important databases worldwide to national and international thesis databases.

d) Definition of search and query terms

The search was carried out on 22 August 2022. No time limitation has been specified in the databases, with the aim of obtaining all studies that have investigated some aspect of the affective domain in dyscalculia throughout history. The combination of different terms related to affectivity and the elements that constitute the affective domain with different terms referring to dyscalculia has been introduced, as in the bibliometric analysis previously carried out (Figure 1). In the databases where it was possible to choose the search field, the parameter *Topic* (title, abstract and keywords) was selected.

e) Review process

The publications included in the systematic review were screened four times. In the first screening, the different combinations of descriptors were entered in the databases and 110 documents were obtained in WoS, 100 in Scopus, 128 in Psychology Database, 25 in Dialnet, none in TESEO and 5 in OATD. In the second screening, the titles and abstracts of the publications were read and those that did not meet the established inclusion and exclusion criteria were eliminated. In WoS 18 documents were selected, in Scopus 17, in Psychology Database 9, in Dialnet 3 and in OATD 2. In the third screening, the full text of the publications was read, and duplicates were deleted, thus obtaining 18 documents. Finally, a fourth screening was carried out, in which the search was completed using the snowball method (Wohlin, 2014) where more articles were obtained from the bibliographic references of the publications read, considering only those that met the original inclusion criteria. This complementary search resulted in 6 additional papers, so that the review consisted of 24 publications. A summary of the entire selection process can be seen in the diagram in Figure 4.

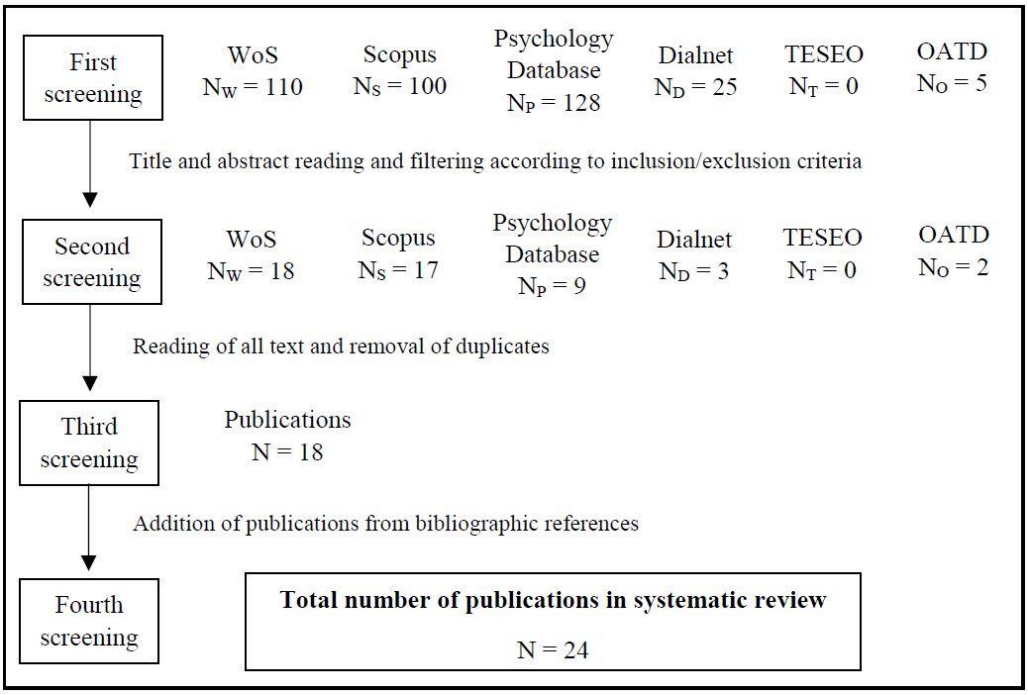

Figure 4. Diagram showing publication selection

f) Data extraction

After the selection of studies meeting the established inclusion and exclusion criteria, the criteria by which the characteristics of the studies have been coded have been made explicit:

- Bibliographic reference.
- Topic.
- Type of study. A distinction has been made between those publications that are more empirical in nature, specifying the type of study carried out and the characteristics of the sample, and those that carry out theoretical reviews.
- Objective of the research.
- Tests or instruments used in the study.
- Research contributions.
- Main scientific field.

Results

The 24 publications that form part of the systematic review are listed in Table 1. The publications are organized according to the criteria defined above and ordered by date of publication.

Table 1. Systematic review publications

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Martínez (2002)	- Self-concept - Perceived social support - Emotional functioning	Examine group and genre differences in self-concept, perceived social support and emotional symptoms in students with different learning disabilities.	Quantitative correlational research. Sample: 120 students between 6th grade and 2nd year of secondary school (reading learning disability (RLD), MLD, both learning disabilities and typically developing).	- Self-concept: Self-Perception Profile for Learning 8Disabled Students. - Perceived social support: Social Support Scale for Children. - Emotional functioning: Behavior Assessment System for Children.	Results show students with comorbid disability in reading and mathematics present lower levels of intellectual self-concept, academic self-concept, perceived parent support, perceived friend support and higher scores in depression, sense of inadequacy, emotional symptoms, and personal adjustment.	Education
Rubinsten and Tannock (2010)	- Math anxiety - Affective priming	Investigate the effects of math anxiety on numerical processing in children with dyscalculia.	Quantitative quasi-experimental research. Sample: 12 students with dyscalculia and 11 with typical development, aged 7 to 13 years.	Arithmetic-affective priming task.	Results show that in children with dyscalculia arithmetic facts are related with negative emotions as well as words related with mathematics. It is suggested that arithmetic-affective priming might be used as an indirect measure of math anxiety.	Psychology
Passolunghi (2011)	Math anxiety	Assess the relationship between mathematics ability and emotional processes such as math anxiety in children with and without MLD.	Quantitative quasi-experimental research. Sample: fourth-graders, 18 with MLD and 18 with typical development.	Mathematics Anxiety Rating Scale (MARS).	Results show that children with MLD show higher levels of math anxiety than in other subjects, where their levels of anxiety are similar to those of normal achievers.	Psychology

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Acosta-Escareño (2013)	Affective-motivational aspects	Analyze academic performance in reading and mathematics, executive functioning, affective-motivational system, and learning and metacognitive strategies in students with MLD, with RLD, with both difficulties, and in the control group.	Longitudinal quantitative quasi-experimental research. Sample: 141 4th to 6th students.	Questionnaire for teachers about their students.	Results show an improvement in the total score of the affective-emotional elements (intrinsic orientation, self-efficacy, anxiety and self-regulation and effort) in the 4 participating groups from 4th to 6th grade, which could have been caused by their maturation. Students with MLD experience higher levels of anxiety than students without it.	Psychology
Narimani et al. (2013)	Emotions and behavior	Investigate the effectiveness of Acceptance/Commitment and Emotional Regulation training in high-risk behaviors of students with dyscalculia.	Quantitative experimental research. Sample: 60 sixth-grade students with dyscalculia.	Mohammadi's high-risk behavior questionnaire.	Acceptance/Commitment and Emotional Regulation training have been effective in reducing high-risk behaviors, thus leading to a reduction in negative emotions, self-destructive, and impulsive behaviors in students with dyscalculia.	Psychology
MacKinnon et al. (2014)	Stress reactivity	Examine the relationship between stress and cognitive processing deficits in children with math disability.	Quantitative quasi-experimental research. Sample: 83 first graders with math disability and without it.	Cortisol and circadian rhythm measurement: Salimetrics Expanded Range High Sensitivity Salivary Cortisol Enzyme Immunoassay Kit.	Children with math disability and high stress reactivity show a poorer performance on working memory and math tasks compared to their typically developing peers.	Psychology

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Wu et al. (2014)	Math anxiety	Study the relation among math ability, math anxiety, and internalizing and externalizing behaviors.	Quantitative correlational research. Sample: 366 second and third graders.	Scale for Early Mathematics Anxiety.	Results show a significantly higher level of math anxiety in children with MLD than in typically developing children.	Psychology
Graefen et al. (2015)	Internalizing problems	Examine the relationship between math disability and internalizing problems	Qualitative study. Sample: 1436 (pre)adolescents.	Multi-informant approach (parents, teachers, self-report)	Results revealed that math disability puts (pre)adolescents at a higher risk for internalizing problems. External and self-ratings differed between boys and girls, indicating that either they show distinct internalizing symptoms or they are being perceived differently by parents and teachers. Results emphasize the importance of both a multi-informant approach and the consideration of gender differences when measuring internalizing symptomatology of children with math disability. Depressive and anxious symptoms need to be considered for an optimal treatment of math disability.	Psychology
Lai et al. (2015)	Math anxiety	Investigate effects of math anxiety and mathematical metacognition on word problem solving.	Quantitative correlational research. Sample: 224 4th grade students.	Mathematics Anxiety Scale for Children.	Results show that children with MLD scored lower in self-image and higher in learning math anxiety than the typically developing children and high achieving children.	Mathematics Education

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Mammarella et al. (2015)	Math anxiety	Examine verbal and visuospatial short-term memory and working memory performance in children with dyscalculia and high math anxiety.	Quantitative quasi-experimental research. Sample: children with dyscalculia and high math anxiety and typically development children.	Abbreviated Math Anxiety Scale	Findings show that children with dyscalculia do not show impairments in verbal tasks, but do show impairments in visuospatial tasks. Children with math anxiety had difficulties with verbal memory tasks.	Psychology
Zerafa (2015)	Affective domain aspects	Conduct an intervention in children with dyscalculia through the *Catch Up Numeracy* program.	Quantitative quasi-experimental research. Sample: two 10-year-olds and one 7-year-old children with dyscalculia.	Metacognitive questioning technique.	The intervention program has had a positive impact on the affective domain of the children. An increase in self-esteem and a more positive attitude towards learning mathematics were observed.	Mathematics Education
Scrich et al. (2017)	- Demotivation - Low self-esteem	Offer some theoretical considerations about dyslexia, dysgraphia and dyscalculia.	Literature review	This section is not developed.	The lack of motivation for study, low self-esteem and school leaving in students with dyslexia, dysgraphia and dyscalculia deserves an immediate scientific intervention in the Ecuadorian educational system.	Education
Wright (2017)	Math anxiety	Examine the relationship between math anxiety and MLD.	Quantitative quasi-experimental research. Sample: 30 children with MLD and 29 typical learners, ages 7 to 12 years.	- The Scale for Early Mathematics Anxiety, for students in 2nd and 3rd grade. - The Math Anxiety Rating Scale for Elementary School Students, for children in 4th, 5th, and 6th grades.	Results show that children with MLD manifest a higher level of math anxiety than typically developing children.	Psychology

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Devine et al. (2018)	Math anxiety	Study the comorbidity of dyscalculia and math anxiety.	Quantitative correlational research. Sample: 1757 primary (8-to 9-year-old) and secondary (12- to 13-year-old) school children.	Abbreviated Math Anxiety Scale.	Children with dyscalculia are twice as likely to have high math anxiety as children with typical math performance. In relation to gender, girls present more this comorbidity.	Psychology
Kucian et al. (2018a)	Math anxiety	Examine if there is a relationship between math anxiety and changes in brain structure in children with and without dyscalculia.	Qualitative study. Sample: 43 children between 7.8–15.9 years of age (23 with dyscalculia).	Math-Anxiety-Interview for German speaking primary school children.	Findings demonstrate for the first time that math anxiety in children is associated with alterations in brain volume and that children with dyscalculia show higher math anxiety scores compared to children without dyscalculia.	Psychology
Kucian et al. (2018b)	- Math anxiety - Affective priming	Study the relationship between negative emotions and arithmetic performance in children with and without developmental dyscalculia through affective priming tasks.	Quantitative correlational research. Sample: 172 children between 7–11 years of age (76 with dyscalculia and 96 controls).	- Math-Anxiety-Interview for German speaking primary school children. - Affective priming task.	Findings did not reveal negative math priming effect in children with dyscalculia. They showed more math anxiety when they were explicitly assessed by a specific math anxiety interview and showed lower math performance compared to controls. Math anxiety was equally present in boys and girls and interfered negatively with performance.	Psychology
Feitosa-Moraes et al. (2018)	Motivation	Show the negative effects of dyscalculia on students' motivation for learning.	Literature review	This section is not developed.	Dyscalculia can lead to lack of motivation to learn, low self-esteem and self-image mitigation.	Education

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Mutlu (2019)	Math anxiety	Determine the dimensions of the relationship between math anxiety and mathematics achievement of the third-grade students with and without dyscalculia.	Quantitative correlational and descriptive research. Sample: 288 third graders.	Math Anxiety Scale.	The results show that there is a strong correlation between participants' math anxiety and math performance. The level of math anxiety of students with dyscalculia does not differ from those with low performance.	Mathematics Education
Nascimento (2019)	Math anxiety	Analyze the effects of a Computerized Cognitive Training mathematical skills on math anxiety in children with dyscalculia.	Quantitative experimental research. Sample: 72 students aged between 8 and 10 years.	Mathematics Anxiety Interview and Mathematics Anxiety Scale	In the results of the Mathematics Anxiety Scale, children with dyscalculia aged 8 and 9 years had moderate mathematics anxiety and those aged 10 years had extreme mathematics anxiety. And in the results of the Mathematics Anxiety Interview, the 8-year-olds had no math anxiety and the 9- and 10-year-olds had some symptoms.	Psychology
Ghislanzoni et al. (2020)	Internalizing and externalizing problems	Investigate the psychopathological profile of children and adolescents with Specific Learning Disorders from their point of view and the point of view of their mothers.	Quantitative quasi-experimental research. Sample: 98 students of 11.79 mean age with Specific Learning Disorders (including dyscalculia) and their respective mothers.	Psychopathological profile: Achenbach System of empirically-based assessment.	Students with dyscalculia were rated by the mothers as having more internalizing, affective and anxiety problems. The results highlight that the mothers of students with Specific Learning Disorders have observed stronger difficulties than the students themselves.	Psychology

Reference	Topic	Objective	Type of study	Test	Research contribution	Main scientific field
Kohn et al. (2020)	Math anxiety	Evaluate a computer-based learning program for children with dyscalculia (Calcularis 2.0).	Quantitative correlational research. Sample: 67 children with dyscalculia from 2nd to 5th grade.	Math Anxiety Interview with the help of an anxiety thermometer	Children with dyscalculia who have received training with Calcularis program that had a higher level of math anxiety have shown less improvement.	Psychology
Vahidi et al. (2020)	Math anxiety	Determine the role of executive functions in predicting math anxiety	Quantitative correlational and descriptive research. Sample: 95 students.	Math Anxiety Scale.	Results suggest that reasoning, organization, and active memory significantly impacted the prediction of math anxiety in students with dyscalculia.	Psychology
Sainio (2021)	Academic emotions	Investigate the relations between learning disabilities, academic emotions, and school achievement during the transition from primary school to lower secondary school.	Quantitative quasi-experimental research. Sample: 848 adolescents in grades 6 and 7.	Achievement Emotions Questionnaire (enjoyment, hope, pride, anxiety, anger, hopelessness, shame, and boredom in literacy and in math).	Students with mathematical disabilities showed lower enjoyment, lower hope, and higher anxiety than those without mathematical disabilities. The results indicate that subject-specific academic emotions should be taken into account when considering the relationships between mathematical disabilities and academic performance.	Mathematics Education
Saga et al. (2022)	Anxiety and emotions	Investigate the effect of negative emotions on mathematical performance in children with and without dyscalculia.	Quantitative quasi-experimental research. Sample: 20 in first year of secondary school (10 with dyscalculia y 10 controls).	Psychosocial tests, a quality of life test, an anxiety test and the Zareki-R mathematical performance test.	Psychosocial quality of life and high level of anxiety in children with dyscalculia have a great influence on their mathematics performance.	Psychology

Results

Two clear groups were found among the literature reviewed, according to their topic. One group is made up of research on math anxiety, this being the main theme (14/24 publications), and the other group is made up of studies that examine different constructs related to the affective domain (including emotions but without explicit reference to math anxiety), being both groups somehow mutually exclusive.

Within the first group, research examining the relationship between dyscalculia and math anxiety shows a higher level of math anxiety in students with dyscalculia compared to typically developing peers. Wright (2017) investigates this comorbidity in children aged 7 to 12 years, Devine et al. (2018) in children aged 8 to 9 and 12 to 13, Saga et al. (2022) in children in the first year of secondary school, Wu et al. (2014) in second and third graders, and Lai et al. (2015) in fourth graders. Passolunghi (2011) finds higher levels of anxiety in mathematics than in other subjects. Mammarella et al. (2015) study the development of verbal and visuospatial short-term memory and working memory in children with dyscalculia and high math anxiety and conclude that they had difficulties with verbal memory tasks. Vahidi et al. (2020) show in their results that some executive functions, such as reasoning, organization or active memory, can predict math anxiety in these students. Kucian et al. (2018a) exhibit for the first time that math anxiety in children is associated with alterations in brain volume and children with dyscalculia show higher math anxiety scores compared to children without dyscalculia. Mutlu (2019) also points to this difference but finds that the level of math anxiety of students with dyscalculia does not differ from low achievers. The studies by Kucian et al. (2018b) and Rubinsten and Tannock (2010) use affective priming tasks, which involve solving some arithmetic tasks after hearing a positive, negative, or neutral word. The findings of the first authors did not reveal negative math priming effect in children with dyscalculia, but they showed more math anxiety when they were explicitly assessed by a specific math anxiety interview. In contrast, Rubinsten and Tannock (2010) indicate the relationship in children with dyscalculia of arithmetic facts with negative emotions and math-related primes and suggest that this task can be used as an indirect measure of math anxiety. Finally, within this group, it has been found research that indicates an improvement in math anxiety in children with dyscalculia following intervention or training with a specific program, for example, Kohn et al. (2020) use the computer-based learning program Calcularis 2.0. In Zerafa (2015), through an intervention with the *Catch Up Numeracy* program, a more positive self-esteem and attitude towards learning mathematics has been observed, and Narimani et al. (2013) point out that Acceptance/Commitment and Emotional Regulation training have been effective in reducing negative emotions and self-destructive and impulsive behaviors in students with dyscalculia. On the other hand, Nascimento (2019), using Computerized Cognitive Training of mathematical skills, finds different results depending on the tool used to assess anxiety.

With the Mathematics Anxiety Scale, children presented math anxiety between moderate and extreme levels, and with the Mathematics Anxiety Interview, they did not present math anxiety or only had some symptoms.

In the second group, a wide variety of affective aspects are assessed. MacKinnon et al. (2014) examine the relationship between stress and cognitive processing deficits in children with math disability and their results showed high stress reactivity and poorer performance on working memory and math tasks compared to their typically developing peers. Martinez's (2002) results show that the students in his sample, those with comorbid mathematics and reading learning disability have the lowest levels of intellectual and academic self-concept, of perceived support from parents and friends, and higher scores on depression, feelings of inadequacy, emotional symptoms, and poorer personal adjustment. In their review of some learning disorders in the Ecuadorian education system, Scrich et al. (2017) highlight that lack of motivation to study, low self-esteem, and school dropout in students with dyslexia, dysgraphia and dyscalculia deserve immediate scientific intervention. Likewise, Feitosa-Moraes et al. (2018) show that dyscalculia can lead to lack of motivation to learn, low self-esteem and self-image mitigation. It has been found research in which a test is not used to find out the characteristics of the affective profile of children with dyscalculia, but interviews or questionnaires are carried out. The results of the questionnaire conducted with teachers about their students with MLD in Acosta-Escareño (2013), show an improvement in the total score of the affective-emotional elements (intrinsic orientation, self-efficacy, anxiety and self-regulation and effort) in the transition from 4th to 6th grade of Primary Education. In the study conducted by Ghislanzoni et al. (2020), mothers reported that their children had more internalizing, affective, and anxiety problems. Reports from parents, teachers, and the children themselves in the study by Graefen et al. (2015) reveal that math disability increases the risk of pre-adolescents having internalizing problems. In addition, external ratings and self-assessments differed between boys and girls, indicating that they show different internalizing symptoms or are perceived differently by parents and teachers. And responses to the Achievement Emotions Questionnaire by 11–13-year-olds in Sainio (2021) show that students with MLD showed less enjoyment, less hope, and more anxiety than those without MLD in their transition from Primary School to Lower Secondary School.

From the above results we can conclude that the prediction made at the beginning of this research, in which we conjectured about the scarce presence of affective evaluations in students with dyscalculia, has been fulfilled. It can also be seen that most of the articles were published in the last 20 years and the trend of their topics has been increasingly focused on math anxiety. In addition, the small sample of publications found related to math disabilities coincides with the result obtained by Lambert and Tan (2020) in their review, where they conclude that research in this area is underrepresented in mathematics educational

research. If we take into account the three basic components that make up the affective domain (beliefs, attitudes, and emotions), the predominance of the study of math anxiety highlights the lack of research into the remaining components and the rest of the emotions.

By paying attention to the scientific domain to which the 24 selected articles belong, most of them are from the field of Psychology (17/24), while 3 yield in the field of general Education and the rest can be associated to the field of Math Education. This leads us to consider that it could be very enriching to increase research in the field of Education, especially in Mathematics Education, from where another point of view can be obtained.

The negative nature of the conclusions of most of the studies found in the systematic review on the affective profile of students with dyscalculia highlights the need to pay attention to this aspect. Thus, attention to the components of the affective domain within the classroom is of great relevance. If these are of a negative nature, as has already been observed in the research carried out, they can influence and aggravate the difficulties suffered by these students in their mathematics learning.

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