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OBM Neurobiology

Review

Technological Resources for Early Intervention in Cases of Dyscalculia: A Deductive-Inductive Categorization

Estefanía Espina [1, †], José M. Marbán [1, †, *], Ana I. Maroto [2, †]

1. Department of Didactics of Experimental Sciences, Social Sciences and Mathematics, Faculty of Education and Social Work, University of Valladolid, Valladolid, Spain; E-Mails: estefania.espina@uva.es; josemaria.marban@uva.es
2. Department of Didactics of Experimental Sciences, Social Sciences and Mathematics, Faculty of Education of Segovia, University of Valladolid, Segovia, Spain; E-Mail: anaisabel.maroto@uva.es

† These authors contributed equally to this work.

* **Correspondence:** José M. Marbán; E-Mail: josemaria.marban@uva.es

Academic Editors: María José Hernández Serrano and Paula Renés Arellano

Special Issue: Implications of Technologies on the Brain Development in Younger Students

OBM Neurobiology
2023, volume 7, issue 4
doi:10.21926/obm.neurobiol.2304191

Received: May 29, 2023
Accepted: October 18, 2023
Published: October 23, 2023

Abstract

Dyscalculia is a math learning disability that significantly interferes with students' academic performance and math-related aspects of their daily lives. Early diagnosis and the design of intervention programs adapted to the needs of each case are essential. In this sense, multiple technological resources are created to address both issues. Still, it is difficult to identify which characteristics they share and which are more relevant regarding didactic suitability. Given this situation, this research proposes categorizing these resources according to the type of addressee, objective, format, and supporting scientific evidence. The categorization process has been carried out in two phases: deductive and inductive. In the first phase, a systematic review of the literature was carried out in the main scientific publication databases. Based on the review publications reading, the aspects common to the technological resources found were identified in the second phase, and the final categorization criteria were created. The result of such a procedure provides a valuable bank of technological resources for intervention in dyscalculia at early ages. However, more scientific evidence is lacking to support its efficacy and validity in educational settings.

Keywords

Learning disabilities; dyscalculia; technological resources; intervention

1. Introduction

Mathematical competence is identified as a key component for the full development of committed and critical citizenship. At the same time, advances in research point to mathematics education at an early age as one of the best predictors of academic success in this field and of the development of mathematical competence in later years [1]. However, some of the barriers to the correct learning of mathematics, particularly the development of numerical and computational skills, are not identified or diagnosed. If these barriers are identified, it is usually late, which limits the effectiveness of any intervention to help students overcome them or learn to live with them without them becoming a limitation. This is the case of dyscalculia, a specific learning disability of neurobiological and, probably, genetic origin [2], which affects the correct acquisition of arithmetic skills and significantly interferes with academic performance and activities of daily living related to mathematics [3]. It is an "unexpected" phenomenon, as it occurs in students with an average intelligence level and appropriate schooling [4]. It is a relatively unknown learning disorder and is often not identified and diagnosed even after the schooling stage has been entirely covered [5]. This is especially serious considering that early diagnosis of dyscalculia is a crucial element since the sooner its symptoms are detected, the sooner intervention programs can be implemented for its treatment and thus minimize the difficulties it entails. At the same time, the importance of knowing the level of development of mathematical competence of students with dyscalculia must be considered so that the intervention can be adapted as much as possible to their needs [6].

Concerning dyscalculia, the intervention has been approached in recent years from two different but often complementary approaches. On the one hand, we find intervention proposals through which, by implementing specific activities and games supported by the use of manipulative materials, students with dyscalculia are (re)educated mathematically. They are provided with different ways to access mathematical knowledge and alternative strategies to fix concepts, solve problems, and perform calculations. On the other hand, we find interventions based on routines and practices, generally of short duration, in interaction with some intelligent tutoring system or adaptive program, i.e., interventions in technological environments. Troya and Sánchez (2017) [7] bet on information and communication technologies (ICT) as tools for inclusion and improvement of mathematical learning for students with dyscalculia. In this sense, several studies present different technological proposals to support children with dyscalculia. However, as the range of technological resources that can be used by teachers and families, as well as by other professionals in the educational field, to support mathematical development in situations of dyscalculia is becoming more and more numerous, it is helpful to be familiar with the characteristics that can facilitate discriminating their pedagogical suitability for each specific case. With this purpose in mind, the present study aims to elaborate a first categorization of these technological resources based on a systematic review of the existing scientific literature. Thus, this study shows the results of a first approach to the supply of such resources as part of a more ambitious project whose primary purpose is the design of personalized protocols and itineraries of mathematics (re)education for the support of students with dyscalculia (Figure 1) based on evidence from research. This study is linked to the first phase in a direct way and to the last one in a more propositional way.

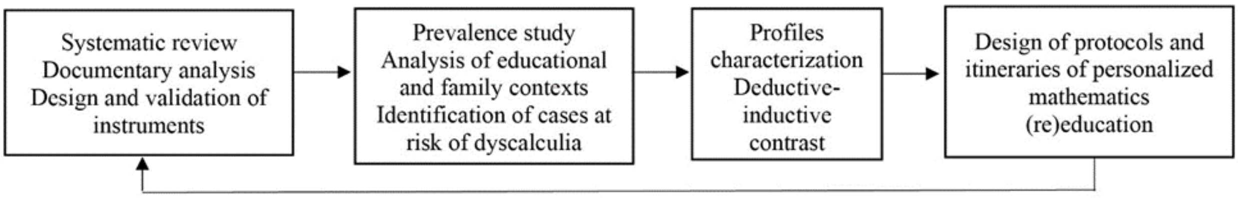

Figure 1 Phases of the global project. Authors' elaboration.

2. Theoretical Framework

Since the beginning of the 20th century, different studies have been published identifying and analyzing different manifestations of losing the ability to perform calculation tasks. This pathology is initially attributed to brain damage and labeled as *acalculia*. But it was not until 1974 that Ladislav Kosc [8] first precisely defined the term dyscalculia to refer to "a structural disorder of mathematical abilities that has its origin in genetic or congenital disorder in those parts of the brain that are the anatomical-physiological subtract of the maturation of the mathematical skills adequate to age, without a simultaneous disorder of general mental function" (p. 165). However, even though almost half a century has passed since then, there is still no single and widely accepted definition of dyscalculia; instead, it has evolved, sometimes responding to the approach or current from which the problem was approached. Thus, one of the most recent definitions for dyscalculia, on which the present research is based, is the one presented in the fifth version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), where dyscalculia is located within neurodevelopmental disorders and is assigned to a pattern of difficulties characterized by problems in processing numerical information, learning arithmetic operations, and correct or fluent calculation [9].

The prevalence of this disorder varies according to the criteria used in the different investigations that have been carried out, but, in general, it can be said that dyscalculia has a prevalence of between 2.27% and 6.4% of the school population [10]. On the other hand, it is not a disorder that is always present in isolation since a quarter of people affected by dyscalculia show comorbidity with other disorders such as ADHD, dyslexia, language disorder, anxiety, etc.

Different studies based on neuroimaging techniques have found alterations in the neural substrate of numerical processing in children with dyscalculia. In particular, a reduced activation of areas involved in basic numerical processing has been observed while performing tasks of a mathematical nature [11], as well as a reduction in gray matter and differences in connectivity between parietal and occipitotemporal regions [12]. The variation among the criteria used to identify children with dyscalculia in the research and the heterogeneity of mathematical skills have also prevented reaching a desired clear consensus on the symptoms associated with this disorder [13], collecting in Table 1 the most commonly cited ones.

Table 1 Symptoms of dyscalculia by school level. Authors' elaboration.

School level	Dyscalculia symptoms
Childhood Education	Difficulty in acquiring the basic principles of numbering and counting (numerical sequence, one-to-one correspondence, cardinality principle). Difficulty in classifying objects by their characteristics. Difficulty in making number-quantity correspondence. Does not acquire subitizing of small quantities (up to 5). Does not make small estimates (up to 10). Difficulty understanding terms related to mathematics. Problems copying Arabic numerals. Does not automate the number of fingers.
Primary Education	Difficulty in subitizing tasks and estimating quantities. Difficulty learning, processing, memorizing, or solving numerical sequences (counting backward, counting 2 by 2, 5 by 5...). Difficulty understanding the structure of the number line. Problems to identify, write down, or classify numbers. Difficulty in understanding the positional value of numbers (units, tens, hundreds). Inability to understand and remember mathematical concepts, rules, formulas, sequences (order of operations), and basic mathematical operations (+, -, x, /). Need of manipulative strategies to operate (objects, fingers, ...) persists. Difficulty in solving mathematical problems. Presents a deficient spatial and temporal sense.
Secondary Education	Poor grades in mathematics. Errors in calculations and slowness to perform them. Does not understand abstract concepts. Lack of automation of arithmetic facts. Processes mechanically but not conceptually or with strategies. Does not understand arithmetic problems. Poor use of numbers in daily life.

Finally, as noted in the *Introduction*, it is increasingly common to find proposals for intervention in dyscalculia based on technological resources. The use of this type of resource facilitates the teacher's work. It can promote faster and better progress in students than ordinary teaching methods, encourage student participation, and allow autonomous and independent learning, among other benefits [14]. Studies such as those by Benavides-Varela et al. (2020) [15] and Prabavathy and Sivaranjani (2020) [16] show findings that demonstrate a positive impact of the use of this type of resource in the intervention of students with dyscalculia. Benavides-Varela et al. (2020) [15] highlight that interventions based on digital technology can be conceived as an appropriate tool to help children with specific mathematical needs and to offer them additional opportunities to carry out mathematical tasks in an alternative technological context. On the other hand, Prabavathy and Sivaranjani's (2020) [16] findings showed that the use of virtual manipulatives could improve the acquisition of essential arithmetic learning in children with dyscalculia and also increase their motivation to learn mathematics.

To facilitate the reading and understanding of this study, we must point out that from now on, when we refer to technological resources, we will refer to the set of digital tools (software, applications, web pages, etc.) that can serve both to support the professional who performs the intervention as well as the students who receive it.

3. Methodological Process

The process followed for the elaboration of the categorization was the one proposed by Rojas (2014) [17], who considers that this process is made up of two phases: one deductive and the other inductive (Figure 2).

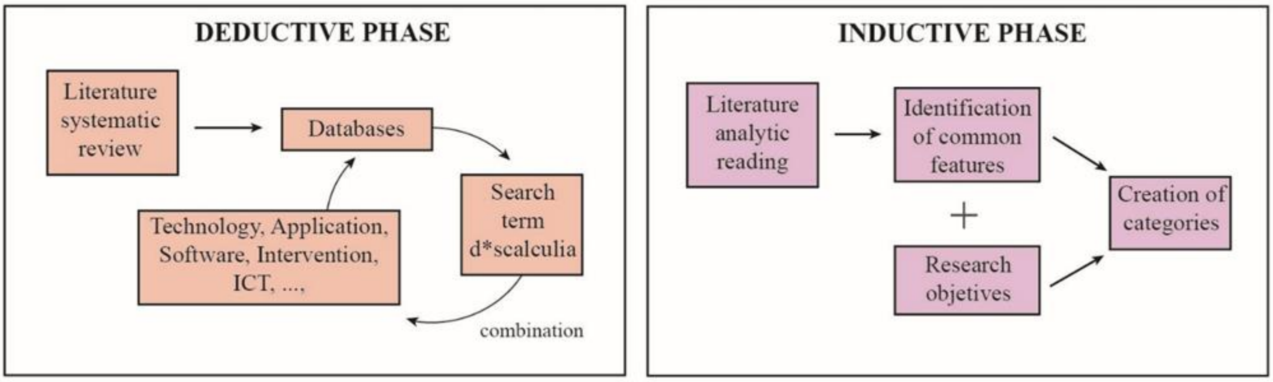

Figure 2 Categorization process. Authors' elaboration.

3.1 Deductive Phase

In the first phase, following the PRISMA 2020 guidelines, this study carried out a systematic review of the literature related to the topic under study [18]. The search was carried out trying to cover a wide variety of bibliographic sources, from the largest and most essential databases worldwide (*Web of Science, Scopus, Psychology Database, Scielo, Dialnet*, etc.), to national and international thesis databases (*TESEO (Doctoral Theses Database) and OATD (Open Access Theses and Dissertations*)). The combination of different terms related to technological resources with various terms referring to dyscalculia was introduced into these databases. Figure 3 shows all the descriptors used.

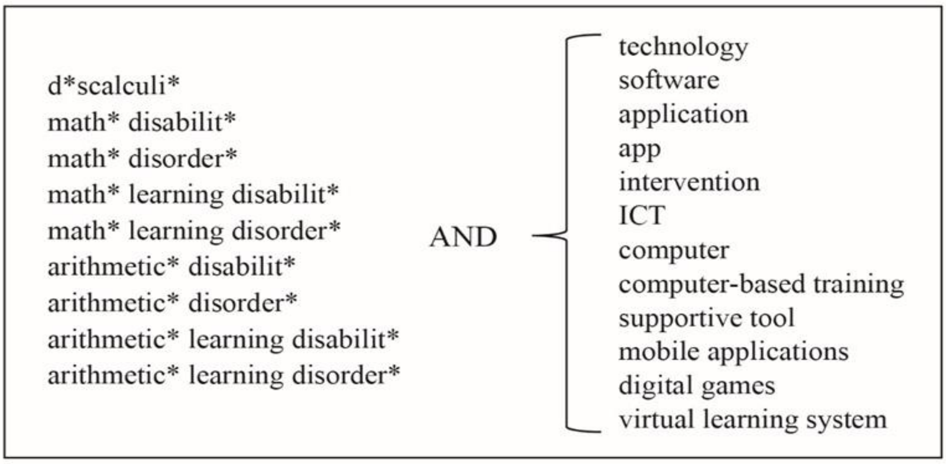

Figure 3 Descriptors used in the search. Authors' elaboration.

The criteria for inclusion and exclusion of publications in the review were as follows:

- We have included studies that present technological resources for specific interventions in dyscalculia.
- We have included studies whose publication dates are within all the periods the databases offer.
- We have included studies in any language.
- We have only included publications of a scientific nature and not those merely informative or divulgative.
- We have excluded studies that show technological resources not aimed at improving mathematical competence in students with learning difficulties.
- We have excluded studies that have been carried out with adults, covering only school age.

The information search process underwent four screening stages. In the first one, the different combinations of descriptors were entered into the databases, and 254 documents were obtained. In the second screening, a quick reading of the titles and abstracts of the publications was carried out, and those that did not meet the established inclusion and exclusion criteria were eliminated, obtaining 128 documents. In the third screening, the full text of the publications was read, and duplicates were eliminated, thus getting 44 papers. Finally, a fourth screening was conducted, and the search was completed using the snowball method [19]. Further articles were obtained from the bibliographic references of the publications read. This complementary search resulted in four additional papers, so the review consisted of 48 publications. Some of the most relevant papers found that present different technological proposals to support children with dyscalculia are the following: Drigas et al. (2016) [20], Hurtado and Duque-Méndez (2018) [21], Miundy et al. (2017) [22] and Robotti and Baccaglini-Frank (2017) [23].

3.2 Inductive Phase

In the second phase, we proceeded to the analytical reading of the 48 documents selected in the first phase. This reading identified the aspects common to the technological resources found per the research objectives.

As a result, the following categorization criteria were defined:

- The type of potential user to whom the technological resource is addressed. A distinction is made between those that have been specifically designed to intervene in cases of students with dyscalculia and those that have been designed for all students but, in turn, are recommended for students with dyscalculia.
- The primary purpose for which the technological resources have been created. The following can be distinguished: a) To train mathematical skills through digital activities to improve them; b) To train some of the cognitive skills that are affected by dyscalculia through games; c) To teach different basic mathematical concepts with the help of online lessons in the form of video tutorials; and d) To help the learning of mathematical content by serving as a facilitating and supporting tool.
- The type of format in which the intervention is presented. They are shown through groupings of activities or games, a single game, lessons through videos and tools.
- The languages in which the technological resources are displayed.
- The type of device where the technological resources are available.
- The main mathematical skills trained.
- An indication of whether the website of the technological resource provides or gives access to scientific evidence of validity and efficacy. A positive answer has also been given whenever relevant studies have been found in the scientific literature concerning such questions while performing this research.

The first six criteria emerged from the response to the research objective posed at the outset, while the last criterion emerged from the analytical reading of the literature.

4. Results and Discussion

The results obtained after the systematic review and categorization process are presented as a table for better understanding and visualization (Table 2).

Table 2 Technological resources for intervention in dyscalculia.

Potential user	Objective	Format	Name	Language	Device	Skills trained	Evidence*
Students with dyscalculia	Train mathematical skills through digital activities	A single game with several levels	Number Race	English and French	Computer	Number formats, counting, addition and subtraction	YVW & YEW
			Number Catcher	English, French, Arabic and Hebrew	Computer and smartphone	Number formats, addition, subtraction, base 10 principle and multi-digit numbers	NV & NE
			Graphogame-Math	English, Spanish, French, Dutch, Norwegian, Greenlandic and Portuguese	Computer and smartphone	Verbal counting, number comparison, subitizing, object counting and arithmetic	NV & YEL, CS
			Dots2Digit and Dots2Track	English	Computer	Numerosity-digit correspondence	NV & NE
			NumberBeads	English	Computer	Composing and decomposing numbers	NV & NE
		Set of activities or games	Calcularis	English, German and Ukrainian	Computer	Automatization of number representations, mental number line, arithmetic operations, and arithmetic fact knowledge	NV & YEL, CS

			Meister Cody - Talasia	English and German	Computer and smartphone	Quantity-number-linkage, part-whole relationship, spatial ability, relational number perception, fact retrieval, subitizing, understanding of the positional notation system, and transcoding	YVW & YEW
			NeurekaNUM	Spanish and Catalan	Computer and smartphone	Mental number line, exact calculation, ten-based number system, and resolution of word problems	YVW (NA) & YEW
			Discalapp	Spanish	Smartphone	Mathematics basic skills	NV & NE
Students with dyscalculia	Train mathematical skills through digital activities	Set of activities or games	DisMAT	Portuguese and English	Smartphone	Size, direction, memory, measures, time, orientation, and monetary system	NV & YEL, CS
			Dinamo Números	English, Spanish and Portuguese	Computer	Direction and spatial orientation, visual discrimination and approximation, number as symbols - single and double digit, counting, comparison, estimation, ordering numbers, number sequencing, number facts, mental strategies, number bonds, problem solving, time, and multiplication	YVW & YEW

			Calculic Kids	Malay	Smartphone	Number counting, object counting, addition and subtraction operation	NV & YEL, CS
Students with dyscalculia	Train cognitive skills through games	Set of games	Elevate	English	Smartphone	Memory, mental math, and language	NV & YEL, CS
			NeuroNation	English, French, Dutch and Russian	Smartphone	Working memory, inhibition, and cognitive flexibility tasks	NV & NE
			MathRx program	English	Computer	Inductive reasoning skills, math comprehension, memory, number strategy, attention, and visual processing	NV & NE
			Lumosity	English, Spanish, French, Dutch, Portuguese, Japanese and Korean	Smartphone	Speed, memory, attention, flexibility, problem solving, and mathematics	NV & YEW, CS
	Teach mathematical concepts through video tutorials	Lessons with videos	Karismath	English and Urdu	Computer and smartphone	Visual, numerical, and verbal reasoning	NV & NE
			Maths Explained	English	Computer and smartphone	Understanding numbers, basic facts, addition, subtraction, multiplication, division, decimals, percentages,	NV & NE

						fractions, algebra, area and perimeter, ratio, and place value	
Students with dyscalculia	Facilitate the learning of mathematical content	Digital help tool	Shape Math	English	Computer	Addition, multiplication, division, money, fractions, and percentages	NV & NE
			Calculating Aid Tools: KidKanit	English	Computer	Addition, subtraction, multiplication, division, and math problems	NV & YEL, CS
			Know the abacus	Spanish and English	Smartphone	Numbers, counting, and basic operations (addition and subtraction)	NV & NE
			Long Division	English	Computer	Division	NV & NE
All students (with and without dyscalculia)	Train mathematical skills through digital activities	Set of activities or games	Smartick	Spanish	Computer and smartphone	Mental arithmetic, reasoning, logic, and programming	NV & NE
			Slate math	English	Smartphone	Mathematical processes and cognitive processes (selective and sustained attention, reasoning, order relations, and problem solving)	NV & NE
			MathemAntics	English	Computer and smartphone	Quantity comparison, counting, subitizing, estimation, addition, and subtraction	NV & YEL, CS

[*] Note. The meaning of this column is developed in more detail later in this section. YVW, YVL: evidence of validity in website or literature; NV: no evidence of validity; YEW, YEL: evidence of efficacy in website or literature; NE: no evidence of efficacy; NA: does not provide access to evidence; CS: single case study.

4.1 Technological Resources for Students with Dyscalculia

The technological resources that have been specifically designed to carry out an intervention with students with dyscalculia and whose purpose is the training of mathematical skills through the proposal of digital activities are mostly referred to in scientific publications as *computer-based learning programs*. Among them, a distinction is made between programs consisting of a single game and several games. The programs *Number Race* [24], *Number Catcher* [25], *Graphogame-Math* [26], *NumberBeads* [27], and *Dots2Digit and Dots2Track* [18] offer a single game broken down into different levels, whose characteristics are modified to increase difficulty and, in some cases, to incorporate other skills or content. On the other hand, the programs *Calcularis* [28], *Meister Cody - Talasia* [29], *NeurekaNUM*, an updated version of the *Nummerus* program [30], *Discalapp* [31], *DisMAT* [32], *Dinamo Números* [33], and *Calculic Kids* [34], present a grouping of digital games or activities associated with the different mathematical skills that are intended to be trained.

We also found technological resources in mobile application formats such as Elevate [35], *NeuroNation* [36], and *Lumosity* [37], or brain training programs such as *MathRx* [38], which offer games, tasks, or exercises to train different cognitive skills (working memory, attention, processing speed, etc.). These programs focus on the underlying cognitive skills required to learn mathematical concepts efficiently and effectively, solve problems, and perform mathematical computations.

Concerning the understanding of basic mathematical concepts by people suffering from dyscalculia, two platforms were located: *Karismath* [39] and *Maths Explained* [40], which propose lessons through video tutorials. The videos aim to improve the understanding of mathematics through carefully designed visual images combined with relevant mathematical vocabulary and concepts.

Finally, within the category of technological resources designed for students with dyscalculia, digital assistive technology tools aimed at facilitating the learning of mathematical content in students with dyscalculia were identified. For example, *Shape Math* [41], which offers a technique for solving mental and written mathematical problems based on the geometric representation of the base 10 number system; *Calculating Aid Tools: KidKanit* [42], which provides various tools to help with basic skills instruction in the areas of addition, subtraction, multiplication, and division; *Know the Abacus* [43], which provides a digital abacus for calculus training, and *Long Division* [44], which helps with a step-by-step long division drill.

4.2 Technological Resources for All Students

Concerning technological resources designed for all students but which, in turn, are recommended for students with learning difficulties in mathematics or dyscalculia, the search and analysis results included the Smartick platform [45] and the applications Slate Math [46] and MathemAntics [47]. They all have as their main objective the work and training of multiple mathematical processes and mathematical skills through a set of playful digital activities and adaptive processes.

4.3 Validity and Effectiveness of Technological Resources

The review aimed at ascertaining whether any research supported the efficacy and validity of the technological resources found, yielding results worth highlighting. Thus, for the resources *Number*

Catcher, Discalapp, Dots2Digit and Dots2Track, NumberBeads, NeuroNation, MathRx program, Karismath, Maths Explained, Shape Math, Know the abacus, Long Division, Smartick, and *Slate Math*, no publications were found showing scientific validation procedures or (quasi-)experimental impact studies analyzing their efficacy, neither on the website nor in the literature. In the case of the *NeurekaNUM* program, it is specified in the publications that a validation and effectiveness procedure has been carried out, but no such documentation is shown or made available for the validation process on its website, but is provided for the effectiveness process. In *Calcularis, Graphogame-Math, Calculic Kids, Elevate, Lumosity, Calculating Aid Tools: KidKanit, DisMAT,* and *MathemAntics* no validation procedure is shown or referenced, while the evaluation of the effectiveness of the training proposed by the program has been carried out through a single case study published in the scientific literature, except in *Lumosity*, published in its website. Finally, the *Number Race, Meister Cody - Talasia,* and *Dinamo Números* programs were located, in which both the validation procedure and studies of its efficacy are shown and detailed in their websites. These technological resources show the validity of their software through the results obtained in the statistical analyses they have performed (correlation analysis, analysis of variance ANOVA, etc.). This information can be consulted in the studies referenced in the first column of Table 3. This table details some of the traits (sample, length of training, and research main results) of the studies that demonstrate the effectiveness of technological resources mentioned in the last column of Table 2.

Table 3 Some characteristics of the effectiveness evaluation studies.

Name	Sample	Length of training	Main results
Number Race [48]	- Age: 7-9 years old - Experimental group: 9 children with mathematical learning difficulties	Five weeks (half an hour per day, four days a week)	The software adapts well to varying levels of initial knowledge and learning speeds and shows an evolution of number sense and arithmetic scores.
Graphogame-Math [26]	- Age: 6 years old - Experimental group: 30 children with low numeracy skill - Control group: 30 typically performing children	Three weeks (daily intervention session)	The short training produced improved performance in number comparison, but this short-lived effect requires more research.
Calcularis [49]	- Age: 2^{nd} to 5^{th} grade (mean age 8.96 years) - Experimental group: 39 children with dyscalculia - Control group: 33 children with dyscalculia	4-5 times per week with training sessions of 20 minutes	Calcularis supports children with dyscalculia to improve their arithmetical abilities and their mental number line representation.

Meister Cody - Talasia [50]	- Age: 2nd to 4th grade - Experimental group: 111 children with substantial arithmetic difficulties - Control group: 1064 typically performing children	3 days per week (20-30 minutes each day)	Markedly improved math performance after a 6-week training.
NeurekaNUM [30]	- Age: 7-12 years old (mean age 8.48 years) - Experimental group: 17 children with dyscalculia	8 months	The software contributes to increase math performance on dyscalculic children. These results need to be followed up with larger samples and more controlled studies.
DisMAT [51]	- Age: 5-10 years old (mean age 8.2 years) - Experimental group: 8 children having difficulties with numbers and mathematical concepts	Not indicated	This game may help not only to improve the math results obtained by children, but also to provide the elements that may potentiate their progress in mathematics.
Dinamo Números [33]	- Age: 4th to 6th grade - Experimental group: 12 children with math difficulties - Control group: 3 children with math difficulties	3 months	All 12 children improved significantly and over half the group doubled their scores.
Calculic Kids [52]	- Age: 6-10 years old - Experimental group: 7 children with dyscalculia	3 weeks	It was noted that Calculic Kids is effective and has potential to be used in classrooms to improve the performance of children with dyscalculia.
Elevate [53]	- Age: 18 years of age or older - Experimental group: 146 individuals - Control group: 125 individuals	4 weeks	The Elevate treatment group, which had access to Elevate games and training exercises, scored higher and improved more than the control group.
Lumosity [54]	- Age: 7-14 years old (mean age 10.9 years)	5 days per week for 6 weeks	The training approach is potentially associated with improved number sense, math

	- Experimental group: 16 females		and related skills, as well as functional changes in math-related neural systems.
Calculating Aid Tools: KidKanit [42]	- Age: 3rd grade - Experimental group: 5 children with math learning disability	10 sessions (3 hours per each session)	The results showed that Calculating Aid Tools: KidKanit helps improve basic calculation of students with dyscalculia.
MathemAntics [47]	- Age: 5 years old - Case study	24-minute sessions	MathemAntics offered an intriguing and amusing virtual world to explore, tools to use, problems to solve, unanticipated events, checking procedures and mathematizing.

It should be noted that *Meister Cody - Talasia* and *Smartick* resources also include an instrument for diagnosing dyscalculia: *CODY-M 2-4* and *Dyscalculia Risk Detection Test*, respectively. More and more advances have been made in the field of neuroscience to the detection of dyscalculia. For example, methods such as the auditory brainstem response (BAEP) [55, 56], and the voxel-based morphometry [12] stand out. In this same line, it is considered of interest to mention some of the instruments that have been found during the review and that use ICT as a medium for the early detection of dyscalculia in students. Among them we find the online screening instruments *Diamante* [22], for the age range 6-9 years; *Dyscalculia Screener* [57], and *Di-calc* [58] (belonging to the *Di-test battery*), for ages between 6 and 14 years; the *BADyG Test* [59], from 3 to 18 years; *Dyscalc* [60] and *DyscalculiUM* [61], for over 14 years; and, finally, the *Cognitive Assessment for Patients with Dyscalculia (CAB-DC)* [62], for all ages from 7 years. Applying these tests in digital format simplifies the data collection process for professionals and is a very attractive element for students to participate in these processes.

5. Conclusions

The era of technology in which we find ourselves has led to rapid growth in the last 20-30 years of developing a set of technological tools and resources with a didactic intention aimed at correcting or compensating the problems caused by specific learning difficulties or certain learning disorders. In the case of dyscalculia, various resources can be used in the school or family environment to treat and intervene this disorder, from mobile applications to computer games. However, the search process carried out for this categorization has revealed a shortage of personalized resources that meet the specific individual needs that students with dyscalculia may have, although they can be handy tools for the process of mathematical re-education. We consider that the specific needs of students should be interpreted in two senses. On the one hand, they are specific needs because they are children with dyscalculia, as opposed to students who do not have it. On the other hand, they are also specific because each student has different characteristics. It is a very heterogeneous student body.

Not only do we need specific resources for children with dyscalculia, but a greater degree of personalization is necessary within the existing resources. So that when a child uses this resource, they can better set up a series of parameters of this resource to make them more efficient and effective with it. The resource should not be closed and have the same trajectories, the same levels, or be only adaptive in the level of difficulty. We consider it necessary to have a way to customize the resources according to the profiles of the students.

Following these considerations, this study provides a significant contribution, offering a compilation and categorization of the current technological resources for the specific attention of students with dyscalculia. Most of them are aimed at the primary school stage, and the mathematical contents on which they focus their attention through their activities are those related to number sense (estimation, counting, comparison, subitizing, mental number line, place value, numerical relationships, etc.) and, very significantly, with calculus.

The resources in the present review cover various functions for the intervention process in dyscalculia, and the authors or companies that have created them indicate that they are effective. However, one of the aspects that stands out from the research is the notable and frequent absence of scientific evidence supporting their efficacy and validity. There is still a lack of evidence on both the design of the resources and the measurement of their impact. This fact remains an open and attractive issue for scientific progress.

Author Contributions

All the authors contributed equally to this work.

Funding

This research has been made possible through the financial support of the Ministry of Education of Castilla y León and through other aids focused on the hiring of predoctoral researchers, co-financed by the European Social Fund. In addition, it was financed through the POC convocation, which is part of the TCUE 2021-2023 Plan, and has been selected within the framework of an operational program co-financed by the European Regional Development Fund and the Castilla y León Regional Government.

Competing Interests

The authors have declared that no competing interests exist.

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