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A Systematic Literature Review of Empirical Evidence on Students with Mathematics Learning Disabilities

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Abstract

Mathematics is a particularly important component in our daily life and many students find it as an exceedingly difficult subject to be learned. The similar problem is being faced by special needs students such as those with learning disabilities (LD). This paper provides a current and thorough literature review of the empirical evidence on students with mathematics learning disabilities. The authors conducted the review of literature from the year 2016 to 2020 using Education Resources Information Center (ERIC) as the database. A total of 31 articles were found. Multiple mathematics learning disabilities were identified and the educational interventions that were used vary accordingly. Finding shows that most of the studies focused on technology-based interventions to help students with intellectual disability which includes problem solving and creative thinking. The implications of the study are also discussed in this literature review, which indicates that teachers need to use the appropriate educational interventions to meet the needs of students with learning disabilities and maximize their mathematics learning outcomes in schools.

Keywords: mathematics, learning disabilities, educational interventions, systematic literature review, special education

Introduction

Mathematics is an essential subject that has its continuity in our daily life. Many students encounter learning difficulties in mathematics as they find it a complicated subject to be understood due to its natural characteristics. Kunwar et al. (2021), also say by its very nature being an abstract subject, it raises the problem of learning difficulty. Meanwhile, special needs students face mathematics learning disabilities (LD) as their cognitive development is at very minimal level. Historically, people with disabilities and other special needs in most, if not all, countries around the world have faced discrimination in the provision of education (Okech, 2021). They are often neglected as many teachers focus on the mainstream students by providing them the appropriate teaching strategies. Baglama et al. (2017), argues that social skills including daily life skills, shopping, travelling, reading, and writing; basic mathematical skills are also necessary to use in daily life for individuals with special needs. It is certain that students with mathematics learning disabilities require specific support in learning the concepts and contents of mathematics. Supporting pupils with special educational needs should be part of a proactive approach.

Ikhwanudin and Suryadi (2018), say that the term difficulty in learning mathematics is called mathematics learning disabilities (MLD). They have stated in the article that some literature and

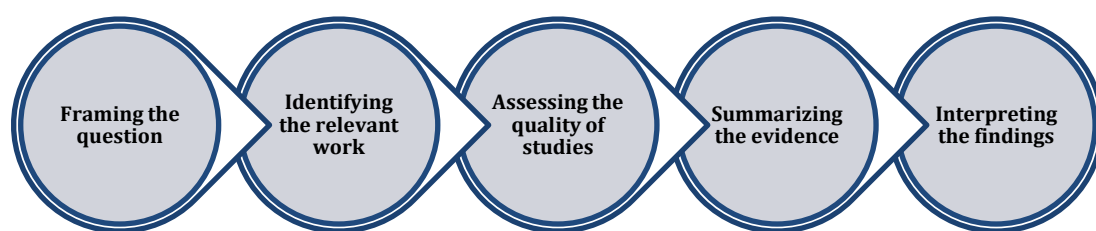
researchers call MLD as dyscalculia. For example, according to Nagar (2016), learning disability in mathematics is called "developmental dyscalculia". While Geary and Hoard (2001) explain that acquired and developmental dyscalculia refer to deficits in the processing of numerical and arithmetical information that are associated with overt brain injury or presumed neurodevelopmental abnormalities, respectively. It has also been argued that many pupils with dyscalculia have significant difficulties with the language of mathematics (Bessoondyal, 2017). Eichhorn (2016) defines mathematics learning disability as students and adults with mathematics learning disability (MLD) are individuals that perform at a level substantially below their peers in mathematics, whose poor performance cannot be explained by any deficit in vision, speech, hearing, or intelligence. Although mathematics learning disabilities have significant impacts on the students' mathematics achievement, Mazzocco and Myers (2009) says that to date, research on mathematics disability (MD) is far less extensive than research on reading disability (RD).

Mathematics achievement of the students with mathematic learning disability could be improved with the application of effective education interventions. Choosing the right educational intervention will affect the students with mathematics learning disability in a positive way. Kitchens et al. (2016), suggest that all teaching and learning strategies need to be investigated if they promise any potential benefits for learners to overcome mathematics disability. They have stated so in the article since an intervention named Cover, Copy and Compare appeared to be an effective intervention to help students with mathematics learning disability in mathematics achievement. While Mckissick (2017), discusses that the intervention used in his article, the Success Maker has demonstrated an ability to assist struggling learners and acclaims that the need for an effective remediation should be focused on. To review on the mathematics achievement of students with mathematics learning disability, this study examines the types of mathematic learning disability faced by the students and the types of educational intervention used.

Methodology

This systematic literature review used Khan et al. (2003) guidelines as shown in Figure 1. This systematic review process consists of five steps that started with framing the question, identifying the relevant work, assessing the quality of studies, summarizing the evidence, and interpreting the findings.

Figure 1: The five steps in systematic literature review



Source: Khan et al. (2003)

Framing the question

Among key points that should be considered in the stage of formulating the research questions are the developed research question must guide the entire SLR (Mohamed Shaffril et al. 2020). The research questions were also intended to help find the articles within the scope using the appropriate keywords. Two research questions were developed, and they are stated as below.

- i. What are the types of mathematics learning disabilities faced by the students?
- ii. What are the educational interventions used for students with mathematics learning disabilities?

Identifying the relevant work

Firstly, appropriate keywords were identified to use in the search process of articles related to the topic in the education database. The keywords used were “Mathematics Learning Disabilities”, “Mathematics Learning Disabilities AND Educational Interventions” and “Mathematics AND Students with Learning Disabilities”. In this study, the manual searching was used on the selected database, ERIC. This helps to retrieve about 969 articles that discuss about the types of mathematics learning disabilities and the educational interventions. It was found that not all those articles met the topic required for this study hence they were removed, leaving a total of 47 articles. However, this step was continued with the screening process based on the set of criteria as shown in Table 1. The articles were reviewed in depth which resulted in 36 articles. All the articles were journal articles and conference proceedings.

Table 1: Screening Process

Criteria	Inclusion	Exclusion
Database	Published on a valid database	Published on a non-valid database
Publication Timeline	2016-2020	2015 and before
Document Type	Journal article, Conference proceedings and Dissertation theses	Chapters in book and literature review
Document Availability/Condition	A full-text article	Not a full-text article
Language	English	Non-English
Nature of the study	Focus on issues on mathematics education for special needs students with mathematics learning disabilities	Not focus on issues on mathematics education for special needs students with mathematics learning disabilities
Intervention	Reports educational interventions	Does not report educational interventions
Setting	Must be conducted at the preschool, primary and secondary levels	Was not conducted at the preschool, primary and secondary levels

Assessing the quality of studies

A total of 36 eligible articles were found after the first screening process. However, the articles were evaluated before it is further reviewed to achieve objectives of this study. Data evaluation consists of the phase in which the reviewers analyze each reference collected and define the articles that is included in the SLR list. The process of evaluation was performed in four sub steps that were discussed by Mariano et al. (2017) in their article about guidance to perform systematic literature review in bioinformatics. Table 3 shows the four sub steps which started with title evaluation, abstract evaluation, diagonal reading, and full text-reading.

Table 3: Data evaluation

Sub steps	Description	No. of articles	
		Included	Excluded
Title evaluation	Does the title of article relate to the research question, objective, and keywords of the study?	36	0
Abstract evaluation	Does the abstract fulfill the criteria such as introduction, formulation of the study's aim, methodology used, finding and results, conclusion, and impact of the research work?	32	4
Diagonal reading	Do the introduction, table or figure titles, conclusion fulfill the research question or objectives of the study when the content was scanned in a zig zag pattern?	32	0
Full-text reading	Does the article score more than 5 complying five criteria such as objectives of the study, literature review, type of mathematics learning disabilities identified, educational intervention used and results and conclusion?	32	0

Based on Table 3, keywords were searched in the title evaluation process which resulted in the approval of all 36 articles. In the abstract evaluation, 4 articles were excluded (Keller et al., 2018; Lei et al., 2018; Prendergast et al., 2017; Wilkey et al., 2018) as they failed to fulfill one of the criteria which is the statement of implication particularly. The result shows that the remaining 32 articles comply with the criteria for abstract assessment. In diagonal reading sub step, none of the articles were eliminated as all the 32 articles were approved according to the aspects such as the relevance of the introduction, table title and conclusion in the article. The final step was the full-text reading, and the articles were evaluated by a scoring system as shows in table below.

The scoring system allowed the researcher to evaluate the quality of the articles based on 5 main criteria such as objectives of the study, literature review, statement of type of mathematics learning disability and educational intervention used and result and conclusion. Each criterion was given scores as following. (2) if the study complies with the requirements of the question; (1) if the study partially satisfies the requirements of the question; or (0) if the study does not fulfill any of the question requirements. If the article has obtained a score of equal or higher than 5, it will be included for the review in this study. Articles that scored less than 5 were excluded as not meeting the quality standard. In this case, one article (Lambert & Tan, 2016) was removed as it scored 4 which is less than 5, leaving 31 articles qualified for this study. According to Margot and Kettler (2019), the second author should review the included and excluded articles against the criteria and confirm that all retained articles met the criteria to guard against bias. Hence, as the validation process the articles were reviewed again by the second researcher of this study to assess the quality.

Table 4: Scoring system for full-text reading

Article	Criteria and Scores					Total Score (10)
	Objectives/ Aims	Literature Review	Type of Mathematics Learning Disability	Educational Intervention	Result and Conclusion	
Special Education Teachers' Views on Using Technology in Teaching Mathematics	2	2	2	2	2	10
Dis/Ability and Mathematics: Theorizing the Research Divide Between Special Education and Mathematics	1	2	0	0	1	4
How Can I Help my Students with Learning Disabilities in Mathematics?	2	2	1	2	2	9
Teacher and Student Use of Gesture and Access to Secondary Mathematics for Students with Learning Disabilities: An Exploratory Study	2	2	2	2	2	10
Effectiveness of Pearson's Success Maker Mathematics for Students with Disabilities	2	2	2	2	2	10
Math Manipulatives for Students with Severe Intellectual Disability: A Survey of Special Education Teachers	2	2	2	2	1	9
Promoting Access to Common Core Mathematics for Students with Severe Disabilities Through Mathematical Problem Solving	1	1	2	2	1	7
Fractions Learning in Children with Mathematics Difficulties	2	2	1	2	1	8
Culturally Responsive Professional Development for One Special Education Teacher of Latino English Language Learners with Mathematics Learning Disabilities	1	2	2	2	1	8
Teaching Students with Moderate Intellectual Disability to Solve Word Problems	2	2	2	2	2	10
How Students with Mathematics Learning Disabilities Understands	2	2	2	2	2	10
Fraction: A Case from the Indonesian Inclusive School						
Using Computer for Developing Arithmetical Skills of Students with Mathematics Learning Difficulties	1	2	2	2	2	9

Mathematics Instruction for Secondary Students With Learning Disabilities in the Era of Tiered Instruction	2	2	2	2	2	10
Teaching Addition to Students with Moderate Disabilities Using Video Prompting	2	2	2	2	2	10
Meta-cognitive Strategies in Problem Solving for Children with Learning Difficulties in Mathematics at the Primary Level	1	2	2	2	2	9
Mathematical Problem-Solving Processes of Students with Special Needs: A Cognitive Strategy Instruction Model 'Solve It!'	2	2	2	2	2	10
A Student With a Learning Disability and Multi-Step Equations With Fractions	2	2	2	2	2	10
Instructional Scaffolds in Mathematics Instruction for English Learners With Learning Disabilities: An Exploratory Case Study	2	2	2	2	2	10
Promoting creative thinking for gifted students in undergraduate mathematics	2	2	2	2	2	10
Student with special needs and mathematics learning: A case study of an autistic student	2	2	2	2	2	10
Perspectives on Algebra I Tutoring Experiences With Students with Learning Disabilities	2	2	2	2	2	10
Developing Number Sense in Students With Mathematics Learning Disability Risk	2	2	2	2	2	10
Students with Special Needs in Digital Classrooms during the COVID19 Pandemic in Turkey	2	2	2	2	2	10
Examining teaching based on errors in mathematics amongst pupils with learning disabilities	1	2	1	1	1	6
Prime Online: Exploring Teacher Professional Development for Creating Inclusive Elementary Mathematics Classrooms	2	2	2	2	2	10
Quality of Explanation as an Indicator of Fraction Magnitude Understanding	2	2	2	2	2	10
Point of View Video Modeling to Teach Simplifying Fractions to Middle School Students With Mathematical Learning Disabilities	2	2	2	2	2	10
Examination of Cognitive Processes in Effective Algebra Problem-Solving Interventions for Secondary Students with Learning Disabilities	2	2	2	2	2	10

Haunted by Math: The Impact of Policy and Practice on Students with Math Learning Disabilities in the Transition to Post-Secondary Education in Mumbai, India	2	2	2	2	2	10
Effects of an Intervention on Math Achievement for Students with Learning Disabilities	2	2	2	2	2	10
Combining Like Terms: A Qualitative Meta-synthesis of Algebra I Interventions in Mathematics and Special Education	2	2	2	2	2	10

Summarizing the evidence

The researcher summarized the selected articles to answer the research question of this study. To ease the process of summarizing the articles, data extraction was conducted in Microsoft Excel and tabulated into Summary Matrix (Appendix A), which includes the name of author, year of publication, document type, research design, keywords, type of mathematics learning disabilities and educational intervention (Rahim et al., 2021). Subsequently, Table 5 were constructed to make the researchers to have a quick review on the two important data which is the type of mathematics learning disability and the educational intervention that were discussed among the articles.

Table 5: Summary of type of mathematics learning disability and education interventions of included articles

Researcher	Year	Data	
		Type of mathematics learning disability	Educational Interventions
Basak Baglama et al.	2017	Mathematical concept	Technology Tool
Gracia Jiménez-Fernández	2016	Dyscalculia	Interventional framework focused on number sense and problem solving
Bronwyn Ewing	2016	Mathematics achievement	Math Intervention Program- multi-sensory forms of teaching and learning
Casey Hord et al.	2016	Demonstrate mathematics relationships within equations- organize their cognitive process and diagram problems	gesturing processes of tutors
Steven K. McKissick	2017	Cognitive performance	instructional learning system rooted in behaviorist instructional theory- Success Maker mathematics
Bree Ann Jimenez & Carol Stanger	2017	Severe Intellectual disability	physical math manipulatives
Fred Spooner et al.	2017	Mathematical problem solving	conceptual model- schema-based instruction combined with evidence-based

Jing Tian & Robert S. Siegler	2017	Fraction knowledge	fraction magnitude knowledge for numerical understanding
Michael J. Orosco & Naheed A. Abdulrahim	2017	Problem solving comprehension	Culturally Responsive Professional Development
Diane M. Browder et al.	2018	Moderate Intellectual Disability- Solve Word Problems: addition and subtraction	modified schema-based instruction that embedded effective practices (e.g., pictorial task analysis, graphic organizers, systematic prompting with feedback)
Trisno Ikhwanudin & Didi Suryadi	2018	Fraction knowledge	instructional methods
Yılmaz Mutlu & Levent Akgün	2019	Dyscalculia-Arithmetic skills	Computer aided instruction materials
Shaqwana Freeman-Green et.al	2018	Mathematical concepts, foundational skills	Mathematics Instructional Approaches
Scott A. Dueker & Helen I. Cannella-Malone	2019	Numeracy- addition and subtraction	Video Prompting
Hemant Bessoondyal	2017	Learning difficulties in mathematics in problem solving	Meta-cognitive Strategies
Ufuk Özkubata et.al	2020	Mathematical Problem-Solving Processes	Cognitive Strategy Instruction Model 'Solve It!'
Casey Hord et al.	2020	Fraction concepts, struggling with possible anxiety	gestures, verbal instruction
Qingli Lei et al.	2020	Mathematics problem solving, mathematical thinking with both concrete and abstract units, mathematical content-language usage	Instructional Scaffolds in Mathematics Instruction
Parinya Sa Ngiamsunthorn	2020	Creative thinking	challenge-based learning, problem solving process, project-based learning, well-designed questions and in-depth learning style in the classroom
Sabaruddin et.al	2020	Autistic	teacher behavior
Casey Hord & Anna F. DeJarnette	2020	Remembering Algebra I content, posing strategic questions to students, dealing with students' math anxiety	program- gestures and strategic questioning
Mehmet Hayri SARI	2020	Number sense	Tablet-PC games designed to develop approximate number system

Gulcihan Yazcayir & Hasan Gurgur	2020	Intellectual Disability	inclusive education in Digital Classrooms - lessons on TV
Noga Magen-Nagar	2016	Disability in cognitive functioning and mathematical functioning	use of conceptual and procedural mathematical knowledge
Cynthia C. Griffin et.al	2018	Intellectual Disability	Professional development (PD) in mathematics- Prime Online
Lindsay Foreman-Murray & Lynn S. Fuchs	2019	Fraction Magnitude Understanding	Quality of Explanation
Elizabeth M. Hughes	2019	Fraction concepts	Point of View Video Modeling (POVM) intervention including virtual demonstrating of concrete mathematics manipulatives
Jiwon Hwang et.al	2019	Cognitive Processes	Effective Algebra Problem-Solving Interventions
Melinda (Mindy) S. Eichhorn	2016	Lack the math content knowledge	Policy and Practice
Vivian D. Kitchens et al.	2016	Math achievement	Cover, Copy, and Compare for learning basic math computation skills
Rebecca A. Dibbs et al.	2020	Algebraic thinking	Conceptual teaching

Based on the table above, it is found that 14 types of mathematic learning disability were examined which is (1)dyscalculia, (2)mathematics achievement, (3)cognitive process or performance, (4)intellectual disability, (5)mathematical problem solving, (6)fraction knowledge or concepts, (7)mathematical concepts and foundation skills, (8)numeracy involving addition and subtraction, (9)creative thinking, (10)autistic, (11) remembering Algebra 1 content, (12)number sense, (13)math content knowledge and (14)algebraic thinking. In this regard, some of the mathematic learning disabilities discussed in the articles could be merged and categorized with one main type of mathematic learning disability as shown in Table 6. Hence, this resulted in the identification of 8 main types of mathematics learning disabilities.

Table 6: Main types of mathematic learning disability

No.	Main Type	No. of Articles
	Intellectual disability	
1	a) Mathematical problem solving b) Creative thinking	10
	Mathematical concepts and foundation skill	
2	a) Fraction knowledge/concepts b) Numeracy- Addition & Subtraction c) Remembering Algebra 1 content d) Algebraic thinking	10
3	Mathematics achievement	2

4	Dyscalculia	2
5	Cognitive process/ performance	4
6	Autistic	1
7	Number sense	1
8	Math content knowledge	1

Meanwhile, the types of educational interventions discussed in the included articles were also summarized as shown in table below.

Table 7: Educational interventions used in the included articles

No.	Main types	No. of Articles
	Technology tool-based lesson	
1	a) Computer aided instruction materials b) Video Prompting c) Tablet-PC games d) Digital Classrooms - lessons on TV e) Professional development (PD) in mathematics- Prime Online f) Point of View Video Modeling (POVM) intervention including virtual demonstrating of concrete g) Cover, Copy, and Compare for learning basic math computation skills	8
	Gesturing processes	
2	a) Gestures and verbal instruction b) Gestures and strategic questioning c) Quality of Explanation	4
	Mathematics Instructional Approaches	
3	a) Instructional methods b) Instructional learning system rooted in behaviorist instructional theory- Success Maker mathematics c) Instructional Scaffolds in Mathematics Instruction	4
4	Schema-based instruction	2
	Physical math manipulatives	
5	a) multi-sensory forms of teaching and learning b) challenge-based learning and project-based learning,	3
6	Problem solving	2
7	Use of conceptual and procedural mathematical knowledge	2
8	Cognitive Strategies	3
9	Culturally Responsive Professional Development	1
10	Policy and Practice	1
11	Teacher behavior	1

Initially, it was found that there were 29 types of educational interventions used in the included article. The educational interventions were reviewed further to categorize under few main educational

interventions. Subsequently, a total of 11 different educational interventions were used by the researchers between the year 2016 to 2020.

Interpreting the findings

The next step was to interpret the findings based on the information obtained from Table 5, Table 6, and Table 7. It is found that intellectual disability was discussed and examined mathematics learning disability in ten of the included articles. Intellectual disability in mathematics includes mathematical problem solving and creative thinking. It was the most focused learning disability in the year 2017, 2018 and 2020 by the researchers. The researchers also focused more on the understanding of mathematical concept and foundation skills by the students with mathematics disabilities. 10 of the included articles have emphasized the learning disability of students in the understanding of mathematical concept in topics such as fraction, numeracy involving addition and subtraction and algebraic thinking.

Regarding the types of educational intervention, a total of 8 articles have discussed about using various methods related to technology tools-based lessons. Specifically, the researchers of those articles have used computer aided instructional materials, video prompting, and tablet-PC games to help certain types of mathematic learning disabilities faced by the students. Gesturing process and mathematical instructional approaches were also used as the interventions in about 8 articles. Every included article has discussed about research findings based on mathematics learning disability and educational interventions used. Table 8 shows the summary of the included articles based on the name of the researcher and findings (Yuzie et al., 2021).

Table 8: Summary of findings of included article

Researcher	Year	Findings
Baglama et al.	2017	Many special education teachers responded that mathematics skills can be taught more effectively by using technology where Technology really facilitates to teach mathematical concepts and skills.
Jiménez-fernández	2016	An efficient method of intervention in learning disabilities should include an explicit teaching of different strategies, which regularly strengthen the acquisition of each step; telling the child how to proceed and use strategies of problem solving; proposing significant problems to the student which have different semantic structures.
Ewing	2016	Students were found to be highly engaged and enthusiastic about math activities. Attention spans and levels of disengagement improved.
Hord et al.	2016	Participants seemed to benefit from their own use of gestures while thinking and communicating about mathematics as well as from observing the tutors' gestures when the tutors were explaining a concept.
Mckissick	2017	Students who received SMM with fidelity produced significantly higher mathematics achievement gains than students who did not receive the recommended usage of the treatment.
Jimenez & Stanger	2017	Evidence-based practice in mathematics for students with disabilities has demonstrated the positive impact of concrete manipulatives to support math understanding.

Fred Spooner et al.	2017	Incorporates evidence-based practices for teaching mathematics to students with severe disabilities.
Tian & Siegler	2017	Interventions have greatly improved the fraction knowledge of U.S. children with MD. These successful interventions put great emphasis on representing fraction magnitudes with number lines.
Michael J. Orosco & Naheed A. Abdulrahim	2017	Mathematics is More Than Numbers, Endowing Children with Linguistic Mathematics Capital, and Mathematics Comprehension Is a Cognitive Adventure. The participant was able to provide instruction that promoted student's word problem solving development.
Diane M. Browder et al.	2018	Students' generalized skills to the real-world problems showed improvement. Six out of eight participants completed the intervention and mastered the problem solving steps for all problem types.
Ikhwanudin & Suryadi	2018	Students with mathematics learning disabilities performed two mental acts with corresponding ways of understanding and ways of thinking; those are interpreting and problem-solving.
Mutlu et al.	2019	Individual had a positive effect on counting skills of students with MLD, they made progress in understanding the concepts of units and tens place values and the students could perform addition. There was a considerable increase with students' problem-solving speed.
Freeman-green et al.	2018	Recognize the continued need for specialized instruction for students with LD as they progress through the upper grades.
Dueker & Cannella-malone	2019	All three students improved their accurate completion of addition problems immediately upon introduction of the video prompting intervention.
Bessoondyal	2017	Data obtained from pretest and post-test and observations conducted through the training sessions have shown that this strategy training has been effective in helping children with learning difficulties in mathematics in problem solving. It has also helped these children to develop a positive attitude towards mathematics and have successful experiences with mathematics.
Özkubat et al.	2020	The findings of the study revealed that 'Solve It!' was effective in teaching mathematical problem-solving skills for students with special needs.
Hord & Saldanha	2020	When the tutor supported the student with gestures, verbal instruction, and managing his work on paper, the student was able to make some progress.

Lei et al.	2020	The results showed that kinesthetic and linguistic scaffolds were the most beneficial for helping ELs with LD to cultivate mathematical thinking with both concrete and abstract units, while also helping to increase the sophistication of their mathematical content-language usage.
Ngiamsunthorn	2020	This study discovered that an adequate use of challenge-based learning, problem solving process, project-based learning, well-designed questions, and in-depth learning style in the classroom effectively fostered their insightful and creative thought.
Sabaruddin et al.	2020	The result indicated that mathematics learning for students with autism as performed in inclusive education was different from regular education programs, in which teachers were required to adjust materials with students' psychological condition.
Hord & Dejarnette	2020	The tutors reported positive experiences in the program including learning from field experience and, learning to promote the progress and learning of students with learning disabilities using gestures and strategic questioning.
Sari	2020	Increase in both estimation precision and mathematics achievement of the experimental group. The games played during the experimental process not only helped in teaching the spatial representation of magnitude, but they also led to an improved mathematics achievement.
Yazcayir & Gurgur	2020	Students with special needs could not follow the lessons on TV regularly, many of them did not attend online lessons, and their teachers did not give feedback about their activities. The findings have indicated that children were unwilling and unable to adapt to distance education.
Nagar	2016	The research findings support and indicate the importance of coordinating an analysis of the pupils' errors and the choice of a didactically adapted teaching strategy. The current study is thus innovative in examining the use of conceptual and procedural mathematical knowledge by the preservice teachers and the teacher.
Griffin et al.	2018	Study findings suggest that Prime Online positively influenced general and special education teachers' reported beliefs and practices, and their learning of mathematics content for teaching, and generated high teacher satisfaction ratings.
Foreman-murray & Fuchs	2019	Results indicated a significant moderate correlation between accuracy and explanation quality.

Hughes	2019	All three students favorably maintained the skills after the completion of the intervention (n = 2, 100%; n = 1, 80%), however, performance decreased when transferring skills to word problems (n = 2, 40%; n = 1, 0%). Overall, the intervention appeared to be effective to teach.
Hwang et al.	2019	We also found that each intervention incorporated several instructional strategies (i.e., scaffolds) to support students through the cognitive process of problem solving.
Eichhorn	2016	The results suggest that current special education policies and college practices in Mumbai do not prepare students with math learning disabilities with the math knowledge that they need to succeed in post-secondary mathematics courses.
Kitchens et al.	2016	There was a significant difference in math achievement from pre- to post-test scores for students with learning disabilities who participated in the Cover, Copy, and Compare treatment, $t(14) = -15.09, p < .001$.
Dibbs et al.	2020	Although both mathematics and special educators used student-centered and collaborative techniques to encourage students to share algebraic reasoning, students with mathematics difficulty and disability struggled to participate meaningfully, and directions for further critical work in algebra are specified.

Discussion

The findings differ between researchers based on the identified mathematics learning disabilities and educational interventions. Table 9 shows the different types of educational interventions used for common mathematics learning disabilities.

Table 9: Different types of educational interventions used for common mathematics learning disabilities

No.	Mathematics Learning Disability	Educational Intervention
1	Intellectual Disability	Physical math manipulatives Schema-Based Instruction (SBI) Culturally Responsive Professional Development Cognitive Strategy Instruction (CSI) Mathematical Instructional Approaches Technology-based lessons
2	Mathematical Concepts and Foundational Skills	Technology based lesson Numerical understanding Mathematical Instructional Approach Gestures and verbal instruction Quality of explanation
3	Cognitive Performance	Gesturing process Mathematical Instructional Approach Use of conceptual and procedural knowledge

Table above presents three most researched mathematics learning disabilities in all the included articles. It shows that the educational interventions used vary among the researchers depending on the effectiveness and characteristics of the participants chosen for the study. The types of mathematics learning disabilities and educational intervention are explained further in the next sections.

Types of mathematics learning disabilities

Researchers have identified and discussed about students with different types of mathematics learning disabilities between the year 2016 to 2020. Majority of the researchers designed educational interventions for students with intellectual disability in mathematics and understanding of mathematical concepts and foundational skills. Baglama et al. (2017), found that if children with special needs are given the opportunities to learn mathematics, their conceptual understanding and ability to transfer knowledge is increased. While, Tian and Siegler (2017), argue about the conceptual understanding of fraction that students with mathematics learning disabilities lag behind in numerous aspects of fraction knowledge, including comparing and ordering fractions, estimating fraction magnitudes on a number line, performing fraction arithmetic calculations, and solving word problems involving fractions. Likewise, Ikhwanudin and Suryadi (2018), found that many teachers in the inclusive school stated that fractions were one of the topics that difficult to teach, especially for students with mathematics learning disability. It is explained that students with mathematics learning disability face difficulty learning numerical concepts, and the concept of numbers. Understanding concepts involves making connections between ideas, facts, and skills and the metacognitive process of reflecting upon and refining that understanding (Freeman-green et al., 2018).

Intellectual disability is also mainly discussed by the researcher, and it includes problem-solving skill and creative thinking of the students as mentioned earlier. According to Stanger (2017), many students with severe disabilities may not master the early numeracy skills (number recognition, set making, and patterning) due to slow developmental progressions, but more often due to a lack of experiences or exposure within their education. Problem-solving is an individual's ability to better understand and use text, numeracy and calculation. Spooner et al. (2017), also reported that for students with severe disabilities, the ability to apply mathematical problem-solving skills to a job, during leisure activities, or in independent living situations, will build independence and lead to a greater quality of life. Meanwhile, Orosco and Abdulrahim (2017) argued that students with MLD are often unable to learn to problem solving because word problems are unforgiving in terms of the constant need to build specific working mathematics and English knowledge that is dependent on reading comprehension. Despite the importance of problem solving, research on mathematics for students with moderate intellectual disability (moderate ID) has primarily focused on computation with limited attention to teaching students when or why to apply skills (Browder et al., 2018).

According to Jiménez-fernández (2016), mathematical learning disabilities are also called dyscalculia that is, difficulties in the production or understanding of quantities, numerical symbols or basic arithmetic operations. This is consistent with the statement in Mutlu et al.'s (2019) studies saying that dyscalculia is a difficulty in learning or comprehending arithmetic and it is a common term especially used to describe the lack of mathematical skills related to arithmetic and solving arithmetic problem. The researchers have also found that students with mathematics learning disability also encounter low or moderate cognitive performance level. Mckissick (2017), argued that students with low cognitive performance level underperformed on yearly progress in mathematics relative to their non-disabled peers. Students with LD often struggle with working memory (i.e., processing, storing, and integrating more than one set of information) as well as cognitive and metacognitive processes such as effectively processing, diagramming, and solving multi-step mathematics problems (Hord et al., 2016).

Educational Interventions

The researchers have discussed about multiple educational interventions and its effectiveness on helping students with mathematics learning disabilities. Technology-based lesson has been the most preferred intervention by the researchers. Regarding this, Baglama et al. (2017), reported that technology-based lesson really facilitates to teach mathematical concepts and skills. For example, steps

for making four operations and problem solving can be very easily visualized and simplified with technology. Likewise, Mutlu et al. (2019) found that technology based interventions hold great promise for the development of academic performance of students with learning difficulties and today technology has become a valuable tool. It is also stated that most of the mathematical concepts are abstract concepts which require a high-level cognitive activity. It is possible to explain and stimulate most of these concepts with computer technologies.

The findings show that the researchers used physical mathematics manipulatives to the students with mathematics learning disability. Ewing (2016), reported that students were found to be highly engaged and enthusiastic about mathematics activities. This is found to be consistent with Stanger's (2017) study reporting that teaching numeracy skills with the use of concrete manipulatives facilitate student learning. Many researchers have reported findings based on Schema-Based Instruction (SBI) as one of evidence-based educational interventions for teaching mathematical problem solving to students with high-incidence disabilities. Premade graphic organizers should be provided for each problem type that includes visual supports (Spooner et al., 2017). Meanwhile, Browder et al. (2018), reported that SBI has been shown to effectively teach word problem solving of all problem types to students at risk of mathematics difficulties or those with high incidence disabilities. In this article, students not only learned to solve word problems by following the 12-step task analysis but also acquired the complex skill of discriminating between three problem types (i.e., group, change, compare) that included two operations of addition and subtraction.

Gesturing process had been discussed by few researchers in helping students in the understanding of mathematical concept and to improve their cognitive performance. Gesturing, which is any physical motion (e.g., hand waving to indicate motion, pointing and moving the pointer finger, etc.), can be helpful for students in the context of mathematics learning. Students often benefit from their own use of gestures, and use of gestures by their teachers, when they are thinking through problems because gesture can convey meaning without requiring an overwhelming number of cognitive resources. Gesturing is potentially, very beneficial regarding math interventions for students with LD (Hord et al., 2016). Hord and Saldanha (2020) again reported that the use of gestures (e.g., hand movements to draw attention to [or show the relationship between] problem elements) by both teachers and students seemed to support students with mathematics learning disabilities on concepts.

The researchers found mathematics instructional strategy as an effective educational intervention as well. Success Maker Mathematics is initial placement assessment designed to identify grade level skills, provide immediate feedback and provides instructional scaffolds on an individual basis by McKissick (2017). Ikhwanudin and Suryadi (2018), reported that students with math learning disability needs mathematics instructional strategy as they could not develop other mental acts like explaining or inferring. They cannot use the other strategies like a benchmark or residual which demands the ability to infer and explain. Students with MLD understand fraction procedurally. Meanwhile, Freeman-green et al. (2018) argued that students who have struggled in mathematics has shown that explicit instruction is highly effective at increasing academic performance.

Other than these educational interventions, Orosco and Abdulrahim (2017) have argued that culturally responsive special education provides teachers with the support needed to implement evidence-based mathematics practices and interventions with student's cultural and linguistic experiences to help them in problem-solving skills. In addition, this conceptual framework prepares special education teachers to make a concentrated effort in classrooms to incorporate students' cultural and linguistic experiences with authentic student-centered learning activities. Tian and Siegler (2017), reported about the use of conceptual and procedural mathematical knowledge in helping students with mathematic learning disability on understanding fraction. The importance of understanding fraction magnitudes, especially using number lines to represent magnitudes, is emphasized because its authors also viewed understanding fraction magnitudes as fundamental to understanding fraction arithmetic and mathematics more generally.

Conclusion

The study was carried out to identify the types of mathematics learning disabilities faced by the students and the educational interventions that had been used to overcome the problem. It can be concluded that intellectual disability and the understanding of mathematical concept is the most faced by the students mathematics learning disability. These students lag the normal peers in mathematic achievement and they need initiate more efforts as it was caused specifically by the two types of learning disability mentioned above. Eichhorn (2016) also agrees to this by saying that students with mathematics learning disabilities (MLD) reported having to study harder and longer than their peers. The inadequate knowledge of the teachers regarding student MLD can also impact the learners in creating negative feelings and attitude towards learning mathematics (Kunwar et al., 2021).

In regard of this, these special need students should be introduced by the teachers to a very well improvised educational interventions which will increase their mathematics achievement. It is also found that teachers should adjust their pedagogical way of teaching by using educational interventions such as implementing technology-based lessons, effective mathematic instructional approaches, cognitive strategies, and physical math manipulatives. Effective educational interventions have positive impacts on the students with mathematics learning disabilities. Therefore, special education teachers should apply educational interventions that are appropriate for the students with mathematics learning disability to provide them a good quality of education and to meet the individual needs of learners without discrimination (Ikhwanudin & Suryadi, 2018).

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