

The Use of Learning Aids for *Dyscalculia*: Systematic Literature Review

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ABSTRACT

The aim this study to analyze learning aids that can improve understanding of mathematics in *dyscalculia* children. Systematic literature review became the method in this study. This article reviews 13 articles involving more than 4939 subjects and respondents. We reviewed articles published from 2010 to 2021 from the Sage, SpringerLink, Taylor&Francis, and Wiley Online Library databases. All articles were classified by year, research approach, research objectives and strategies offered for *dyscalculia* children. The selection of articles found the use of manual tools and the use of technological aids. The results of the review analysis showed that learning with the help of technology had a greater impact on the learning outcomes of *dyscalculia* students. This research study is limited to mathematics learning aids for children with *dyscalculia*, therefore further research is highly expected on mathematics learning aids for children who have other privileges.

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1. INTRODUCTION

Learning is an activity that must be followed by students. Learning has an important role in providing knowledge about happen around the world (Metikasari et al., 2019) Empirical knowledge is acquired based on experience and observation rather than on accepted policies (Awan et al., 2021; Hidalgo et al., 2022). Early in growth, children learn through what they see. Over time, a child's growth and development is determined by the supportive environment and innate abilities they have. Each child experiences a different period of cognitive development (Houdé, 2019) Children's cognitive abilities are also very varied so that later become their determinant when starting to learn at the formal level.

The cognitive abilities of pre-school children greatly determine their proficiency in a variety of subjects, especially mathematics (Amiyani, 2019) Most people agree on the importance of understanding mathematics to achieve success in life. That cause mathematics is the initial foundation for practicing how to think and how to understand knowledge. Mathematics is

considered the initial foundation of the development for science, technology, thinking and practicality in life (Huang et al., 2012). Early-stage mathematics became the foundation for elementary school that would lead them all the way to the middle and college stages (Atanasova-Pachemska et al., 2015). If their foundations are not strong then it is very likely that the children will have difficulty in expressing the knowledge they should have.

Cognitive in children is an important indicator when developing potential in the field of formal and non-formal education. Good cognitive ability will determine performance in mathematics (Miranda, 2018) Cognitive function in children is in the form of remembering, understanding, applying, analyzing and evaluating (Shuhaimi, 2020) Cognitive children will have a big effect on their ability to understand various subject matter in school (Strenberg, 2020) If a child's cognitive function cannot be developed properly it is very risky to poor long-term outcomes (Chen et al., 2020; Deoni et al., 2022). Thus ending children's difficulties in understanding mathematics.

Children's difficulties in learning are influenced by the weak factor of their ability to process the information presented, or difficulty when developing things that have been learned before (Nation, 2019). Various difficulties encountered in children include dyslexia, namely difficulty in spelling even though it has been taught repeatedly (Snowling et al., 2020) dysgraphia which is the difficulty of children when writing (Protopapas & Parrila, 2018) and *dyscalculia* which is the difficulty in understanding basic mathematical concepts such as numbers and arithmetic (Deruaz et al., 2020).

Dyscalculia is a learning inability directly related to genetics, affecting many things such as difficulty in remembering, understanding and processing numbers (Castaldi et al., 2020; Rohizan et al., 2020) *Dyscalculia* children have difficulties in various aspects of mathematics such as difficulty understanding the delivery given by teachers, they also have a limit in understanding (May & Ahmad, 2021) difficulties that can be caused by limitations in managing memory. Students who experience *Dyscalculia* have difficulty understanding various mathematical concepts, if the mathematical concept is not mastered properly it will be fatal in solving various mathematical problems. Teachers need special treatment to assist children with *dyscalculia* in understanding various mathematical materials.

Difficulties in learning are also influenced by intelligence levels, family, learning interests, emotional states and other factors (Ellinor, 2019) As research conducted by Liang shows that children with learning difficulties have lower levels of intelligence than normal children (Liang & Li, 2019). Two out of three populations in schools have such difficulty in arithmetic that students need to relearn (Williams et al., 2015). Difficulty understanding mathematics is often encountered in elementary to advanced students (Lambert, 2019) The factor of them to care in mathematics is caused by abnormalities in parts of brain that do not function like children normally (Cheng et al., 2018; Mammarella et al., 2021). Based on the factors experienced by most students will encourage education practitioners to find a way out.

Alternative education practitioners in helping to understand mathematics in *dyscalculia* students in the form of creating interesting and fun learning (Baccaglini-frank & Maracci, 2015; Menon et al., 2021) As research has shown the most effective options to help the learning process of children *dyscalculia*. Interesting learning is learning that able to invite students to think without any sense of compulsion and able to do whatever that their responsibility in learning (Williams et al., 2015). Fun learning includes learning that brings the classroom atmosphere to life, all students are actively involved in the thought process and working on assignments (Masturin et al., 2021).

Many studies have covered, described, and examined things related to *Dyscalculia*. This study focuses on systematically reviewing previous research on *dyscalculia*, from this study will obtain the tools that are most often used and can help the mathematics learning process of *dyscalculia* children. The research that is the focus of this paper is a study that describes learning to deal with children with *dyscalculia*. The application of learning style is in the form of applying models, using simple tools and applying various technologies (So, 2013).

The formulation of research questions in this paper refers to an article written by Slamet Sucipto that discusses the design of *Self-Adaptive* needs, summarizing research trends, modeling methods used and the most obvious topics (Satria et al., n.d.). The purpose of the study was to punch literature that provides *Dyscalculia* children or children who have difficulty in understanding mathematics as a subject with various learning alternatives that can help their learning process. To summarize the goal the author describes it into 3 sub-goals. The first, identifying various research sources to review liveliness in developing *dyscalculia* child-specific learning. The second, identify learning alternatives that are often used to provide information on what methods are most appropriately applied in helping *dyscalculia* children's learning process. The third, identify research trends to adapt the ideas and developments of technology used in learning. The research questions consist of RQ1: When was the research done?; RQ2: Who is the subject of research?; RQ3: What approach is used to research?; RQ4: What tools are used?; And RQ5 : What strategy is best used?.

2. METHODS

Literature review is a scientific work that describes certain knowledge that includes substantive findings in the form of theoretical and methodological contributions. Information reviewed from primary research depends on review questions and conceptual frameworks (Hammersley, 2020). The stages of a systematic literature review consist of searching primary data from a database that is relevant to certain criteria, the study selection process by analyzing the article as a whole accompanied by a bibliography, coding studies to answer research questions, determining the feasibility of the primary study with research questions, synthesizing data findings to integrate information generated from article analysis (Newman & Gough, 2020). Coding studies by making research boundaries, determining inclusion and exclusion to obtain research quality and relevance in accordance with research objectives. Analyzing research results from primary data to answer research questions (James et al., 2012).

Literature regularly reviewed the choice in completing this research. The literary method use identify, assess, and interpret all findings on research topics. This is for answer all research questions that have been prepared before. The initial stages carried out in this research process are in the form of collecting as many writings as possible for analysis, then establishing inclusion and exclusion criteria so that the discussion of research is more focused. Then the findings are analyzed one by one to summarize the various findings presented in these writings.

2.1 Search Strategy

The process of searching and selecting ilmiah articles related to learning strategies for *dyscalculia* children was obtained from the journal index in the publisher database Taylor & Francis (571), SpringerLink (708), Wiley Online Library (578), and Sage (371). Literature searching uses the keywords "*dyscalculia*", "*mathematics learning difficulties*", "*mathematics difficulties*", and "*learning strategies for dyscalculia children*". This article was collected from November 1, 2021 to November 10, 2021. Based on the search strategy, the selected 465 discussed learning strategies for *dyscalculia* children.

2.2 Inclusion and Exclusion Criteria

Eligibility criteria are required in choosing to obtain the results of an analysis that answers research questions. Articles are filtered based on inclusions and exclusions that are limited by the author. The selection of written works that meet the requirements i.e. articles, but for the types of chapter books, theses, short reports, studies and non-empirical articles, and non-English papers are removed from collection. In other words, only scopus indexed articles are collected in this analysis. This selection aims to get the results of an analysis that is able to represent various problems during the process of teaching *children dyscalculia*. In this case, 411 articles were selected based on strategies used for children with weak learning abilities.

The determination of learning strategies selected in this study is: *computer base learning, serious game, working memory training, math game, hand on math and mobile app*. These strategies have been used and researched in various writings. This strategy gives better results. Then the analysis data is eliminated by paying attention to the scientific field analyzed. In this case eliminated 379 articles that discussed fields other than mathematics and studied learning difficulties for children other than *dyscalculia*. In the final stages 19 articles were removed because they were included in review literature research and meta-analysis.

2.3 Data Extraction and Analysis

After going through inclusions and exceptions resulted in 13 articles being used to meet the purpose of this study. Articles are thoroughly examined to explore and summarize the various information focused on the study. Based on the information required, the author considers several classifications and rites that are appropriate for the purpose of.

Tabel 1. Criteria of Inclusion and Exclusion

Inclusion Criteria	Exclusion Criteria
Written in English	Articles written in other languages
Published from 2010 to 2021	Published before 2010
Empirical research published in international journals	Types of chapter books, theses, brief reports, non-empirical studies
Related to use the learning strategi for <i>dyscalculia</i> children	Learning strategies for children that have learning difficulties other than <i>dyscalculia</i>
Learning mathematics	Learning other than mathematics

Extraction is structured to classify, analyze and synthesize articles that meet the criteria that have been prepared. So get the data with the best reculation. Learning strategies used for children who have the usual difficulties while learning math are eliminated, as the study focuses on children who have difficulty and are indicated *dyscalculia*.

3. FINDINGS AND DISCUSSION

Findings from the results of analysis and synthesis of related articles have been discussed before. Based on a systematic review obtained 13 articles that meet the requirements, namely strategies used in helping the learning process of *dyscalculia* children. It is based on the considerations and purpose of the research.

Tabel 2. Article Research

Studies	Purpose	Method	Result	Recommendations
(Stranghöner et al., 2021)	Investigate factors that affect academic performance	Qualitative	School settings and basic understanding are closely related to academic performance.	<i>Computer base learning</i>
(Hannant, n.d.)	Evaluate the efficiency of the diagnosis path and the selection of	Qualitative	There needs to be cooperation between medical and pendidikan in diagnosing	<i>Working memory</i>

	learning approaches			groupings and needs of students.	
(Alloway & Carpenter, 2020)	Determine the common ground between learning inability, working memory and behavior	Qualitative		Each child has below average working memory, as well as low scores in arithmetic, writing and spelling skills.	<i>Working Memory</i>
(Lu et al., 2020)	Detecting the effectiveness of abacus to basic arithmetic understanding	Qualitative		Students with abacus courses show better performance in arithmetic calculations and short-term memory	Using abacus aids
(Nas, 2021)	Develop an experimental science guidebook for children who have learning inadequacies	Qualitative		Guidebooks positively affect the conceptual understanding of children who have learning difficulties	Provision of guidebooks
(Kuzmina et al., 2019)	Estimating the effect of phonological processing on mathematical performance	Qualitative		Phonological processes have an effect on number recognition and mathematical performance.	Software utilization
(Lucangeli et al., 2019)	Investigate the impact of metacognitive training programs to improve arithmetic skills	Qualitative		The experimental group showed better accuracy in written calculations and digit transcription.	<i>Intervention psychoeducation</i>
(Naik, 2017)	Review after-college learning achievements using <i>powerpoints</i>	Qualitative		<i>Powerpoint</i> presentations benefit students with mild <i>dyslexia</i> and other learning difficulties	Use of <i>powerpoint</i>
(Shamir, 2017)	Detecting literacy progress with the increasing reach and number of electronic books	Qualitative		Groups guided through <i>ebooks</i> have better literacy than groups that don't.	Provision of <i>ebooks</i>
(Howard-jones et al.,	Diagnosing improved learning	Qualitative		Using neuro-science techniques and	Menerapkan game base learning (the

2015)	through technology by identifying neuroscience		concepts can develop the education and phycology sectors	number race)
(Cipora et al., 2015)	Diagnosing collaboration between Numerical Spatial Associations with technology	Qualitative	Students who have poor visuosptials are no different from students with visuospatial abilities.	Collaboration between Numerical Spatial Associations with technology
(Ekblad, 2013)	Defining neurodiversity for further study with a technological approach	Qualitative	The application of cognitive neuroscience may increase students' learning interest in educational thinking and practice.	Utilizing information technology in the learning process
(Butterworth & Laurillard, 2010)	Detecting ideas used to help <i>dyscalculia</i> children	Quantitative	Adaptive digital methods can strengthen understanding in counting numbers	Using digital (<i>Number Race</i>)

RQ1 when was the research conducted?

Many studies have been published from various databases, including research specializing in his studies of *dyscalculia*. Various approaches have been tried to make it easier for *dyscalculia* children to understand math. Various changes also berinofasi follow the times in helping children *dyscalculia* in learning mathematics. The plan aims to make *dyscalculia* children not too far behind normal children usually.

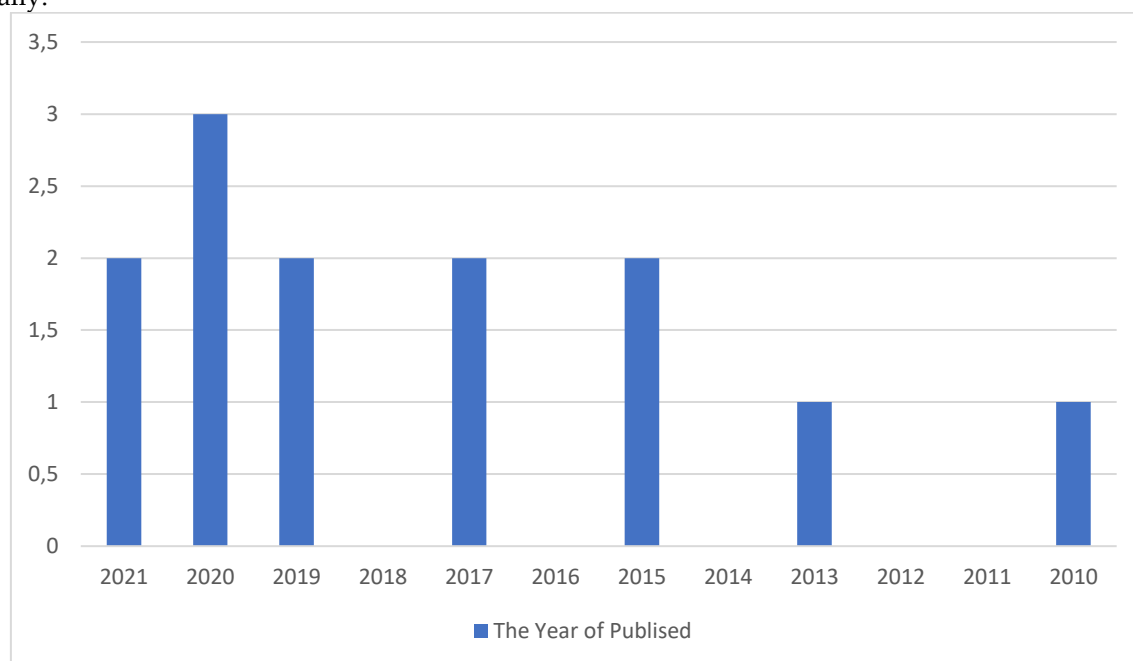


Figure 1. The Year of Publisled

From the table above shows that 2020 ranked the most among other years, this shows that there is more concern for the ability of learning goals for *dyscalculia*. Research on *dyscalculia* must continue to be created because every time it raises new obstacles in dealing with children who have privileges (May et al., 2021). Besides, technology also continues to develop as well as in use to facilitate the learning process.

Students with *dyscalculia* disorders need proper education to improve their various abilities, especially mathematics (Meral & Turnbull, 2014). Learning for *dyscalculia* children requires special and more intense attention in order to achieve maximum results (Yoong, 2020). The learning process also requires careful preparation, starting from diagnosing the disorders experienced by students, ascertaining the extent of their abilities, formulating the achievements that must be obtained and methods that are able to cover all these designs (Delgado et al., 2019; Luit, 2019)

RQ2 Who is the subject of research?

Scientific research compiled and published aims to inform the wider community who are struggling in a field of the latest findings about it. Each study selects a subject based on the goals to be achieved in its study. The selection of subjects becomes a big determinant of the findings that will be expressed in a study.

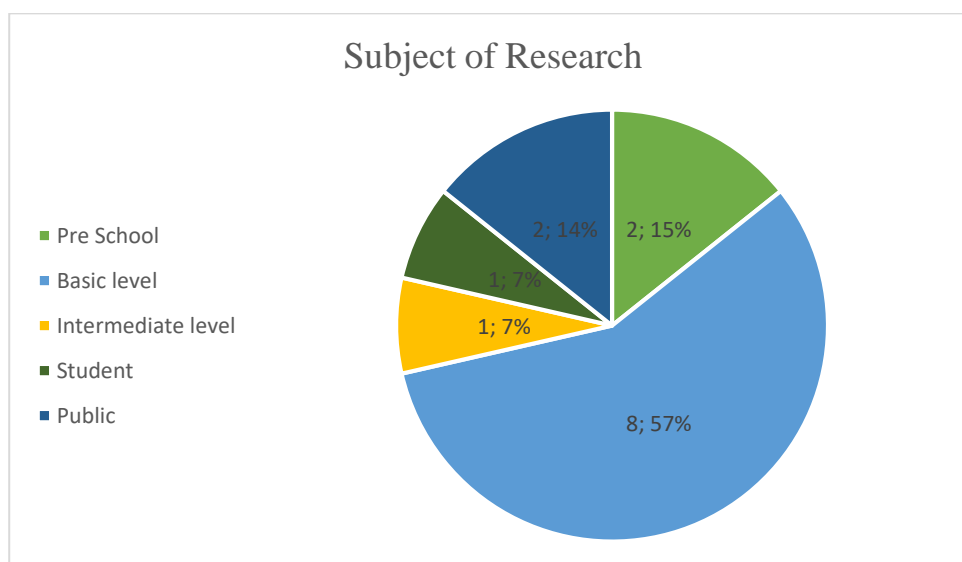


Figure 2. Subject of Research

Overall, those involved in the study were more than 4,846 subjects. Articles written by Paul Howard and Adina make preschool-age and elementary-level children a source of research under review. While Sibel Er Nas selected 5,6,7,8 graders as subjects, they numbered 12 students and the data was analyzed with case studies. Aside from these 3 studies, each writing focuses one level in the selection of analytical data sources.

The research objective is to show that studies on *dyscalculia* focus more on the general public. Studies for preschool and elementary level children are more needed because at this stage children are just starting to develop their cognitive abilities (Syah et al., 2016). So that special attention from an early age will make children's mathematical abilities better than being trained when they start to grow up (Bhatia et al., 2020). Children who are trained from an early age will get used to solving math problems. These habits will help them understand mathematics in depth.

RQ3 What approach is used to research?

The research approach is used to make it easier for researchers to gather information and guide writing to stay consistent. We found artikel analyzed with qualitative and quantitative approaches. The choice of methods is also very diverse by following the approach of each research.

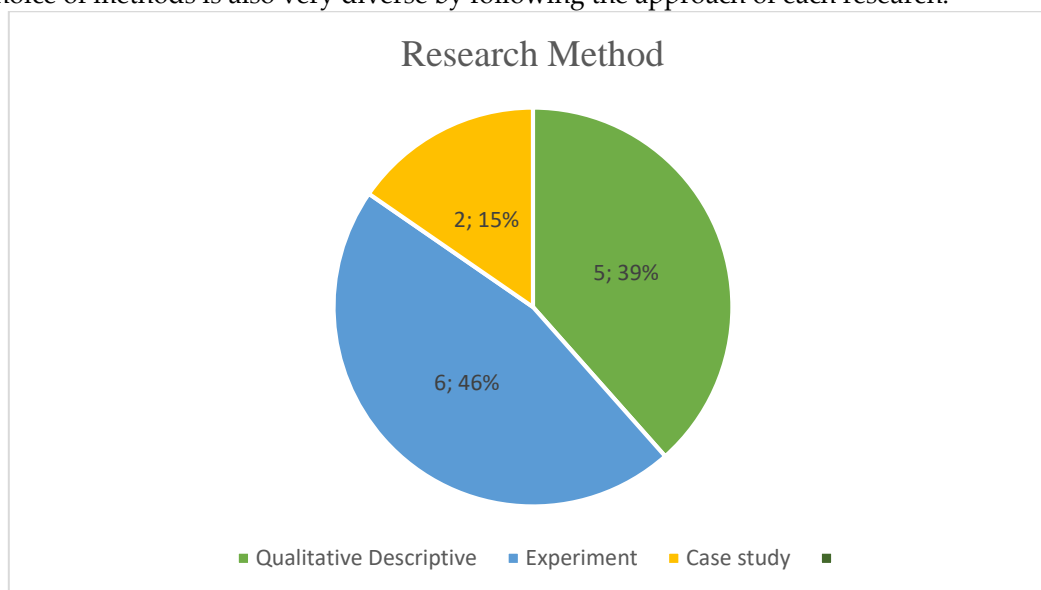


Figure 3. Research Method

Categorization based on the methods used in the 13 articles consists of 5 articles with qualitative descriptive, 6 articles that use experiments to process data and case study methods found as many as 2 articles. The approach used in the research will determine the acquisition of research results. Qualitative descriptive research can explain in detail how the conditions experienced by *dyscalculia* children when facing math problems. Experimental research has a real impact on the methods used to help *dyscalculia* children understand math materials and problems (Widodo et al., 2021). Research through case studies can also provide accurate results regarding the problems faced by children with *dyscalculia*. This is in accordance with research conducted by Lewis et al (2022) which revealed that through a case study he explored the difficulties experienced by the subject of *dyscalculia* in detail and thoroughly.

All approaches used can explain in detail about the best needs to improve the math skills of *dyscalculia* children. The existence of a detailed explanation, application of appropriate methods and data analysis will show the accuracy of the research results (Taherdoost, 2016). The results of this study will help further research to modify and apply it in different samples (Subakti et al., 2021). Besides, it can also be used by education practitioners to develop their classroom curriculum for *dyscalculia* children. The research that has been completed becomes a guide for creating new research with methods that may not have been done before.

RQ4 What tools are used?

The use of aids will facilitate the teaching and learning process. The use of technology in learning will make students more passionate about learning because technology usually provides a variety of interesting features that can make users enthusiastic to use it. Although learning technology has been very much developed, it also requires the role of teachers and parents to be more controlled and limited so that students focus on completing their tugas first and then doing other activities that utilize technology. In this study obtained 8 articles that choose a technological approach, the rest use simple tools in achieve the success of learning *anaka dyscalculia*.

Learning that utilizes technology has a big impact on the success of learning mathematics. Purwaningrum et al (2022) in her research states that digital modules help improve mathematical

literacy skills in *dyscalculia* children. Learning using technology will make teachers and students technology literate. Currently, the use of technology in learning is highly expected because through technology it will create fun learning so that students will not be burdened during the learning process (Schumacher & Ifenthaler, 2018). Good learning is able to create a comfortable class but still has a focus that will be achieved at the end. Learning achievement is strongly supported by a learning process that is in accordance with the child's condition (Boucher et al., 2014). A teacher must know the needs of students during learning, study the difficulties experienced by students during learning and focus students on goals that can improve mathematical abilities.

The ability to understand mathematics in *dyscalculia* children can also be improved with the help of simple aids or math teaching aids (Aprinastuti et al., 2020). Mathematics teaching aids can be created by teachers by utilizing simple materials and tools that are easily accessible. Using visual aids for *dyscalculia* children can lead them to see mathematics in real and form. This method will reduce the perception of students who think that mathematics is just counting abstract numbers (Khasanah et al., 2022). Such conditions will increase students' interest in learning mathematics without complaining about difficulties in understanding it.

Utilizing technology and simple teaching aids in learning mathematics will create a varied learning and teaching process (Samura, 2015). Varied learning eliminates student boredom in learning mathematics. Moreover, the boredom experienced by children with *dyscalculia*. *Dyscalculia* children with severe math difficulties really need special attention when solving various math problems (Ariyanti et al., 2020). The creation of varied learning and a little freedom can provide space for students to think. This allowance provides opportunities for students to explore themselves based on their respective abilities.

RQ5 What strategy is best used?

Technology is growing very rapidly along with the human need for ease in doing various things (Shneiderman, 2020). In addition to facilitating the work of the general public, technology also helps move the world of education to a better era. With technology-based learning makes students who are able to compete with the times. Students are able to access various things that will help them in doing project tasks or increase knowledge of what has been taught in school (Dorafshan & Maguire, 2018). Because teaching in schools is of course very limited, either because the class capacity is still relatively large or the time is very limited and the subject changes every hour.

Technology-based learning by utilizing software is very effective in improving the math skills of *dyscalculia* children (Kaur et al., 2018). Software used for learning can be accessed anytime and anywhere students need. The repetition of material by students can strengthen memory about what is being studied. Ease of access to materials and exercises gives students flexibility to choose when the material is understood again and when the exercise is completed within the specified time limit (Istikomah & Wahyuni, 2018; Molnár & Csapó, 2019). Giving leeway to students to solve math problems further helps them to analyze problems better and get better results.

Software created to help *dyscalculia* can be developed and evaluated based on needs (Dehghani, 2019). The choice of software depends on the material being studied and the abilities that students have. The selection of the right software can significantly improve understanding of mathematical material (Angel et al., 2018). Using software that is full of colors and pictures for children who are still learning mathematics at the elementary level. As for children who are in high school, introduce and use more elegant software according to the material they are studying.

4. CONCLUSION

Children who have difficulty in learning need special ways to make it easier to understand certain materials. The right strategy is the main choice that needs to be considered because every limitation that children have requires a different way to face it. With the use of technology makes learning more desirable by students, but on the other hand teachers must first understand how to

operate technology before teaching it. In this case training for teachers is needed so that the knowledge possessed thoroughly of everything learned.

This literature research has several limitations including analyzing the learning of *dyscalculia* children in the mathematical domain, such conditions may not necessarily be applied to other domains. Learning difficulties in this study only focused on children with *dyscalculia*, but for children who had difficulties in understanding mathematics, children who had other privileges also experienced learning difficulties. This literature review was conducted in 2021 and analyzed articles from 2010 – 2021. This study identifies the ability of special children in understanding mathematics. The privilege possessed by children with *dyscalculia* requires the right diagnosis to find therapy, therefore in the future it is hoped that collaboration between the fields of education and cognitive science will really help children who have the privilege to understand what is being learned. Research that examines the difficulties experienced by other special children is highly recommended in future research.

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