Trend of Mathematics Learning Research for Deaf Children in Indonesia: A Systematic Literature Review

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Abstract

Mathematics learning for deaf children is one of the many objectives to be achieved in fulfilling the mandate of Article 31 of the 1945 Constitution of the Republic of Indonesia. Moreover, it refers to the need for prompt and targeted interventions to support their mathematical education as a fundamental field of study that underpins problem-solving in all areas of life. This study is a systematic literature review that conducts content analysis on a number of research articles indexed in Google Scholar that have been published throughout Indonesia from 2013 to May 2023, with various aspects related to mathematics learning for deaf children as the focus of the study. The current study reveals that in the past three years, there has been an increase in the number of research studies focusing on mathematics learning for deaf children in Indonesia. Among these studies, the dominant research designs used are research and development (R&D) and quantitative research. The topic "Numbers" is the most researched material. Additionally, Elementary Schools and "tests" consecutively become the most commonly selected subjects and instruments. Meanwhile, Java Island, especially East Java Province, becomes the location where the majority of research studies are conducted. Furthermore, the development of instructional media has become the main focus of many studies. In light of these research findings, several recommendations have been proposed for future research related to mathematics learning for deaf children in Indonesia. Several suggestions have been put forward, such as increasing the diversity of research types and selecting more complex mathematics topics, as well as choosing research locations more evenly.

Keywords: deaf, mathematics learning, SLR

Introduction

Education as a citizen's right is enshrined in Article 31, Paragraph 1 of the 1945 Constitution of the Republic of Indonesia, which states, "Every citizen has the right to education." This article is supported by the subsequent statement in Article 31, Paragraph 2, which reads, "The government strives to establish and implement a national education system." (Herawati, 2016). Based on both paragraphs, in line with (Linda & Muliasari, 2021) we can conclude that every citizen has the right to receive education regardless of their social, economic, and physical or mental health conditions. In other words, children with disabilities or differences also have the same right to receive education (Yuniawatika et al., 2016; Irfan et al., 2018; Sumartini et al., 2020). For example, for those who do not have complete limbs like most people, or other deficiencies that affect a child's intelligence due to various factors before or after birth or commonly we call children with special needs.

One type of child with special needs is a deaf child. Deafness is a condition characterized by hearing loss that causes an individual to be unable to perceive various stimuli, particularly through their sense of hearing (Somantri, 2018; Septiyani et al., 2021). The limitation of deaf children in receiving auditory information hampers their cognitive development. According to Keith Mousley and Ronald R. Kelly (1998), the difficulties encountered by deaf children can hinder their capacity to acquire mathematical skills, specifically in the domains of mathematical communication and problem-solving. Consequently, The challenges experienced by deaf children lead to lower academic achievements (Azizah, 2018).

Mathematics is a fundamental field of study that underpins problem-solving in all areas of life (Mumpuniarti, 2011; Sahrina & Kusumawati, 2023; Putri & Juandi, 2022). It has well-defined rules, language, and clear and systematic reasoning between its concepts (Febrilia, 2019; Afriansyah et al., 2020). There is a widely held consensus that mathematics is a discipline that should be taught from an early age due to its crucial role in various aspects of life, including the home, workplace, and society (Alifulloh, 2016; Rahmi & Musdi, 2017; Milkhaturrahman et al., 2022; Hikmah & Saputra, 2023). Therefore, children with special needs, including deaf children, also require this field of study.

The limitations in auditory modality that hinder individuals from learning mathematics need to be addressed through various concrete and functional learning activities, or by mediating messages through the remaining functioning senses. This modification is referred to as special services (Alifulloh, 2016; Nisa et al., 2018). Similarly, when it comes to mathematics learning for deaf children, special services should be provided to facilitate their learning process (Suningsih & Arnidha, 2017).

One approach to enhance mathematics learning services for deaf children involves conducting research specifically focused on their mathematical education. In line with the research by I Kadek Yasa Sumalasia (2020) and Elsa Agustina & Moh Zayyadi (2023), research on mathematics learning for deaf is crucial due to several unique challenges involved. Furthermore, in researching mathematics learning for deaf children, researchers can develop instructional materials and teaching methods that consider these challenges and create more inclusive and meaningful learning experiences for the deaf. Research on mathematics learning for deaf children can also contribute to improving the quality of education in Indonesia and provide greater opportunities for them to reach their full potential (Margarita & Wahyuno, 2014).

In Indonesia, as of May 14, 2023, no literature review research specifically investigating the trends or developments in mathematics learning research for deaf children in Indonesia has been found in the accredited SINTA Kemendikbud journals of Mathematics Education and Special Education. Therefore, the purpose of this study is to gather information on diverse studies that explore the topic of mathematics learning for deaf children in Indonesia by conducting content analysis on several research findings in mathematics education and special education published in Indonesia from 2013 to 2023.

This research seeks to offer comprehensive insights by addressing the following questions: (1) How has the number of research studies on mathematics learning for deaf children in Indonesia evolved over the years? (2) What is the diversity of research designs used in studies on mathematics learning for deaf in Indonesia? (3) Which topics most frequently emerge in research on mathematics learning for deaf in Indonesia? (4) Which educational levels are predominantly studied in research on mathematics learning for deaf in Indonesia? (5) What instruments do researchers utilize in their studies on mathematics learning for deaf in Indonesia? (6) Which locations are most commonly featured in research on mathematics learning for deaf in Indonesia? (7) What is the focus of research conducted by researchers on learning mathematics for deaf children in Indonesia?. These inquiries serve the purpose of collecting essential data within the analyzed research. Furthermore, these questions aim to shed light on the landscape of research concerning mathematics learning for deaf in Indonesia. This includes aspects such as the quantity of research conducted, research methodologies employed, specific mathematical topics explored, educational levels examined, research instruments utilized, research locations, and the primary focus of the conducted studies.

In several aspects, this research differs from previous studies that focused on mathematics learning for deaf children. First, this research is focused on all the articles indexed in Google Scholar that have been published from 2013 to 2023. Second, this research is specifically aimed at investigating a number of articles on mathematics learning with a primary focus on deaf children in Indonesia. Third, several parameters serve as the foundation for content analysis.

Method

Research Design

This research is a Systematic Literature Review (SLR) that adopts the principle of content analysis focuses on examining findings from various research results published in scientific journals and university repositories in Indonesia indexed by Google Scholar. SLR is a method used to comprehensively and objectively synthesize scientific evidence in order to address a specific research question. It aims to provide a transparent and reproducible approach by including all relevant published evidence on the topic and evaluating the quality of this evidence (Lame, 2019). The research methodology employed in this study shares similarities with the approach used by Fauzi and Pradipta (2018).

Data Source

The data for this study was collected through content analysis of articles in the field of Mathematics Education and Special Education. All articles were retrieved from research conducted in the field of Mathematics Education and Special Education, which were indexed in Google Scholar. The process involved using the Publish or Perish 8 software and considering several inclusion criteria, including: (1) The research was conducted between the years 2013 and May 2023. (2) The research was carried out in Indonesia. (3) The research focused on mathematics learning for deaf children. (4) The research clearly stated the specific mathematical topics investigated and the educational level of the subjects involved. By using the keywords "Mathematics, Deaf, and Ability," a total of 46 published articles were identified. After applying the inclusion criteria, 37 articles were selected for analysis in this study.

Research Instruments

To obtain data that aligns with the research objectives, an instrument or inclusion criteria are necessary (Arianti & Juandi, 2022). The instrument used in this study is a content analysis guideline that includes relevant observed aspects adabted from Fauzi & Pradipta (2018). These aspects include: (1) the number of publications per year; (2) the type of research; (3) the selected mathematical topics for the study; (4) the research subjects; (5) the data collection instrument; (6) the research location; and (7) the research focus. Exceptions were made for aspects (1) and (7) in which predetermined categories were not established initially. This was due to the lack of previous studies available as references to determine the appropriate inclusions for these categories. Additionally, for aspect (6), the intended categories are the provinces in Indonesia. Furthermore, categories

for aspects (2), (3), (4), and (5) were predefined prior to data collection. These categories are presented in Table 1.

Table 1. Aspects and Categories used for Content Analysis in this Research

Aspects	Categories	
Types of Research (2)	A.1- R and D	A.4- Quantitative Research
	A.2- CAR	A.5- Mix Method
	A.3- Qualitative Research	
Mathematical Topics (3)	B.1- Numbers	B.3- Geometry
	B.2- Algebra	B.4- Statistics & Probability
Research Subject (4)	C.1- Elementary School	C.3- Senior High School
	C.2- Junior High School	C.4- College
Data Collection Instruments (5)	D.1- Questionnaire	D.4- Interview
	D.2- Documentation	D.5- Observation
	D.3- Test	

Data Analysis

Each analyzed article is classified into specific categories based on predetermined aspects. The classification of article categories is determined by the information provided by the authors in the abstract, methods, and discussion sections of the research articles. Subsequently, the collected data is presented in the form of bar charts.

Results and Discussion

Number of Publications

The number of publications indicates the frequency of research conducted within a specific period. Based on the graph shown in Figure 1, articles discussing mathematics learning for deaf children in Indonesia can be found from 2013 to 2023. There is no specific shifting pattern evident in the number of research studies from year to year. However, with reference to Figure 1, the number of research in 2022 increased significantly compared to previous years. The increasing trend in the number of research on mathematics learning for deaf children in Indonesia suggests a rise in the number of researchers investigating this field. Meanwhile, as of mid-May, only one research study has been published in 2023. It cannot be compared to the numbers of previous years as it has not completed a full year.
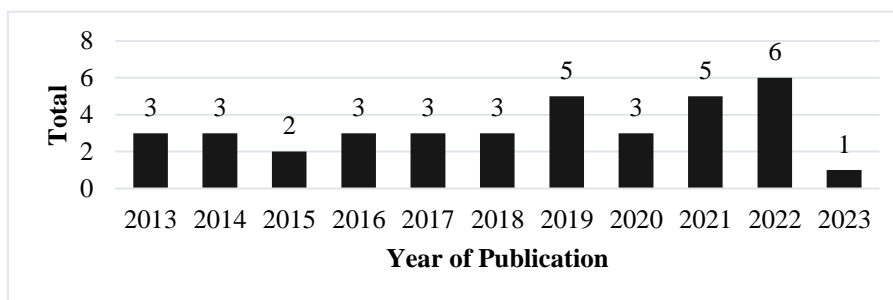
Figure 1. Trend of the Number of Research Studies on Mathematics Learning for Deaf Children in Indonesia from 2013 to 2023

Most research is motivated by researchers' concern for the issue of educational equality for children with special needs, which has been highlighted by the government in the constitution. One of the most prevalent problems today is the lack of attention to mathematics learning for deaf children. Learning is often done merely as an obligation without being accompanied by research-based efforts to improve its quality. Therefore, conducting research is believed to be the most effective way to address this issue.

Through research, Researchers can identify the instructional designs or media that are most effective and can optimally accommodate mathematics learning for deaf children. The more research conducted on mathematics learning for deaf children, the greater its positive impact on the development of education in Indonesia. This perspective aligns with Coburn and Penuel (2016), who state that the primary objective of research is to enhance educational practices.. Furthermore, research can influence educational practices for several reasons: (1) research findings can be considered credible information that teachers can implement, (2) it can provide a fundamental foundation for making educational decisions at various levels, including national, local, or specific institutional contexts, and (3) research findings have the potential to shape teachers' perspectives and thinking.

Types of Research

The type or research methodology influences the research focus. Based on Figure 2, R&D and quantitative research are the most commonly used designs by researchers investigating mathematics learning for deaf children in Indonesia. The higher number of quantitative research aligns with previous studies reporting that in the field of education, researchers tend to favor quantitative research designs over qualitative research (Mohajan, 2020; Uzunboylu & Asiksoy, 2014). Additionally, qualitative approaches are relatively new to educational research (Ulfatin, 2022). However, there has been an observed upward

trend in the use of qualitative research methods in the field, particularly in social research, including several educational issues (Mohajan, 2018). This trend is closely linked to the strengths of the qualitative approach, which allows for a detailed and comprehensive exploration of phenomena.
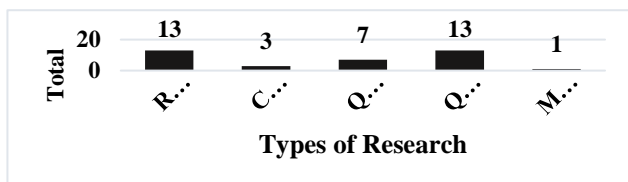

Figure 2. Distribution of Research Studies on Mathematics Learning for Deaf Children in Indonesia based on Research Types from 2013 to 2023

Furthermore, in accordance with Fauzi & Pradipta (2018), research and development (R&D) is also a widely used design in educational research. Developmental research represents one of the prevailing trends in educational research in Indonesia. In this type of research, researchers frequently create educational products based on their previous findings and developmental processes. These products can manifest as books, modules, or teaching materials (Sumalasia et al., 2020).

Mathematical Topic

Mathematics is one of the subjects that encompasses various topics. The topics in mathematics can be categorized into four groups according to the TIMSS standards, namely number, geometry, algebra, and statistics and probability (Prasetyo & Rudhito, 2016). Based on the content analysis of the selected research articles, the mathematics topics addressed represent a small portion of the aforementioned subject groups. According to Figure 3, a total of 25 studies focused on the topic of numbers, making it the most commonly studied topic in mathematics learning for deaf children. On the other hand, there was only one study on algebra, resulting in it being the least investigated topic. This is consistent with Sakiah & Effendi (2021), who state that algebra is an abstract mathematical subject and can be challenging for learners.
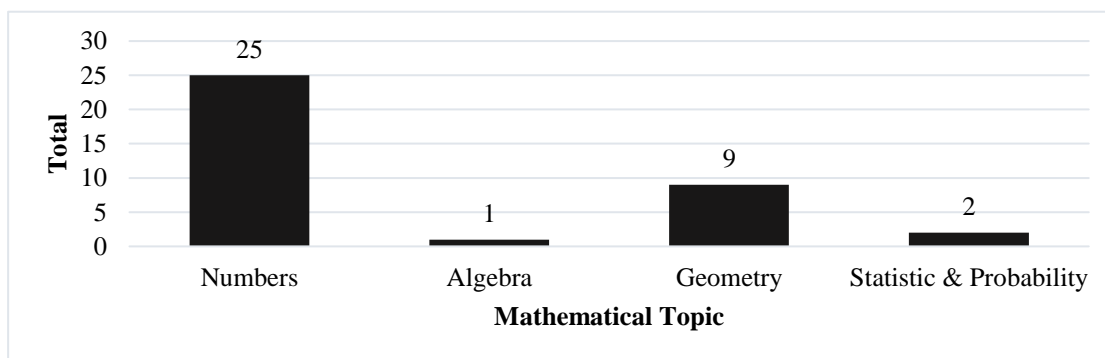
Figure 3. Trends in Mathematical Topics Explored in Research on Mathematics Learning for Deaf Children in Indonesia from 2013 to 2023

Specifically, the conducted content analysis also revealed specific mathematics topics. According to Table 2, the topic of whole number was the most frequently examined topic in research on mathematics learning for deaf children, followed by integers and fractions. Furthermore, although geometry was not the most extensively studied subject, the topic of plane figures emerged quite frequently.

Table 2. Frequency Distribution of Mathematical Topic Details in Research on Mathematics Learning for Deaf Children in Indonesia from 2013 to 2023.

Topics		Frequency	
Numbers	Whole Numbers	8	
	Integers	7	
	Fractions	6	
	Time Numbers	1	25
	Roman Numeral	1	
	Ratio	1	
	Social arithmetic	1	
Algebra	Algebra	1	1
Geometry	Plane figure	6	
	Solid Figure	1	9
	Curve Surface Solid	1	
	Pythagoras theorem	1	
Statistics and Probability	Statistics	2	2
Total		37	37

Research Subjects

Research on mathematics learning for deaf essentially aims to empower their mathematical education. Based on Figure 4, elementary school students were the most commonly selected research subjects, with a total of 20 studies. They were followed by junior high school students and senior high school students, with 15 and 2 studies respectively. Based on the content analysis, no research included college students as subjects in studies on mathematics learning for deaf children.
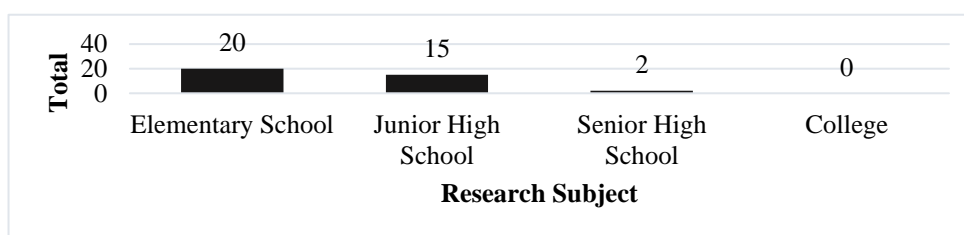

Figure 4. Trends in Research Subjects on Mathematics Learning for Deaf Children in Indonesia from 2013 to 2023

Looking at this trend, it is apparent that current research on mathematics learning for deaf children is predominantly concentrated at the lower levels of education, specifically elementary school, and gradually decreases as the educational level increases. This dominance correlates with the fact that mathematics topics taught in elementary school are relatively easier to develop in research. This aligns with Suryana (2012), who states that mathematics becomes more challenging as the educational level increases, making it increasingly difficult to facilitate research for deaf children at higher levels. Additionally, at higher levels of education, deaf individuals typically do not pursue math-related fields and tend to focus on vocational skills.

Data Collection Instruments

When conducting research, researchers rely on instruments to aid in data collection. In studies related to the development of mathematics teaching materials for deaf children, data can be gathered using various instruments previously developed by researchers. Multiple instruments can be chosen for data collection in a single study (Nasution, 2016). According to the graph depicted in Figure 5, tests are the predominant instrument utilized

for data collection in research focused on mathematics learning for deaf children. This finding aligns with the prevalence of research methodologies such as Research and Development (R&D) and Quantitative Research, which incorporate tests as one of the data collection instruments. Moreover, test-based data collection is considered more objective compared to questionnaires and observations.
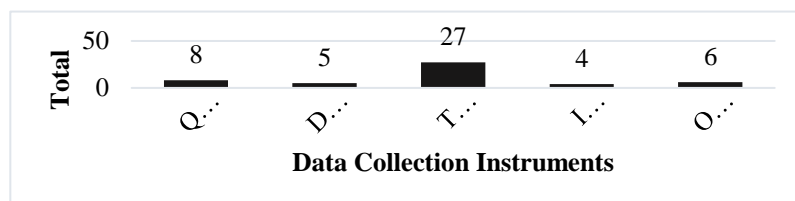

Figure 5. Distribution of Instruments Used in Research on Mathematics Learning for Deaf Children in Indonesia from 2013 to 2023

Research Location

The research location is an important factor in a study as it can influence the research outcomes. Selecting an appropriate research location can strengthen the validity of findings and broaden the generalizability of research results. Additionally, a strategic and relevant research location can assist researchers in collecting the required data and information. Therefore, researchers need to consider factors such as accessibility, representativeness, safety, and availability of facilities when choosing a research location that aligns with the objectives of the study.

Based on Table 3, it can be observed that research on mathematics learning for deaf children in Indonesia is not evenly distributed. In terms of islands, the dominance of research locations is primarily focused on Java Island. Furthermore, East Java province has the highest number of studies, with 13 research projects, followed by West Java in second place with 7 studies. This aligns with the research conducted by Dewi, Saingan & Fahmi (2022), which suggests that this trend is due to Java Island having more educational access and advantages compared to other islands. Meanwhile, based on the content analysis conducted, the eastern region of Indonesia has never been selected as a research location for mathematics learning for deaf children in Indonesia.

Table 3. Distribution of the Number of Research on Mathematics Learning for Deaf Children in Indonesia Based on Research Locations from 2013 to 2023.

Island	Province	Frequency	Total
Sumatera	Lampung	2	3
	West Sumatera	1	
Java	Jakarta	1	25
	West Java	7	
	Central Java	1	
	East Java	13	
	Yogyakarta	3	
Bali & Nusa Tenggara	Bali	3	7
	NTB	2	
	NTT	2	
Borneo	South Borneo	1	1
Sulawesi	South Sulawesi	1	1
Eastern Indonesia	-	-	0

Research Focus

One crucial aspect in the research process is determining the research focus. Research focus is of utmost importance in obtaining a deeper understanding of various topics and phenomena in different fields of study as it emphasizes the aspects to be investigated (Gumilang, 2016). The research focus provides the main direction for researchers to achieve optimal and relevant outcomes aligned with the desired research objectives. In mathematics education research, there are various research foci that can be explored to gain a better understanding of mathematics learning and teaching.

Based on Table 4, the most commonly researched focus in mathematics learning for deaf children is the development of instructional media. According to research content analysis, there are 10 studies that discuss instructional media development. In the second position, the frequently mentioned research focus is the use of media in mathematics learning, with a total of 7 studies. From the content analysis concerning the research focus in mathematics learning for deaf children, it is evident that instructional media receives the most attention, both in terms of media development and media usage.

Table 4. Detailed Distribution of Research Focus in Mathematics Learning for Deaf Children in Indonesia in from 2013 to 2023

No.	Research Focus	Frequency
1	Learning Design	2
2	Mathematical Communication	1
3	Mathematical Understanding	4
4	Learning Difficulties	1
5	Learning Methods	2
6	Learning Models	6
7	Learning Approaches	4
8	Use of Learning Media	7
9	Development of Learning Media	10
Total		**37**

The aforementioned findings align with previous studies, which have explored the implementation of mathematics learning for children with special needs in Indonesia. These studies have investigated various aspects, including subjects, educational levels, materials, student abilities, and research methods (Fitriani & Prahmana, 2021). This indicates an ongoing research trend in the field of mathematics education for deaf children in Indonesia, which is reflected in both the study aspects and the analysis results presented in this research. Notably, the emphasis on learning media, which has been a prominent focus in recent research, is consistent with the findings of Marschark et al. (2011). Their work highlights the efforts of cognitive science and educational research to explore innovative approaches for enabling deaf students to access mathematics.

Conclusion and Suggestion

In this study, articles highlighting mathematics learning for deaf children in Indonesia and published in Google Scholar indexed journals from 2013 to 2023 have been reviewed. A trend was found indicating an increase in the number of studies on mathematics learning for deaf children in the last three years (2020, 2021, and 2022). Among the numerous publications, research and development (R&D) and quantitative research were the predominant approaches employed. The material "Numbers" is the most chosen topic. Meanwhile, among the various educational levels, elementary school was the most frequently chosen subject for research. The test instrument is the most commonly used data collection tool. Meanwhile, the island of Java, especially the province of East

Java, is the location where research on mathematics learning for deaf children is most often conducted in Indonesia. In addition, the development of instructional media emerged as the most extensively research focus area.

Based on the findings of this study, several implications or recommendations can be derived for future research. Firstly, there is a need to enhance the frequency of research on mathematics learning for deaf children in Indonesia, with a particular emphasis on utilizing qualitative approaches. Secondly, the scope of meticulous mathematical topics should be expanded to include more complex material, in order to explore appropriate teaching methods for deaf children, including those at the higher education level. Thirdly, researchers should provide comprehensive and transparent information regarding their research instruments, including the assessment of validity and reliability. Lastly, it is recommended that research related to mathematics learning for deaf children be conducted in other regions of Indonesia, especially in eastern Indonesia to provide a more equitable representation of education for deaf children.

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