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# Mathematics Learning for Students with Special Needs

**Ediyanto Ediyanto[1*], Zulkipli Zulkipli[2], Asep Sunandar[3], Subanji Subanji[4], Nor W. Abdul Wahat[5], Dzintra Iliško[6]**

[1,3,4]Universitas Negeri Malang, Malang, Indonesia

[2]Sekolah Tinggi Teknologi Indonesia, Tanjungpinang, Indonesia,

[5]Universiti Putra Malaysia, Selangor, Malaysia,

[6]Daugavpils University, Daugavpils, Latvia

## Abstract

Learning limitations have mostly been observed among school-age children. Simultaneously, inclusive education does not only place students with special needs in the general classroom but also expect those students to be meaningfully involved in the curriculum and mathematics learning activities, along with their classmate. The current study purpose is to explore the mathematics learning strategies for students with special needs, primarily the students with vision impairment, autism, and hearing impairment. This study was carried out by selecting the 2011-2022 published scientific articles and categorizing them. The 17 selected articles focused on mathematics learning for students with vision impairment, autism, and hearing impairment. Following our review results, the recently available mathematics learning should be accommodate students with special needs by providing learning media and explicit instruction. Besides, the special education teacher can aid the mathematics teacher by informing the development stage, excellence, and weakness of each special needs student, while also helping formulate the most effective mathematics learning.

**Keywords:** Mathematics learning, special needs, autism, visually impaired, hearing impaired, learning modification.

## Introduction

The constraints of learning have been commonly observed in school-age children (Arpi & Ferrari, 2013; Farr et al., 2018; Spasojević et al., 2018). Hamzah, Maat, and Ikhsan (2021) argue that some students might difficult to involve concepts and symbols mathematic. In other hand, Jarrett (1999) expresses that most children with special needs also experience learning limitations. Generally, students with learning limitations face difficulties in hearing, talking, reading, writing, and thinking during the learning processes, including in mathematics learning (Amelia & Supena, 2022; Sun & Wallach, 2014; Whitney, 2022). In science and mathematics, students with special needs frequently encounter issues in computation, problem-solving, terminology, drawing a conclusion, and integrating their new and existing knowledge.

Similar to other children, the students with special needs also present complex and varied uniqueness. Further, the excellent intellectual capacity of some students with special needs is often overshadowed by their deficiencies (Mahmoud, 2021; Okyere et al., 2019; Schoop-Kasteler et al., 2022). Children with special needs often experience different learning conditions compared to regular children (Avramidis et al., 2000; Gartner & Lipsky, 1987; Gay, 2002). Therefore, mathematics teachers are obligated to ensure that the students with a special needs learn the learning and primary content similar to their regular classmates.

In recent decades, science and mathematics education and professional organization have imposed a higher standard for students, emphasizing the learning strategy that positions students to actively and independently learn. At the same time, inclusive education places students with special needs in the general classroom while also requiring them to be actively involved in the curriculum and mathematics learning, similar to their classmates (Fuchs et al., 2015; King-Sears, 1997; Oktaviani, 2022; Sukinah & Triadi, 2022). This high expectation is supposed to bring significant implications for students with learning limitations (Klingenberg et al., 2019; Sabaruddin et al., 2020a; Safitri & Dhaifi, 2020). The current study aims to explore the mathematics learning strategies for students with special needs, primarily for students with visual impairment, autism, and hearing impairment.

## Research Method

This research was initiated by selecting 2011-2022 published scientific articles from journals and categorizing them. The selected relevant papers examined mathematics learning for students with visual impairment, autism, and hearing impairment.

**Corresponding Author e-mail:** ediyanto.fip@um.ac.id

**https://orcid.org/0000-0001-9344-5962**

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### Selection of Articles

The selected articles were from peer-reviewed journals in the ERIC (https://eric.ed.gov) database. Those articles were determined using the keywords "mathematics learning for students with special needs." In addition, this study only selected research from the last ten years and added the descriptors "mathematic instruction," "mathematic concepts", and "teaching methods." The results found 311 articles that matched the search for the Selection of Articles stage.

### Research Analysis

This literature review was carried out using the best evidence approach. The best evidence approach from the article selection. The articles selection was conducted based on the articles' conformity with our research purpose. In addition, we only select peer-reviewed articles only. Further, the obtained articles were analyzed and verified. We used the same criteria in this process, following the research purpose. Based on the results of this search, 311 articles were reduced to 32.

### Categorization of Articles

Each of the selected articles was analyzed following the recent growing research purpose. In addition, we also ensure that each of those chosen articles potentially carries more than one finding. Finally, we decided to categorize only the terms "visual impairment, autism, and hearing impairment." Thus, only 17 articles (five for visual impairment, six for autism, and six for hearing impairment) were used to explore the mathematics learning strategies for students with special needs.

## Results

### How do teachers attempt to teach mathematics to students with visual impairment?

The visually impaired children encounter issues in their vision (Kourkouta et al., 2017). This limitation induces various daily life obstacles, including problems in education processes (Ayanniyi et al., 2013; Salleh & Ali, 2010). Therefore, visually impaired children are said to experience physical hindrances. In a book entitled *The National Academies of Sciences, Engineering, Medicine,* Teutsch, et al. (2016) described that, universally, visual impairment carries negative influences and obstructs academic achievements. Linearly, other studies reported that students with visual impairment face hardships during mathematics learning (Mejia et al., 2021; Pratama et al., 2018), so they require the best assistance in mathematics courses. Simultaneously, these students are expected to develop their mathematics skills as linearly as regular students (Oyebanji & Idiong, 2021; Poorya et al., 2011). Thus, mathematics learning for visually impaired students can be challenging. Various different obstacles faced by these students obligate teachers to present more significant attempts in teaching mathematics. A number of learning approaches being investigated in previous studies on mathematics learning for visually impaired students are summarized in Table 1.

### How do teachers conduct mathematics learning for students with autism?

Children with autism have emotional problems that affect their daily life (Chen et al., 2015). Consequently, the emotional issues disrupt their learning activities, communication, and interaction with friends and teachers (Harjusola-Webb & Robbins, 2012; Humphrey & Symes, 2010). A number of studies reported that autistic children with no intellectual restraint experience emotional issues, such as being easily enraged, mournful, or anxious. Their intense anxiety induces panic disorder, social anxiety, and depression (Kent & Simonoff, 2017; Ozsivadjian et al., 2012). Those factors of obstacles affect these students' mathematics learning progression. Thus, teachers hold a vital role in helping those students cope with those hindrances. As a response, teachers and practitioners have attempted to implement a particular mathematics learning strategy for students with autism, as presented in Table 2.

**Table 1:** Mathematics Learning Strategies for Students with Visual Impairment

| *No.* | *Author* | *Research Finding* |
|---|---|---|
| 1 | (Nahar et al., 2022) | Mathematics braille with Nemeth code helps visually impaired students resolve calculation problems |
| 2 | (Brawand & Johnson, 2016) | One of the effective Mathematics learning methods for students with visual impairment is learning using an abacus and braille |
| 3 | (Nazemi et al., 2012) | The use of audio in Mathematics learning helps visually impaired students who have limited eyesight |
| 4 | (Maćkowski et al., 2022) | Computer-assisted Mathematics learning enhances the visually impaired students' learning motivation |
| 5 | (Fatimah et al., 2022) | Mathematics learning with flipped classroom approach carries positive influences on students with visual impairment |

**Table 2:** Mathematics Learning Strategy for Students with Autism

| *No.* | *Authors* | *Research Findings* |
|---|---|---|
| 1 | (Sabaruddin et al., 2020b) | Students with autism tend to encounter issues and ignorance if they are given an exercise item that differs from the example |
| 2 | (Barnett & Cleary, 2015) | In enhancing the mathematics skills of students with autism, teachers are required to do an intervention |
| 3 | (Siregar et al., 2020) | Teachers have to use a combination of learning strategies to maximize the learning quality of students with autism |
| 4 | (Ku Nuraini CKM et al., 2020) | Attractive graphic and animation media in game-based Mathematics learning improve the learning enthusiasm of students with autism |
| 5 | (Chu et al., 2020) | An emotion regulation strategy significantly lowers the negative emotional behaviors of students with autism while accelerating their mathematics learning |
| 6 | (King et al., 2016) | Medium to high interval intervention during mathematics learning carries great results for students with autism |

**Table 3:** Mathematics Learning Strategies for Students with Hearing Impairment

| *No.* | *Authors* | *Research Findings* |
|---|---|---|
| 1 | (Sabaruddin et al., 2020) | Teachers have to adopt effective, sufficient, and uncomplicated languages in communicating with students with hearing impairment |
| 2 | (Jannah & Prahmana, 2019) | IRME learning approach with pipet media improves students' with hearing impairment comprehension in fractional numbers materials |
| 3 | (Gottardis et al., 2011) | Visual media can be used in mathematics learning to facilitate the learning for students with hearing impairment |
| 4 | (Krause & Wille, 2021) | In simple mathematics learning, the sign language and visual media should be synchronized to aid mathematics learning for students with hearing impairment |
| 5 | (Olaoluwa & Ayantoye, 2016) | Brained based learning approach can be adopted to establish a challenging, entertaining, active, and meaningful learning environment for students with hearing impairment |
| 6 | (Thai & Mohd Yasin, 2016) | *Magic Finger Teaching Methods* (MFTM) improve students' confidence, persistent, and motivation in learning mathematics |

### How do teachers teach mathematics to students with hearing impairment?

Hearing impairment is referred to a person with hearing problems (Demorest & Erdman, 1987). For students, hearing impairment carries adverse effects on their individual performance, including in learning mathematics (Marschark et al., 2015; Sarant et al., 2015). Therefore, teachers are expected to design practical mathematics learning strategies to escalate the learning efficiency of hearing-impaired students. Particularly, the teachers have to put extra effort into interpreting information through the verbal, body, and sign language to help the hearing-impaired students learn mathematics. Their steps are crucial, as mistakes in writing and sign language synchronization result in bias in expressing a mathematics concept or symbol (Husniati et al., 2020; Nolan & Keazer, 2021). The results of previous studies concerning teachers' strategies in optimizing mathematics learning for hearing-impaired students are shown in Table 3.

## Discussion

The firm correlation between mathematics learning, affective process, learning motivation, cognitive process, as well as its regulation has been universally acknowledged (Hanin et al., 2017; Pekrun & Linnenbrink-Garcia, 2012). Meanwhile, the most common obstacle in special mathematics education covers the school culture, curriculum, and administrative aspects (Aljundi & Altakhayneh, 2020; Preston et al., 2018). Students' experience in resolving mathematics learning is crucial for their character development, primarily for students with special needs (Case et al., 1992; Swanson & Sachse-Lee, 2001). Therefore, the fundamental principle for inclusive education, multiculturalism, and special education should be realized to ensure excellent development for every child. Several studies articulate that students who receive explicit instruction as a problem-solving strategy present a better ability to resolve mathematics problems and represent problems using mathematics expression (Montague et al., 2011, 2014). Meanwhile, ethnomathematics could play a role as context here to enrich students' knowledge and own culture (Peni, 2022).

During mathematics learning for visually impaired students, teachers' mistakes in enunciating mathematics sentences may result in biased meaning, negatively affecting those students. Prasetyawan & Fitriana Masitoh (2019) provides a less precise narrative in the following example:

$$y = \frac{2x + 3}{4}$$

If the teachers narrate that "y is equal to 2*x* plus 3 per 4", then it has a biased meaning. The better narration for that sentence is "y is equal to the results of 2*x* plus 3 per 4."

Minimum visual access does not lower someone's ability to visualize (Healy & Fernandes, 2020). Thus, teacher bears a vital role in modifying the learning media enabling visually impaired students to enhance their imagination through their hearing (Ahmed & Chao, 2018; Widodo & Wahyudin, 2018). Previous studies have discovered several learning approaches to develop visually impaired students' mathematics skills, such as through learning media and specific learning methods. Some researchers reported the efficiency of mathematics braille with Nameth code in facilitating mathematics learning processes (Brawand & Johnson, 2016; Nahar et al., 2022). A study also discovered that an abacus aids students with visual impairment in resolving mathematics calculation problems (Brawand & Johnson, 2016). Also, audio media can be adapted to assist visually impaired students in the learning process (Nazemi et al., 2012). However, it should be noted that the audio media should use sufficient language to avoid teaching biased mathematics language.

In addition, children with autism are defined as children with emotional issues. These children commonly exhibit communication disruption and problems during interaction with their peers and teachers, influencing their mathematics learning. Autistic students' inclination to experience emotional disturbance requires teachers to construct an emotion regulation strategy to help them cope with that psychological issue (Bolourian et al., 2018; Losinski et al., 2019). The emotion regulation strategy comprises situation modification, cognitive transformation, affection distribution, and response modulation (Halperin & Pliskin, 2015; Harley et al., 2019; Utomo, 2015). Studies have reported that emotion regulation significantly reduces negative emotions in students with autism while simultaneously improving their mathematics learning performance (Chu et al., 2020; Samson et al., 2012). In certain situations, teachers have to carry out an intervention for students with autism (Barnett & Cleary, 2015; King et al., 2016; Lee, Ho, & Bhargavi, 2022). In line with that, teachers can assess their students' mathematical abilities through mathematics assessment (Homdijah, Heryati, & Ehan, 2021). The intervention for students with autism can be carried out primarily to cope with their most frequent issue of verbal and non-verbal communication. Fundamentally, teachers have to formulate the procedures to grow autistic students' interest in attending learning processes (Brosnan et al., 2016; Schaefer Whitby, 2013).

For students with hearing impairment, teachers' synchronization between sign and visual languages is crucial to help them process mathematics learning (Krause & Wille, 2021; Thai & Mohd Yasin, 2016). It should be noted that the hearing impairment of each individual can be different. Low-level hearing impairment significantly correlates with mathematics skills (Neher et al., 2011; Oberg & Lukomski, 2011). However, students with advanced hearing impairment need to be assisted by special education teachers to attain optimum learning results (Courey et al., 2013; Lidström & Hemmingsson, 2014). The essential elements for these hearing-impaired students cover effective, proper, and uncomplicated language that simplifies language synchronization.

## Conclusions

The available mathematics learning strategy should be facilitate learning for students with special needs through the provision of explicit learning instruction and media. Thus, special education teachers have to aid the mathematics teachers in designing effective mathematics learning by explaining the academic developmental level, superiorities, and weaknesses of the special needs students.

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