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Teaching Mathematics to Students with Learning Disabilities

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Abstract

Teaching mathematics to students with learning disabilities (LD) is challenging. The challenges are frequently connected to the requirement for more knowledge and skills in teaching mathematics to these students. Thus, this study examined teachers' knowledge and experience levels in teaching mathematics to students with learning disabilities. Data were collected data through a questionnaire administered to 61 special education teachers in two states. The 24-item questionnaire covered the respondents' demographics, mathematics instruction knowledge, and knowledge and experience level in mathematics instruction. Data were collected through Google Forms and in-person using convenience sampling and were analyzed descriptively. The results revealed that most teachers understood the importance of in-depth knowledge of mathematics, the learning processes of students with learning disabilities, and the specific challenges students with LD experience. Nevertheless, the teachers demonstrated varied confidence regarding their knowledge and experience, where most respondents rated their experience as moderate. Furthermore, a strong foundation in mathematical knowledge and the ability to understand individual student characteristics were required. These results highlighted the need to enhance teachers' professional development through focused workshops and development programs. Training that emphasizes integrating effective teaching strategies, mathematical content knowledge, and assistive learning technologies is recommended to ensure teachers can effectively meet students with LD's unique needs.

Keywords: Mathematics Teaching, Special Education, Learning Disabilities, Pedagogical Content Knowledge, Teacher Knowledge

Introduction

Students have equal rights to access education, regardless of background or ethnicity. Teachers can understand the LD student's needs, strengths, and weaknesses through a comprehensive assessment. Every student with a learning disability (LD) has unique cognitive, physical, and behavioural aspects. Teachers of students with LD, especially in special education settings, should be skilled in using flexible teaching approaches based on the student's abilities and learning styles (Byrd & Alexander, 2020). In addition to effective instruction with appropriate strategies, teachers must consider students' confidence and motivation in the learning process. Confident and motivated students are more focused during classroom instruction, and negative behaviors can be reduced (Nawi & Salleh, 2022). Furthermore, students' motivation is sustained through praise and positive reinforcement of their efforts and achievements. Teachers can also separate large tasks into smaller, manageable steps to aid students in feeling more confident about completing assignments, improving academic performance (Amran & Toran, 2024).

Teaching mathematics to students with LD is challenging. These students need more support to understand basic mathematics conceptually. The challenge is closely related to a lack of knowledge and skills in teaching mathematics to students with LD. Students with LD learning mathematics require a specific teaching approach to aid their comprehension of the concept (Abol, 2023). Teachers' instructional strategies should use visual, kinesthetics, and auditory aids to aid students in understanding mathematics ideas. Hence, teachers are strongly advised to effectively use teaching aids and technology, such as manipulatives and interactive software, to explain abstract concepts (fractions and integers). Additionally, scaffolding in stages is essential to provide gradual support and reduce guidance as students become more proficient (Vivi et al., 2019). Furthermore, mathematics instruction should integrate specific teaching strategies, such

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as cooperative learning, which encourages students to work in small groups to solve mathematical problems together (Nizam & Taat, 2020). Moreover, mathematical games can create a more enjoyable and engaging learning atmosphere (Lin, 2023). Teachers must be patient, as constant practice is essential to aid students with LD in mastering mathematical concepts. Thus, teachers must ensure they are equipped with the relevant knowledge and skills to teach mathematics to students with LD effectively.

While teachers possess knowledge and skills related to teaching strategies, effective instruction in a special education classroom is challenging. Many teachers require assistance in delivering effective teaching to students with LD (Pawlak & Gross, 2019). Furthermore, numerous teachers need more confidence or adequate training in adapting their teaching to meet students with LD needs (Kamarudin et al., 2022). In Malaysia and globally, more studies are needed on teachers' perceptions of knowledge and experience in teaching mathematics to students with LD. Previous studies focused on general teaching strategies for mainstream mathematics classrooms with LD (Liong, 2019). Therefore, this study aimed to examine teachers' perceptions of teaching mathematics to students with LD. Specifically, the research objectives are:

a) to identify teachers' perception of the importance of knowledge and experience in teaching mathematics to students with LD
b) to identify teachers' perception of their own knowledge and experience in teaching mathematics to students with LD

Literature Review

Mathematics Instruction Knowledge

Shulman's (1986) teacher knowledge model illustrates two knowledge components teachers must master to teach students effectively: content knowledge and pedagogical content knowledge. The model has become a foundation in studies on teacher competence in teaching a specific subject. The model states that teachers with specialized subject knowledge will be more effective in delivering lessons than teachers who lack that knowledge. Shulman (1989) emphasized that teachers must know the subject content and the best means of teaching that content, which include methods for explaining complex concepts, addressing student misunderstandings, and using relevant examples and analogies.

Content knowledge is a deep understanding of the subject matter being taught. Teachers must master the facts, concepts, theories, and structure of the discipline. This knowledge allows teachers to explain concepts clearly and accurately to students (Jamin et al., 2022). Pedagogical content knowledge involves an understanding of the teaching and learning process. Teachers must know effective teaching strategies, techniques, and approaches, classroom management, and understanding student development (Bakar et al., 2020). Pedagogical content knowledge aids teachers in planning and conducting engaging and meaningful lessons (Ningsih et al., 2019).

Shulman's model guides teacher education programs and emphasizes the importance of balancing content knowledge and pedagogy and integrating both to ensure effective and meaningful teaching (Masingan & Sharif, 2019). Teachers with strong pedagogical content knowledge have a better ability to adapt their teaching to meet students' needs, make better instructional decisions, and respond more effectively to students' learning challenges (Ambotang & Anuar, 2023). Based on Shulman's model, Ball et al. (2005) developed the Mathematical Knowledge for Teaching (MKT) framework, which focuses on the key elements for mathematics teachers to teach effectively in the classroom. Ball et al. (2005) stated that MKT consists of two crucial elements: teachers' knowledge of mathematical content and their ability to teach that content effectively. Teachers with strong MKT are better able to provide effective mathematics instruction, better understand student needs and difficulties, and use appropriate teaching strategies and technologies to enrich mathematics learning (Odumosu et al., 2018; Csíkos & Szitányi, 2019; Charalambous et al., 2020; Jacob et al., 2020). Furthermore, teachers with robust MKT can identify students' challenges in mathematics and plan lessons that address those challenges. Teachers who understand how students learn mathematics can provide more precise and effective explanations (Azmay & Rosli, 2023).

Other researchers reported slightly different ideas about the knowledge needed for teaching. For example, Carrillo et al. (2018) suggested that mathematics teaching content and pedagogical content knowledge can be divided into three key elements. Content knowledge includes topic knowledge, mathematics structure, and mathematics practices. Pedagogical content knowledge involves mathematics instruction knowledge, understanding mathematics learning characteristics, and knowledge of mathematics learning standards. Delgado-Rebolledo and Zakaryan (2019) reported that these types of knowledge are interconnected to ensure students' effective mathematics learning.

Students with LD in Special Education

The LD is caused by developmental, neurological, or psychological disorders. The American Psychiatric Association (2013) states that specific LDs are classified as disorders that affect the ability to read, write, and perform

mathematical calculations. The specific LD can be divided into several main categories, and include dyslexia, dysgraphia, and dyscalculia. Students with LD in special education settings encounter significant challenges in specific areas of learning.

Dyslexia is one of the most common LD and can affect the ability to read and write (Busri & Mohammad, 2021). Students with dysgraphia experience challenges in producing legible and organized handwriting and may also struggle with spelling. Fuadah et al. (2023) discussed how dysgraphia can affect students' writing abilities and fine motor skills. Lastly, dyscalculia involves difficulties in understanding mathematical concepts and performing calculations (Mohmad et al., 2023). Students with dyscalculia find it challenging to understand basic mathematical concepts, recall mathematical facts, and perform calculations.

Most students in special education also require specific attention regarding behaviour, which challenges teachers during lessons. Teachers' ability to manage students' behavior is closely related to the teachers' experience and knowledge of teaching students in special education settings, which include those with LD. Technology in teaching, a structured teaching approach, and individualized methods tailored to students can achieve effective behavior management among students with LD (Nawi & Salleh, 2022; Liong, 2019). Thus, students with LD require appropriate teaching strategies to address their unique learning needs (Nawi & Salleh, 2022). Teachers must be adept at using different teaching approaches to provide the most suitable learning experience for students with LD. For example, teachers can adapt the learning environment according to the students' needs, abilities, and learning capacities. Teachers who select effective teaching strategies for mathematics enhance students with LD's understanding of the subject better manage their behavior and create a positive and productive learning environment.

Special education teachers frequently rely on traditional methods that fail to engage students with LD in classroom activities. This issue presents a challenge to mathematics teaching and learning as students with LD may become easily bored if classroom activities do not capture their interest. Teaching aids are crucial in mathematics teaching and learning, which involves abstract concepts. The types of materials and support that can aid in facilitating effective mathematics teaching in the special education classroom should be examined (Ja'apar, 2017). Furthermore, teachers' creativity in selecting the appropriate materials and support must be researched to ensure that the learning process is effective and beneficial for students. In this context, teachers can modify teaching methods or techniques, adjust the time allocated for each activity, arrange activities, and use teaching aids that meet students' needs. Florian and Linklater (2010) indicated that inclusive education benefits all students, including those with LD, by providing a supportive learning environment.

Thus, teachers' professional development requires enhancement, specifically teachers in special education programs. Darling-Hammond (2000) reported that continuous and comprehensive training aids teachers in understanding and implementing effective teaching strategies. Furthermore, Friend and Cook (2010) and Hariz and Khairuddin (2021) stated that meaningful collaboration between teachers, especially special education teachers and mainstream teachers, was essential to support students with LD holistically. Marlina et al. (2023) emphasized the importance of differentiated instruction, where teachers adjust teaching methods according to student's individual needs as students with LD require extra support from teachers with adequate knowledge, skills, understanding, and abilities (Derapa & Mohamed, 2018).

Methodology

This survey was conducted to identify teachers' perceptions regarding the knowledge and experience required for teaching mathematics to students with LD in special education settings. A 24-item questionnaire was distributed to 61 mathematics teachers in special education settings in selected schools in Sabah and Sarawak. The instrument was adopted and translated from Sheppard and Wieman (2020) and has been validated by mathematics and special education experts at one of the public universities. The questionnaire consisted of 10 items in Section A related to demographic information, and seven items in Section B, which comprised statements about the knowledge and experiences teachers should possess for teaching mathematics to students with LD. The respondents rated the statements on a five-point Likert scale: not at all important, a little important, moderately important, quite important, and extremely important. In Section C, respondents choose their agreement on seven items based on their knowledge and experience level in teaching mathematics according to a six-point Likert scale: strongly disagree, disagree, somewhat disagree, somewhat agree, agree, and strongly. Data were collected through Google Forms and in person using convenience sampling. The data were analyzed quantitatively to obtain the mean, standard deviation, frequency, and percentage.

The demographic data demonstrated that most respondents were female (n = 53, 86.9%) (Table 1). The respondents' geographic distribution was nearly equal, with 32 (52.5%) from Sabah and 29 (47.5%) from Sarawak. Twenty-eight respondents (45.9%) were between 31 and 40 years old. All respondents possessed the necessary teaching

Table 1: Respondents' demographics

Demography	Category	Frequency	Percentage (%)
Sex	Male	8	13.1
	Female	53	86.9
Age (years)	20–30	11	18
	31–40	28	45.9
	41–50	22	36.1
Academic qualification	Bachelor's Degree in Education	34	55.74
	Master of Education	8	13.11
	Other (Diploma in Education)	19	31.15
Option	Special Education (Learning Disability)	15	24.6
	Remedial Education	15	24.6
	Non-specialized	31	50.8
Experience teaching special education needs students with learning disabilities (years)	0–4	24	39.3
	5–9	12	19.7
	10–14	18	29.5
	15– 20	7	11.5
Experience teaching mathematics to SEN students with learning disabilities, years	0–4	37	60.7
	5–9	9	14.8
	10–14	11	18
	15–20	4	6.5

qualifications, and 34 teachers (55.74%) had a bachelor's degree in education. Fifteen respondents each (24.6%) had majored in special education focused on LD and in remedial education. Nonetheless, 31 respondents (50.8%) were from non-specialized fields.There were 24 teachers (39.3%) who had less than four years of experience with students with LD. Similarly, 37 teachers (60.7%) had less than four years of experience teaching mathematics to students with LD. This result might have been because the respondents were not permanently assigned to teach mathematics to students with LD every academic year (Table 1).

Results

The Importance of Knowledge and Experience in Teaching Mathematics

This section presents data on the knowledge and experience teachers should possess when teaching mathematics to students with LD. The respondents answered seven items on a five-point Likert scale (Table 2). The analysis indicated that the knowledge and experience required for teaching mathematics had an overall mean score of 4.63 (standard deviation = 0.386).

The data analysis determined that Item 3 received the highest percentage of agreement, with 86.0% of respondents indicating that knowing students individually is important. Items 2 and 4 also received high agreement percentages regarding general knowledge about how students learn and their specific challenges in learning mathematics. 51 (83.6%) and 50 (82%) of the 61 respondents considered having general knowledge of how students learn mathematics and knowing the specific challenges experience faced by students with LD. The results from these three items demonstrated the respondents' consistent perception regarding the importance of understanding the characteristics of each student with LD, their learning styles, and the challenges they experience in learning abstract mathematical concepts. Nevertheless, effective mathematics teaching requires more than knowledge about students with LD. 40 respondents (65.6%) considered it extremely important for a teacher to have solid mathematical knowledge to teach concepts accurately. Table 2 presents the descriptive analysis of Section B, and includes the frequency and percentage for each item, focusing on the knowledge that teachers should have in teaching mathematics to students with LD.

Although agreement was slightly lower for Items 5, 6, and 7 compared to the other items in the same category, teacher agreement remained above 50% (the majority). Regarding items related to teaching experience, 36 respondents (59%) agreed most with Item 7. Contrastingly, 35 respondents

Table 2: Knowledge and experience teachers should possess in teaching mathematics

Statement	*Not at all important*	*A little important*	*Moderately important*	*Quite important*	*Extremely important*
It is important to have a deep knowledge of mathematics.	0 (0)	0 (0)	2 (3.3)	19 (31.1)	40 (65.6)
It is important to have general knowledge of how students learn mathematics.	0 (0)	0 (0)	0 (0)	10 (16.4)	51 (83.6)
It is important to know individual students.	0 (0)	0 (0)	0 (0)	8 (13.1)	53 (86.9)
It is important to know the specific challenges faced by students with LD.	0 (0)	0 (0)	0 (0)	11 (18)	50 (82)
It is important to have experience teaching in general.	1 (1.6)	1 (1.6)	5 (8.2)	19 (31.1)	35 (57.4)
It is important to have experience teaching mathematics.	1 (1.6)	0 (0)	4 (6.6)	25 (41)	31 (50.8)
It is important to have experience teaching special education.	0 (0)	0 (0)	7 (11.5)	18 (29.5)	36 (59)

Note: Values are in frequencies and percentages (in parentheses).

(57.4%) highly agreed with Item 5. 31 respondents (50.8%) highly agreed that teachers should have experience teaching mathematics. Teachers with experience teaching students in special education settings are better equipped to develop effective teaching styles based on the characteristics of each student with LD.

Teachers' Knowledge and Experience in Teaching Mathematics

This section focuses on the results regarding the respondents' knowledge and experience in teaching mathematics to students with LD in special education. Section C of the questionnaire also contained seven items (Table 3), but the items were modified to denote the respondents' knowledge and experience teaching mathematics. The items were scored on a six-point Likert scale.

The overall mean value of teachers' knowledge and experience in mathematics teaching was 4.773 (standard deviation = 0.689). This result suggested that the respondents agreed on average that they possessed the necessary knowledge and experience to teach mathematics to students with LD. The relatively high mean value indicated a positive

Table 3: Teachers' knowledge and experience teaching mathematics

Statement	*Strongly disagree*	*Disagree*	*Somewhat disagree*	*Somewhat agree*	*Agree*	*Strongly agree*
I have a deep knowledge of mathematics.	0 (0)	2 (3.3)	4 (6.6)	19 (31.1)	34 (55.7)	2 (3.3)
I have general knowledge of how students learn mathematics.	0 (0)	1 (1.6)	1 (1.6)	16 (26.2)	40 (65.6)	3 (4.9)
I know individual students.	0 (0)	1 (1.6)	3 (13.1)	8 (13.1)	41 (67.2)	8 (13.1)
I know the specific challenges for students with LD.	0 (0)	2 (3.3)	1 (1.6)	12 (19.7)	37 (60.7)	9 (14.8)
I have experience teaching in general.	0 (0)	1 (1.6)	5 (8.2)	3 (4.9)	34 (55.7)	18 (29.5)
I have experience teaching mathematics.	1 (1.6)	2 (3.3)	4 (6.6)	7 (11.5)	32 (52.5)	15 (24.6)
I have experience teaching in special education.	0 (0)	5 (8.2)	5 (8.2)	10 (16.4)	26 (42.6)	15 (24.6)

Note: Values are the frequencies and percentages (in parentheses).

perception of the teachers' readiness and capability to deliver mathematics instruction effectively, although the standard deviation indicated variation in agreement. Table 3 presents the descriptive analysis results of the items in Section C.

The results demonstrated a noticeable variation in the distribution of responses regarding the respondents' knowledge and experience in teaching mathematics to students with LD. Although many respondents selected "somewhat agree", "agree", and "strongly agree" for each item (1–7), most frequency and percentage of responses were in the "agree" category. For example, 41 respondents (67.2%) agreed with Item 3, while the response distribution for Items 2 and 4 was nearly the same as that of Item 3, where 40 respondents (65.6%) and 37 respondents (60.7%) agreed that they have general knowledge and understand the specific challenges students face in learning mathematics, respectively. As Items 2–4 focus on teachers' understanding of their students, the results indicated that the respondents felt that they possessed knowledge about their students in the classroom, particularly regarding mathematics instruction.

We found 34 respondents (55.7%) felt that they had solid mathematical knowledge (Item 1) to teach students with LD, although 19 respondents (31.1%) selected "somewhat agree" for the item. Regarding teaching experience, 34 (55.7%) and 18 (29.5%) respondents selected "agree" and "strongly agree", respectively, which indicated that they have general teaching experience in schools. 47 respondents (77.1%) agreed or strongly agreed with Item 6. Furthermore, 50 respondents selected "somewhat agree", "agree", or "strongly agree" for Item 7. The distribution of responses for Items 5–7 demonstrated variation in the respondents' levels of agreement across the available categories. These results suggested that while most respondents felt confident about their general teaching and mathematics knowledge, their perceptions regarding specific experiences and knowledge in teaching students with LD, particularly in mathematics instruction, varied.

Discussion

The respondents considered knowledge and experience to be essential elements in teaching mathematics to students with LD. This analysis was consistent with previous results (Shulman, 1986), which emphasized the importance of pedagogical content knowledge when teaching students with LD. The results indicated that the respondents were aware of the importance of the knowledge and experience those teachers should possess when teaching mathematics to students with LD. The respondents also recognized the significance of understanding the ways of learning and the specific challenges each student faces in special education settings. While the respondents acknowledged the importance of knowledge in teaching mathematics, the data demonstrated varied agreement regarding teachers' knowledge. Briefly, the respondents' awareness of the importance of knowledge and their confidence level in their knowledge differed.

Most of the respondents indicated that a strong knowledge of mathematics is extremely important. Furthermore, most respondents also agreed that they knew how to teach mathematics, although only a few strongly agreed with this statement. This result indicated that despite the respondents' confidence that they possessed the required knowledge, that knowledge requires substantial improvement (Majani & Tahar, 2021). Most respondents agreed that they have teaching experience and a solid mathematical knowledge base, which reflected a high level of engagement and motivation (Hata & Mahmud, 2020; Ambotang & Anuar, 2023). This result was positive as motivated and engaged teachers provide better and more effective instruction. Nonetheless, a significant portion of the respondents disagreed regarding their teaching experience and solid knowledge of teaching mathematics to students with LD.

The results also demonstrated that the respondents understood the importance of recognizing students individually and the challenges experienced by students with LD in learning mathematics. Nevertheless, the respondents' confidence in their knowledge in this area requires enhancement. Teachers who understand each student's characteristics can develop more effective teaching strategies (Amin et al., 2020). Experienced teachers, which include those who teach students with LD, were more confident about their knowledge. This result indicates that teaching experience strengthens teachers' knowledge and confidence (Nizam & Rosli, 2020).

The data indicated that the respondents believed that knowing how students learn mathematics and the specific challenges they face are extremely important. Teachers with experience teaching students with LD are more familiar with practical means of addressing the students' learning needs (Byrd & Alexander, 2020). Although the results demonstrated that the respondents were more likely to agree with their general experience, only one-quarter of the respondents strongly agreed that they have sufficient experience teaching mathematics to students with LD. Therefore, their knowledge and understanding of the teaching and learning of mathematics for students with LD in special education settings requires improvement. Accordingly, workshops or training programs must be developed to enhance teachers' capacity to implement appropriate learning readiness skills for teaching students with LD (Amran & Toran, 2024). This result indicated the need for continuous training programs

to improve teachers' practical experience in this context (Robinson et al., 2019).

Providing training and professional development focused on these aforementioned aspects is critical to ensure that teachers have the relevant skills and knowledge (Aminuddin Baki Institute, 2017). The relationship between awareness of the need for knowledge and the level of self-knowledge indicates a need for ongoing training and professional development (Wei & Alias, 2023). Training that focuses on enhancing mathematical knowledge, effective teaching strategies, and a deep understanding of how students learn is crucial to bridging the gap between knowledge requirements and teachers' knowledge. Knowledge about each student and their specific challenges requires a more tailored, student-centered teaching approach to achieve higher effectiveness (Suhaimi & Shaffeei, 2023). Most teachers specified the importance of knowledge in the specific challenges of students with special educational needs and emphasized the need to strengthen support systems in special education (Abol, 2023). This approach includes providing adequate resources, assistive technologies, and intervention programs tailored to students' needs. Thus, the Ministry of Education should establish higher standards for special education teacher training and assessment to support the learning of students with special needs. Furthermore, policies supporting the enhancement of teachers' knowledge and skills in teaching mathematics should be emphasized to positively affect the quality of education received by students with LD (Lo, 2020).

In summary, the results indicated the importance of teachers' knowledge and experience in ensuring effective mathematics teaching for students with LD and the need for these teachers to receive constant support and practical training. Although the respondents understood the importance of an in-depth knowledge of mathematics and teaching strategies, their confidence regarding their knowledge indicated that improvement was required. Continuous training and professional development are critical to ensure that teachers have the knowledge and skills to teach students with LD effectively.

Conclusion

The results emphasized the importance of teachers' knowledge and experience in effective mathematics teaching for students with LD, specifically their knowledge about the student's characteristics, their learning styles, and the challenges they experience. Although most of the respondents recognized the importance of solid mathematical knowledge and appropriate teaching strategies, their confidence regarding their knowledge varied. The results suggested the need for improvement through ongoing professional training and support to provide teachers with the necessary knowledge and skills. Experience in teaching students with LD was also crucial, but only a few respondents were confident in their experience with mathematics instruction for special education. Therefore, continuous training and professional development focused on effective teaching strategies are necessary to enhance teaching effectiveness and teacher confidence.

This research presents several limitations regarding the depths of data collection through questionnaires and the select teachers involved in the study that can impact the credibility and relevancy of the results. However, these limitations also underscore the urgent need for ongoing assessment of the effectiveness of current mathematics instruction for students with LD. This emphasis on the importance of continuous evaluation should make educators, researchers, and policymakers in the field feel the gravity of the issue. The present study provided a foundation for future research and presented opportunities for more in-depth research. Studies on the factors contributing to success or challenges in mathematics teaching in special education settings are warranted. Further research can also evaluate the effectiveness of training programs for special education teachers in mathematics instruction. Finally, researchers should focus on identifying the most effective elements in enhancing teachers' knowledge and skills and ways to improve teacher education programs.

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