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DETERMINATION OF SECONDARY SCHOOL MATHEMATICS TEACHERS' LEVEL OF KNOWLEDGE ON DYSCALCULIA[1]

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Abstract

This study aimed to investigate secondary school mathematics teachers' awareness of dyscalculia (causes, symptoms, prevalence, and intervention). The study was conducted with the survey model. The sample of the study consisted of 83 secondary school mathematics teachers. The data were collected through a questionnaire consisting of 21 questions. The data were analyzed using frequency analysis. The findings were presented in tables as percentages and frequencies**.** Middle school mathematics teachers' awareness of dyscalculia was quite low and they had insufficient knowledge about the causes of dyscalculia and intervention for it. It was concluded that secondary school mathematics teachers did not receive in-service training on dyscalculia, and the dyscalculia training at the university, teachers' knowledge about the recognition of dyscalculia, and correct and effective intervention in dyscalculia were inadequate. Considering the results of the research, it is suggested that dyscalculia should be included in special education courses and in-service trainings at universities and intervention programs for dyscalculic students in secondary schools should be implemented for prospective mathematics and primary school teachers in addition to their internship courses in cooperation with the Ministry of National Education. Also, prospective teachers should learn about dyscalculia and its intervention, secondary school mathematics teachers should identify dyscalculic students in their classes in cooperation with the Guidance and Research Center and conduct intervention studies for these students. It may also be recommended to investigate the awareness of parents and high school mathematics teachers about dyscalculia.

Keywords: Mathematics Learning Disabilities, Dyscalculia, Secondary School, Mathematics Teachers.

1. Introduction

The concept of dyscalculia as a mathematics learning disorder was first introduced in the 1970s (Kosc, 1974). Later on, the concepts of dyscalculia and developmental dyscalculia were used together with the concept of mathematics learning disability (Mazzocco & Meyer, 2003). Cognitive, psychological, and social sciences continue to investigate the origins of mathematical learning disabilities. According to the World Health Organisation (WHO) International Classification of Diseases Eleventh Revision (ICD-11)defines dyscalculia as an

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individual's math performance being below the expected level compared to his/her peers, even though there is no disorder in the individual's mental development and sensory organs, the individual does not experience psychosocial and neurological distress, and there is no deficiency in the individual's education. Many disciplines, including psychology, have studied the cause of dyscalculia. Although the cause is not fully explained, it is thought that mother-child problems, alcohol, smoking, taking medication during pregnancy, genetic factors, and consanguineous marriages may cause dyscalculia. (Alarcon et al., 1997). Kaufmann et al. (2013) stated that brain activities should also be examined while investigating the causes of dyscalculia and that there are significant differences in the neuronal activities of dyscalculic individuals. Kucian and Von Aster (2015) stated in their study that for the neuronal causes of dyscalculia, abnormal brain activities can be detected by monitoring the brain activation of the individual. The difficulties experienced by the dyscalculic individuals are passed down from generation to generation. So it is thought that dyscalculia might be inherited (Ansari & Karmiloff-Smith, 2002).

Dyscalculia co-exists with other learning disabilities and it is very difficult to diagnose it in isolation from other learning disabilities. It was found that 26% of dyscalculic individuals were hyperactive and 17% were dyslexic (Shalev et al., 1997). While 6.2% of children have dyscalculia, the general opinion is that approximately 5-7% of students have dyscalculia, and it does not vary by gender (Butterworth, 2005).

Dyscalculia directly affects an individual's acquisition of math skills. Individuals with dyscalculia have difficulty understanding simple numerical values and concepts. Dyscalculic individuals have problems grasping numbers intuitively and performing operations with numbers (Chinn, 2011). If a student with a normal level of achievement in his/her classes has low mathematics achievement and generally lags behind his/her peers in learning four operations and has difficulty in performing four operations, the presence of dyscalculia may be considered in the student. (Bird, 2017). According to Babu and Sasikumar (2019), since dyscalculia causes different mathematics difficulties in students, the symptoms of dyscalculia may also differ from student to student. Dyscalculia may also exhibit different characteristics depending on the age of the student. Symptoms of dyscalculia become more evident as the student gets older. Dyscalculia can occur in preschool or even in primary, middle, and high school. According to Hannell (2006), dyscalculic students solve mathematical problems much later than their peers, quickly forget a previously learned operation, a mathematical rule, or what mathematical symbols are and how to use them, cannot perform simple calculations because they cannot understand mathematical symbols, forget which step they

are in when they try to perform a multi-step operation, may change the digits in two-digit or multi-digit numbers (for example, they may read 36 as 63), may confuse operations with integers. When asked about the product of two numbers, they can say the result of the sum of these numbers, they can say that the probability of an event is greater than 1. For dyscalculic students, learning by rote is essential. Dyscalculic students are easily distracted. As a result, when they are asked to compare two numbers, they may decide the magnitude of the number based on the way it is written rather than its value, and they may say that the number written larger is larger.

There are different dyscalculia diagnostic methods in the literature (Filiz, 2021). One of these methods is direct diagnostics. Using checklists prepared by taking into account the characteristics specific to dyscalculic individuals, it is decided by direct observation whether the individual shows signs of dyscalculia or not (Mutlu, 2016). The other method is the inconsistency model, which is based on the inconsistency between an individual's intelligence score and math test score (Butterworth, 2003). The response to intervention model, which is a progressive model, is one of the dyscalculia recognition models. It aims to identify dyscalculic individuals by gradually applying interventions to individuals who are academically underachieving and at risk of learning difficulties (Mutlu & Olkun, 2019). There are also computer-based models of dyscalculia recognition. The dyscalculia browser is an example of this model. Considering the individual's innate mathematical skills, a test consisting of three parts is prepared, and the evaluation is made with the number of correct answers the individual gives to this test and the time taken to answer the test (Butterworth, 2003). In addition to these, dyscalculia can be determined separately with EfT [Enriched for Turkey] and CEEED [Candidate Selection-Examination-Exclusion-Elimination-Decision] diagnostic models or by combining these two models as they complement each other and creating a neuro-psycho-pedagogical diagnostic model (Coştu, 2019).

The medical world advocates intervention studies for the treatment of dyscalculia since there is no drug treatment (Aquil & Ariffin, 2020). Mathematics can be taught to dyscalculic individuals by using direct instruction, concrete-to-abstract instruction, game-based mathematics teaching, and technology-assisted instruction together (Benavides-Varela et al., 2020; Mutlu & Akgün, 2019). Other effective intervention studies include teaching using abacus (Lu et al., 2021), digital-based interventions (Benavides-Varela et al., 2020), using various learning methods and techniques (Kumar & Raja, 2012), and individualized instruction (Kumar & Raja, 2012). These studies increase individuals' mathematics

achievement. Another useful tool that increases math achievement is music training (Ribeiro & Santos, 2017).

Dyscalculia causes serious difficulties in an individual's social and educational life. By intervening in dyscalculic individuals promptly, the difficulties caused by dyscalculia can be minimized. Teachers and parents are extremely important in the early recognition of dyscalculia. Considering the high prevalence rate of dyscalculia in society, that is, the high number of dyscalculic individuals in society (Butterworth, 2005), correct and effective intervention to be applied to dyscalculic individuals promptly is an important need. Although teachers are the most effective people in meeting this need, studies investigating teachers' knowledge levels and awareness of dyscalculia have revealed that mathematics teachers do not have knowledge about dyscalculia and intervention (Sezer & Akın, 2011; Karadeniz, 2013; Nurkan & Yazıcı, 2020), classroom teachers lacked awareness of dyscalculia and could not conduct an effective intervention study for dyscalculic individuals, and although pre-service classroom teachers have awareness of dyscalculia, they do not know the detection and intervention of dyscalculia and have misconceptions about dyscalculia (Kuruyer et al., 2019).

In this study, the awareness and knowledge levels of secondary school mathematics teachers about dyscalculia were determined. The study aimed to determine the missing or incorrect knowledge of teachers for the diagnosis and intervention of dyscalculia and to raise awareness in order to eliminate these deficiencies in teachers. Since teachers are the first people who can recognize the symptoms indicating that an individual is dyscalculic, the study aimed to increase teachers' awareness of dyscalculia and to provide early diagnosis and correct intervention for dyscalculic individuals. Early diagnosis and timely intervention of dyscalculia will increase the academic success of individuals. Increasing an individual's mathematics achievement will improve the individual's life psychologically and socially as well as move the individual forward academically. Because dyscalculia will continue its effect until later ages when it is not corrected and that the education of dyscalculic individuals is costly because it is one-to-one and special education, early diagnosis, and promptly correct intervention will also avail the national economy.

1.1. Theoretical/Conceptual Framework

What is dyscalculia and what are its symptoms?

Dyscalculia is when an individual's mathematical performance is below that of their peers, despite there being no impairment in their cognitive development or sensory organs, no

psychosocial or neurological issues, and no educational deficits (WHO, 2020). Bird (2017) indicated that although an individual may have normal academic achievement in their studies, struggling with even simple, basic numerical operations and resorting to using their fingers for arithmetic operations even in later years could raise suspicion of dyscalculia. Furthermore, Bird highlighted characteristics of individuals with dyscalculia in daily life, such as difficulty in controlling time, problems with spatial orientation, slow processing, difficulties in counting and counting backwards, inability to solve problems, and weaknesses in learning mathematical shapes and visual skills. Examining the classroom behaviors of dyscalculic individuals, Acar and Hiğde (2018) reported observations regarding the classroom behaviors of individuals diagnosed with dyslexia and dyscalculia as follows: Although the individual may not engage in disruptive behavior that would disrupt the flow of the class or disturb the class, they exhibit behaviors that indicate boredom. These behaviors include attempting to pass the time by dropping their pen and trying to pick it up, staring out of the window, not participating in the class, and remaining silent during class. Dyscalculic individuals may exhibit such behaviors in the classroom.

What are the Causes of Dyscalculia?

Researchers have proposed two hypotheses regarding the causes of dyscalculia. According to the domain-general factors hypothesis, dyscalculia arises due to deficiencies in certain cognitive functions in the brain (Can, 2020). On the other hand, the domain-specific factor hypothesis suggests that dyscalculia is caused by difficulties in the innate numerical sense, number module, or number core knowledge in the individual's numerical memory (Mutlu, 2016). Kucian and Von Aster (2015) have noticed that during arithmetic problem-solving, dyscalculic individuals show no brain activity in any module of the brain. Consequently, researchers have concluded that dyscalculic individuals fail to adequately utilize the visual-spatial component of their working memory while solving arithmetic problems (Kucian & Von Aster, 2015).

"Dyscalculia Diagnosis

To diagnose dyscalculia, direct observation can be conducted considering the individual's characteristics and using dyscalculia symptom checklists (Mutlu, 2016). The response-to-intervention method, which consists of identifying students in need of academic support and providing necessary interventions, can be employed (Mutlu & Olkun, 2019). Another dyscalculia diagnostic model is the inconsistency model. It checks for inconsistencies between the individual's intelligence test score and their performance on a mathematics test (Mutlu, 2016). Yet another model is the Multi Filter Model (MFM). This

model diagnoses the individual by passing them through 5 different filters (Mutlu & Akgün ,2017).

‘Dyscalculia Intervention

A number of intervention studies should be applied to individuals diagnosed with dyscalculia. They can start with easier tasks and gradually move on to more difficult exercises (Mutlu & Akgün, 2017). In addition, technology-supported interventions may be advantageous as they remove dyscalculic individuals from social environments that negatively affect them (Kucian & Von Aster, 2015). In Malaysia, a mobile application was designed for the education of dyscalculic individuals. The application emphasises teacher feedback and aims to provide effective mathematics education for dyscalculic individuals (Mazeyanti et al., 2017). A favourite activity that takes place in every child's life as sensory as possible is play (Saygılı, 2017). Repetition is very important and necessary for dyscalculic individuals. It is very logical to use games in situations that require repetition. Individuals of all age groups, especially children, enjoy spending time playing games. Games provide educators with the opportunity to teach from simple to complex. Games facilitate active participation in the learning process and effective learning by engaging individuals in various learning environments, different stimuli, different experiences, and eliciting various emotions (Bird, 2017).

1.2. Literature Review

Citizens require arithmetic skills in their daily, social, and academic lives (Kaçar, 2018). Dyscalculia adversely affects the lives of individuals and families. Dyscalculic individuals face many difficulties in daily life. These difficulties include inability to calculate change for money, confusing 6 and 9 when using phones or elevators, failure to recognize that the symbol '8' is the same as the word 'eight', inability to solve problems, and inability to narrate the sequence of events correctly. In addition to facing numerous challenges in daily life, there may be individuals in their surroundings who think dyscalculic individuals have an intelligence problem. Furthermore, when an individual believes they have an intelligence problem, they may blame themselves, develop a hatred for mathematics, believe they can never do math, and exhibit avoidance behavior when confronted with mathematics.

Early diagnosis is crucial for effective intervention in dyscalculia. Since brain activity decreases with age, it is essential to diagnose dyscalculia at an early age and prepare a

suitable study plan for the individual. When dyscalculia is diagnosed early, ways to cope with dyscalculia can be found, and suitable tactics and skills can be imparted to the individual. If dyscalculia is not diagnosed early, mathematics can turn into a nightmare for the student, and many learning opportunities will be missed (Cornue, 2018). However, according to research, most teachers do not have sufficient knowledge about dyscalculia (Fu & Chin, 2017; Karasakal, 2018; Mutlu et al., 2022; Nurkan & Yazıcı, 2020) and teachers do not know about intervention programmes for dyscalculia (Kaçar, 2018; Mutlu et al., 2022). Middle school mathematics teachers, who continue to teach basic math skills that are an extension of elementary school, play a significant role in diagnosing dyscalculia and providing effective and accurate intervention. The aim of this study is to investigate the awareness and knowledge levels of secondary school mathematics teachers about dyscalculia. The study aims to provide early diagnosis and correct intervention to dyscalculic individuals by increasing teachers' awareness of dyscalculia.

2. Method

2.1. The Design of The Study

In this study, it was aimed to investigate the awareness of secondary school mathematics teachers about dyscalculia, its causes, symptoms, prevalence rate in society, intervention, characteristics of dyscalculic children, and the effects of dyscalculia on the lives of dyscalculic children, and to raise awareness for correction by revealing their missing or incorrect knowledge. This research was conducted with the survey model. The survey model attempts to describe an existing event or situation as it is. It does not make an experimental intervention to the incidents, it expresses the incidents as they are (Çepni, 2014). In survey models, the result that the research wants to reach is expressed with questions. Questions such as “What is it?” express the desired result of the research, that is, the purpose of the research. At the end of the research, questions such as the “what” question expressing the purpose of the research are answered, while it is not possible to answer the “why” question (Büyüköztürk, 2016).

2.2. The Data Collection Process and Tools

In the study, a questionnaire was used to collect data based on teachers’ views. In the development of the questionnaire, firstly, national and international literature on the research topic was reviewed. The questionnaire developed by Bevan and Butterworth (2002), the

semi-structured interview form developed by Wadlington et al. (2006), and the questionnaire developed by Fu Sai Ho and Kin Eng Chin (2017) were used to obtain teachers' views on dyscalculia. A question pool was created for the questionnaire and appropriate questions were selected from this pool. In order to determine whether the questions in the questionnaire were compatible with the conceptual framework and whether this framework was a guide for data collection, the questions in the questionnaire were submitted to the opinions of three academicians who are experts in the field of mathematics education. In accordance with expert opinions;

• The question aiming to learn the university from which the participants graduated has been removed as it is not relevant to the purpose.

• "Other" or "Partially" options have been added to information questions.

• The sentence "You can select multiple options" has been added to questions where multiple choices can be marked.

• Clearer expressions have been preferred instead of words and phrases that may cause misunderstanding in question sentences. One of the two similar items identified in the last question of the survey has been removed. Following these changes, it has been concluded that the questions are understandable. The questions in the survey have been categorized under the following headings:

• Is the frequency of dyscalculia known?

• Are the characteristics of dyscalculic students known?

• Can teachers intervene correctly with dyscalculic students?

• Can teachers recognize dyscalculic students in their classes? The first section is intended to measure teachers' awareness of dyscalculia and their knowledge of the definition of dyscalculia to determine teachers' deficiencies in understanding dyscalculia. The second section aims to understand teachers' ability to correctly diagnose dyscalculia and their level of awareness in identifying dyscalculic students in the classroom. The last question and subheadings aim to determine whether teachers can intervene correctly and to reveal their deficiencies in this regard. The survey consists of a total of 21 questions.

The questionnaire was finalized in line with the reviews and feedback of the field experts.

2.3. The Participants

The sample of the study consisted of 83 secondary school mathematics teachers working in public schools in Erzurum city center. In the study, 150 mathematics teachers

were reached, 83 of them voluntarily agreed to participate in the study and answered the questions in the questionnaire. In this study, a convenience sampling technique was used. Of the participants, 39 (47%) were male and 44 (53%) were female. 11 participants had 0-5 years of professional experience, 35 participants had 6-10 years, 16 participants had 11-15 years, 14 participants had 16-20 years, and 7 participants had more than 20 years of professional experience. 3 teachers have a doctorate, 20 teachers have a master's degree and the other 60 teachers have a bachelor's degree.

2.4. The Data Analysis

Through the Directorate of National Education, a link to the questionnaire created with Google Forms was sent to secondary school mathematics teachers working in public schools in the city center. The teachers answered the questionnaire independently of the researcher. The results were saved in the researcher's drive folder. The results are presented as they are with percentage and frequency tables.

2.5. Reliability and Validity

The research was conducted with a sample consisting of teachers from various age groups, with diverse experiences and demographic characteristics, working in the central district of Erzurum province. In order to enhance the internal validity of the survey, expert opinions (Çepni, 2014) were considered the most scientific approach, and the final version of the survey was determined through expert review. It was concluded that the survey questions accurately measured the target attribute without confounding it with other characteristics, based on expert opinions. Considering that the validity of the research is to reveal the extent to which the target variable to be measured can be measured (Yılmaz, 1996; cited in Terzi, 2019), the validity of the research was ensured. Furthermore, other precautions taken to ensure the validity of the research included the absence of the researcher's involvement during the implementation phase, minimizing the possibility of researcher bias, and presenting the research results directly to the reader without adding interpretations. Presenting the results alongside raw data has made the interpretation process consistent with the data collection process, thus ensuring the reliability of the research.

2.6. Ethics, Acknowledgements, Conflict of Interest and Authorship Contribution Statement

The questionnaire was examined by the Atatürk University Social and Humanities Educational Sciences Unit Ethics Committee where the researchers work and it was decided to be ethically appropriate with decision number 2 on 18.06.2021. For the questionnaire, the application permission numbered E-36648235-605.01-32386328 was obtained from the Erzurum Provincial Directorate of National Education on 20.09.2021.

3. Findings/Results

In this section, the findings obtained from the questionnaire form applied to secondary school mathematics teachers and the interpretations related to these findings are presented.

Table 1. *Teachers' answers to the question "Do you know about dyscalculia?"*

Options	f	*%*
No	45	54
Yes	19	23
Partially	19	23

According to Table 1 which includes the responses of 83 teachers, 54% of the teachers had no knowledge about dyscalculia. Although 23% of the teachers did not have clear information about dyscalculia, they chose the option "I have some knowledge about dyscalculia". The rate of teachers who selected the option "I have knowledge about dyscalculia" was 23%. It was observed that 27% of female teachers and 17% of male teachers had knowledge about dyscalculia. In the study, it was concluded that 20% of mathematics teachers with bachelor's degrees, 35% of mathematics teachers with master's degrees, and 33% of mathematics teachers with a doctoral degree had knowledge about dyscalculia. When the dyscalculia awareness of teachers according to their years of experience was analyzed, the group of teachers with the highest dyscalculia knowledge (45%) were teachers with 11-15 years of experience. Then, the group with the highest awareness of dyscalculia (36%) is the teachers with 20 years of professional experience or more. Teachers with 6-10 and 16-20 years of professional experience have the same level of dyscalculia awareness (29%). The group with the least dyscalculia knowledge (18%) were the teachers with 0-5 years of professional experience. The questionnaire was terminated for teachers who answered "no" to the question "Do you know about dyscalculia?". Question 2 and the following questions were

directed to 38 teachers who answered “I have knowledge about dyscalculia” and “I have some knowledge about dyscalculia”.

Table 2. *Teachers’ responses to the question “Where did you first encounter the concept of dyscalculia?”*

Variables	*Teachers with knowledge of dyscalculia*		*Teachers with partial knowledge of dyscalculia*	
Options	f	%	f	%
Social Media	4	21	8	42
In my work life	7	37	6	31
At my university	4	21	4	21
Other	4	21	1	5

According to the data of the study, 8 teachers encountered the term dyscalculia for the first time during their university education. Of these 8 teachers, 4 had knowledge about dyscalculia. The others have partial knowledge of dyscalculia. 12 teachers encountered the term dyscalculia for the first time on social media and 13 teachers encountered the term dyscalculia for the first time in their professional life. Among the teachers who had knowledge about dyscalculia, 4 of them chose the other option. Among these 4 teachers, 3 of them stated that they first heard the term dyscalculia from family members who are child development graduates, and 1 of them stated that he encountered the term dyscalculia for the first time during the literature review while writing his thesis. None of the teachers encountered the concept of dyscalculia in in-service training. Teachers have never encountered dyscalculia in their family members.

Table 3. *Teachers’ responses to the question “Have you participated in any training on dyscalculia?”*

Variables	*Teachers with knowledge of dyscalculia*		*Teachers with partial knowledge of dyscalculia*	
Options	f	%	f	%
I did not take it as a training or a course	18	95	18	95
I took it as a lecture at my university	1	5	1	5

95% of the teachers who stated that they had knowledge of dyscalculia and partial knowledge of dyscalculia did not participate in any training related to dyscalculia. A total of 2 teachers, only one of the 19 teachers who had knowledge about dyscalculia and only one of the 19 teachers who did not have knowledge about dyscalculia, stated that they received training about dyscalculia.

Table 4. *Teachers' answers to the question "What do you think dyscalculia is?"*

Variables	Teachers with knowledge of dyscalculia		Teachers with partial knowledge of dyscalculia	
Options	f	%	f	%
It is a math learning disability	15	79	17	89
It is a learning disability	1	5	1	5
İt is a math dyslexia	3	16	1	5

Among the teachers who stated that they had knowledge about dyscalculia, 79% knew the correct meaning of the term. This rate was 89% for teachers who have partial knowledge of dyscalculia. On the other hand, it was seen that a total of 4 teachers, 1 with partial knowledge of dyscalculia and 3 with knowledge about dyscalculia, thought that dyscalculia was mathematics dyslexia. On the other hand, 1 teacher with partial knowledge of dyscalculia and 1 teacher with knowledge of dyscalculia thought that dyscalculia was a learning disability.

Table 5. *Teachers' answers to the question "What does dyscalculia cause in students?"*

Variables	Teachers with knowledge of dyscalculia		Teachers with partial knowledge of dyscalculia	
Options	f	%	f	%
Failure in educational and professional life	18	95	10	53
Psychological disturbance	11	58	9	47
Anxiety	16	84	9	47
Carelessness	10	53	8	42
Disturbances in social life	12	63	3	16

In this question and the other questions, teachers were able to tick more than one option. The questions were answered by 38 teachers, including 19 teachers with knowledge of dyscalculia and 19 teachers with partial knowledge of dyscalculia. In this question, when teacher awareness about the situations caused by dyscalculia was examined, it was concluded that the situation in which teacher awareness was high was that dyscalculia causes anxiety and failure in education and professional life. Teacher awareness of that dyscalculia causes psychological discomfort to the individual was low. The situation with the lowest teacher awareness was the effect of dyscalculia on social life.

Table 6. *Teachers' answers to the question "What are the Causes of Dyscalculia?"*

Variables	Teachers with knowledge of dyscalculia		Teachers with partial knowledge of dyscalculia	
Options	f	%	f	%
Attention deficit	7	37	12	63
Hereditary causes	10	53	10	53
Emotional problems	4	21	5	26
Low quality of education	5	26	4	21
Social problems	7	37	4	21
Mental retardation	0	0	2	11
Damage to the brain	2	11	1	5
I do not know	1	5	0	0

When the teachers' opinions on the causes of dyscalculia are examined, 53% of the teachers who said "I have knowledge about dyscalculia" thought that dyscalculia has hereditary causes. This rate was also 53% among teachers with partial knowledge of dyscalculia. The remaining teachers did not think that dyscalculia could have hereditary causes. In addition, 37% of the teachers who reported having knowledge about dyscalculia and 63% of the teachers with partial knowledge of dyscalculia had knowledge that attention deficit is a cause of dyscalculia. Another finding is that only 11% of the teachers with partial knowledge of dyscalculia had the knowledge that mental retardation can cause dyscalculia. None of the teachers with knowledge of dyscalculia thought that mental retardation can cause dyscalculia. On the other hand, 11% of the teachers with knowledge of dyscalculia and 5% of the teachers with partial knowledge of dyscalculia had the knowledge that dyscalculia can occur as a result of brain damage. In line with the answers, it was noticed that 9 teachers, 5 of whom had knowledge of dyscalculia and 4 of whom had partial knowledge of dyscalculia, thought that low quality of education would cause dyscalculia. It is seen that 26% of the teachers who had knowledge about dyscalculia and 21% of the teachers who had partial knowledge thought that low quality of education causes dyscalculia. Another finding is that 21% of the teachers who had knowledge about dyscalculia and 26% of the teachers who had partial knowledge had the knowledge that emotional problems cause dyscalculia. In addition, it was observed that a total of 11 teachers, 7 teachers who had knowledge about dyscalculia and 4 teachers who had partial knowledge, had the knowledge that social problems can cause dyscalculia. That is, 37% of teachers with knowledge of dyscalculia and 21% of teachers with partial knowledge of dyscalculia had the knowledge that social problems cause dyscalculia.

Table 7. *Teachers' responses to the question "Which of the following are symptoms of dyscalculia?"*

Variables	Teachers with knowledge of dyscalculia		Teachers with partial knowledge of dyscalculia	
Options	f	%	f	%
Failure to learn multiplication tables	14	74	15	79
Confusing mathematical signs and symbols	18	95	14	74
Lack of attention	9	47	12	63
Difficulty counting forward and backward	16	84	12	63
Doing four operations too slowly	14	74	9	47
Confusing geometric shapes	10	53	9	47
Inability to solve problems	13	68	8	42
Miscalculating when giving change	13	68	6	32
Lack of interest in mathematics	14	74	5	26
Not understanding fractions	10	53	5	26
Misplacing numbers on the number line and coordinate system	11	58	5	26
Being disoriented	12	63	5	26
Not understanding the changing properties of multiplication and addition	9	47	4	21
Continuous use of ten fingers	11	58	4	21
Inability to learn due to lack of education	3	16	3	16
Visual or auditory deficit	1	5	3	16
Difficulty remembering phone numbers	12	63	3	16
Problems with visual and spatial functions	8	42	3	16
Being dyslexic	5	26	2	11
Inability to understand the lesson due to lack of sensory organs	2	11	1	5
Inability to keep track of time	9	47	1	5

When Table 7 is examined, it is seen that 16% of the teachers who had knowledge of dyscalculia had the knowledge that the inability to learn due to lack of education is a symptom of dyscalculia. This rate is the same for teachers with partial knowledge of dyscalculia. Another finding was that teachers had the knowledge that not being able to understand the lesson due to the lack of sensory organs is a symptom of dyscalculia. The proportion of teachers with this knowledge was 11% among teachers with dyscalculia knowledge and 5% among teachers with partial dyscalculia knowledge. Another finding is related to teachers who thought that having dyslexia was a symptom of dyscalculia. 26% of the teachers with knowledge of dyscalculia and 11% of the teachers with partial knowledge of dyscalculia defended this information. The rate of teachers who thought that lack of attention is a symptom of dyscalculia was 47% among teachers with knowledge of dyscalculia and 63% among teachers with partial knowledge of dyscalculia. It is noteworthy

that the rate is higher than the other findings. In addition to these findings, the percentage of teachers who thought that lack of interest in mathematics is a sign of dyscalculia is 74% among teachers with knowledge of dyscalculia and 26% among teachers with partial knowledge of dyscalculia. Subsequently, it is also noteworthy that there are fewer teachers who thought that visual or auditory deficit is a sign of dyscalculia. Only 5% of teachers with knowledge of dyscalculia and 16% of teachers with partial knowledge of dyscalculia thought that visual and auditory deficits are a sign of dyscalculia. The awareness of difficulty in forward and backward counting as a symptom of dyscalculia was 84% among teachers with knowledge of dyscalculia and 63% among teachers with partial knowledge of dyscalculia. The highest teacher awareness belongs to the symptom of confusing math signs and symbols. The awareness of this symptom was 95% among teachers with knowledge of dyscalculia, while it was lower (74%) among teachers with partial knowledge of dyscalculia. Teacher awareness that difficulty in remembering phone numbers is a sign of dyscalculia was found to be 63% among teachers with knowledge of dyscalculia and 16% among teachers with partial knowledge of dyscalculia. Another option for which we can say that teacher awareness is high was the inability to learn multiplication tables. The awareness rate of teachers with partial dyscalculia knowledge (79%) and the awareness rate of teachers with dyscalculia knowledge (74%) are close to each other. The next is teacher awareness that doing four operations very slowly is a sign of dyscalculia. Teacher awareness that doing four operations very slowly is a sign of dyscalculia is 74% among teachers with dyscalculia knowledge and lower (47%) among teachers with partial dyscalculia knowledge. Following this finding, another finding with high teacher awareness is the finding that teacher awareness that the inability to solve problems is a sign of dyscalculia was 68% for teachers with knowledge of dyscalculia and 42% for teachers with partial knowledge of dyscalculia. Teacher awareness that inability to solve problems is a sign of dyscalculia was close to teacher awareness that being surprised when giving change is a sign of dyscalculia. 68% of teachers with dyscalculia knowledge and 32% of teachers with partial knowledge of dyscalculia were aware that being surprised while giving change is a sign of dyscalculia. When ranking according to the high rate of teacher awareness, the option of disorientation comes next. Awareness that disorientation is a sign of dyscalculia was 63% among teachers with dyscalculia knowledge and 26% among teachers with partial dyscalculia knowledge. Teacher awareness that using fingers continuously and misplacing numbers on the number line and coordinate system is a sign of dyscalculia was found to be at the same rate (58%) in teachers with dyscalculia knowledge. The awareness of teachers with partial knowledge of dyscalculia was lower and

the awareness of placing numbers incorrectly on the number line and coordinate system as a sign of dyscalculia was 26%, and the awareness of using ten fingers continuously as a sign of dyscalculia was 21%. Two awarenesses with the same percentage are that confusing geometric shapes and not understanding fractions are symptoms of dyscalculia. 53% of teachers with dyscalculia knowledge were aware of these symptoms. Teachers with partial knowledge of dyscalculia had 47% awareness that confusing geometric shapes is a sign of dyscalculia and 26% awareness that not understanding fractions is a sign of dyscalculia. However, the two options with lower awareness rates than the others and with the same awareness rate are that not understanding the changing property of multiplication and addition and not keeping track of time are signs of dyscalculia. 47% of teachers with dyscalculia knowledge were aware that these two symptoms are signs of dyscalculia. Among teachers with partial knowledge of dyscalculia, 5% were aware that not being able to keep track of time was a sign of dyscalculia, and 21% were aware that not understanding the changing properties of multiplication and addition was a sign of dyscalculia. In addition, 42% of teachers with knowledge of dyscalculia were aware that having problems in visual and spatial processing is a sign of dyscalculia. This awareness was realized in 16% of teachers with partial knowledge of dyscalculia.

The knowledge that the symptoms of dyscalculia can appear as early as the preschool period was possessed by 79% of the teachers with knowledge of dyscalculia and 68% of the teachers with partial knowledge of dyscalculia. For the existence of an agreed-upon test for the diagnosis of dyscalculia, 47% of the teachers who had the knowledge that there is no test that makes a definitive diagnosis of dyscalculia is the same for teachers with knowledge of dyscalculia and teachers with partial knowledge of dyscalculia. The proportion of teachers who had the knowledge that there is an agreed-upon test for the diagnosis of dyscalculia (53%) was the same for teachers with knowledge of dyscalculia and teachers with partial knowledge of dyscalculia.

The next question is a true-false question and is about whether individuals can overcome dyscalculia. The answers showed that teachers were aware that the effects of dyscalculia can be partially or completely eliminated depending on the characteristics of the student.

Table 8. *Teachers' responses to the question "Have you ever encountered a situation that raises the suspicion of dyscalculia in your professional life?"*

Variables	Teachers with knowledge of dyscalculia		Teachers with partial knowledge of dyscalculia	
Options	f	%	f	%
Yes	8	42	9	48
No	9	47	5	26
Partially	2	11	5	26

To the question "Have you ever encountered a situation suspicious of dyscalculia during your professional life?" 17 of the teachers answered yes, 14 of them answered no, and 7 of them answered partially. Among the teachers with knowledge of dyscalculia, 42% stated that they had encountered a situation suspicious of dyscalculia, 11% stated that they had partially encountered a situation suspicious of dyscalculia, and 47% stated that they had never encountered a situation suspicious of dyscalculia. Among the teachers with partial knowledge of dyscalculia, 48% stated that they had encountered a situation suspicious of dyscalculia, 26% stated that they had partially encountered a situation suspicious of dyscalculia, and 26% stated that they had never encountered a situation suspicious of dyscalculia.

The next question was asked to the 24 teachers who stated that they had encountered a situation that aroused suspicion of dyscalculia or partially encountered such a situation. The question "What was your behavior when you encountered a dyscalculic student?" was asked to measure the awareness of teachers about the correct intervention for dyscalculic individuals. For this question, more than one option can be marked.

Table 9. *Teachers' responses to the question "How did you behave when you encountered a dyscalculic student?"*

Variables	Teachers with knowledge of dyscalculia(10)		Teachers with partial knowledge of dyscalculia(14)	
Options	f	%	f	%
I made them do repetitive activities	3	13	11	46
I referred them to the school's guidance service	7	29	9	38
I continued to teach in different ways	8	33	7	29
I tried to ensure that the students learn from the beginning by using the materials	9	38	6	25
I contacted their families and referred them to the Guidance and Research Center	4	17	3	13
I patiently guided the student	4	17	3	13
I assessed with a special tool to make sure the child was dyscalculic	0	0	2	8

When Table 9 is examined, it is determined that almost half of the teachers who had knowledge about dyscalculia were of the opinion that it is necessary to use materials in teaching, to use different methods, to have the student do repetitive activities and to refer the student to the school's guidance service. Only 2 teachers were of the opinion that "assessment should be done with a special tool". 4 teachers stated that the student should be guided with patience and 4 teachers stated that the student should be referred to the Guidance and Research Center.

The next question was directed to 14 teachers who stated that they had never encountered a situation that aroused suspicion of dyscalculia in their professional lives. The aim was to determine the opinions of the teachers about whether they would be able to recognize a dyscalculic student when they encountered a situation suspicious of dyscalculia. While 4 teachers thought that they could recognize a dyscalculic student, 10 teachers thought that they could partially recognize a dyscalculic student.

For the question "What would you do if you encountered a student with dyscalculia?", more than one option can be marked. The question was posed to 14 teachers who stated that they had never encountered a case of suspected dyscalculia in their professional lives. To this question, 4 teachers answered "I try to make the student learn from the beginning by using materials", 2 teachers answered "I make the student do repetitive activities", 4 teachers answered "I continue teaching with different methods", 10 teachers answered "I refer the student to the school's guidance service", 11 teachers answered "I refer the student to the guidance and research center by interviewing the family", 4 teachers answered "I assess with a special tool to make sure that the child is dyscalculic", 5 teachers answered "I guide the student patiently".

The next question is "What characteristics does a dyscalculic student usually show?" and more than one option can be marked for this question.

When Table 10 is analyzed, it is seen that 11 teachers stated "They have dyslexia", 16 teachers stated "They make calculations with the help of fingers", 15 teachers stated "They cannot estimate approximate values", 17 teachers stated "They experience weaknesses in short and long-term memory", 24 teachers stated "They fail at problem-solving. They process very slowly", 19 teachers stated "They have problems with Money calculation", 2 teachers stated "They have hyperactivity" 24 teachers stated "They cannot order events and numbers correctly", 16 teachers stated "They learn to read the time late", 11 teachers stated "They cannot manage time" 8 teachers stated "They have difficulty in writing", 26 teachers stated

"They are careless", and 31 teachers stated "They confuse symbols with one another. They have difficulty in reading and writing symbols".

Table 10. *Teachers' answers to the question "What Characteristics Does a Dyscalculic Student Mostly Show?"*

Variables	Teachers with knowledge of dyscalculia		Teachers with partial knowledge of dyscalculia	
Options	f	%	f	%
They confuse symbols with one another. They have difficulty in reading and writing symbols	17	89	14	74
They are careless	14	74	12	63
They fail at problem-solving. They process very slowly	13	68	11	58
They cannot order events and numbers correctly	14	74	10	53
They experience weaknesses in short and long-term memory	10	53	7	37
They have dyslexia	5	26	6	32
They make calculations with the help of fingers	11	58	5	26
They cannot estimate the approximate value	10	53	5	26
They have difficulty in writing	3	16	5	26
They have problems with money calculation	15	79	4	21
They learn to read the time late	12	63	4	21
They cannot manage time	9	47	2	11
They have hyperactivity	2	11	0	0

For the question, "How should mathematics be taught to dyscalculic students?", more than one option can be marked. The question was answered by 38 teachers. 22 teachers said "They should be directed to the Guidance and Research Center", and 7 teachers said "It should be taught with peer guidance", 12 teachers said "Plenty of home exercises should be done outside of school", 26 teachers said "Educational games should be preferred in teaching and learning should be ensured while having fun by oneself", 11 teachers said "Teaching should be done by designing activities suitable for the achievements of the current class, 3 teachers said "Brain functions should be checked continuously with the help of a doctor", 6 teachers said "Since the problem will be solved when the understanding of mathematics improves, it should be practiced on this subject continuously", 24 teachers said "Teaching should be done with special programs prepared for the teaching of dyscalculic students", 9 teachers said "Subjects should be taught to students in a hierarchically structured manner", 10 teachers said "Too much repetition should be done", 23 teachers said "Necessary motivation should be provided to reduce anxiety", and 17 teachers said "Teaching should be done with activities that appeal to as many senses as possible".

4. Discussion and Conclusion

It was found that 23% of the middle school mathematics teachers who participated in the study were aware of dyscalculia. This finding is in line with other studies which found that most of the teachers did not have sufficient knowledge about dyscalculia (Akın & Sezer, 2011; Fu & Chin, 2017; Karasakal, 2018; Nurkan & Yazıcı, 2020; Mutlu, Çalışkan & Yasul, 2022).

In this study It was observed that 27% of female teachers and 17% of male teachers had information about dyscalculia. From that, it was concluded that female teachers were more aware of dyscalculia than male teachers. Unlike this finding, Sousa et al. (2017) stated that there was no difference in primary school teachers' knowledge of dyscalculia according to gender.

And then based on the data that 20% of mathematics teachers with bachelor's degree, 35% of mathematics teachers with master's degree and 33% of mathematics teachers with doctorate degree had knowledge about dyscalculia, it was concluded that teachers' awareness of dyscalculia did not increase linearly with educational level. Similarly, Apak (2022) found that preschool teachers' awareness of learning disabilities did not differ according to their level of education.

According to the findings of this study, only two teachers received any training on dyscalculia. Other teachers did not receive any training on dyscalculia. Therefore, it can be said that in-service trainings organized for teachers and special education courses at universities are insufficient in this sense. This finding is in line with other studies showing that teachers did not receive any training on dyscalculia (Fu & Chin 2017). According to the study, no teacher heard the term dyscalculia among family members. Considering the high prevalence rate of dyscalculia in society, it is estimated that teachers and their environment did not hear the term dyscalculia among family members because they did not know dyscalculia. Teachers who thought that they had knowledge of dyscalculia did not have any training on dyscalculic student recognition or dyscalculia intervention, although they encountered the term dyscalculia. Sezer and Akın (2011) also found that none of the participant teachers had heard the term dyscalculia before. However, it was observed that teachers were willing to receive help and training on dyscalculia. In the study by Yangın et al. (2016), approximately 96% of pre-service teachers stated that types of learning disabilities were not included in undergraduate courses. It was suggested to include practices in special education courses in the 3rd and 4th years of university. One of the two teachers who participated in Nurkan and Yazıcı's (2020) study took a course on dyscalculia and stated that

she had knowledge of dyscalculia but felt inadequate in the recognition and intervention of dyscalculia. The other teacher who participated in the study stated that she had never received any training on dyscalculia.

According to the findings, most of the teachers(%79) who stated that they had knowledge about dyscalculia knew the correct meaning of the term dyscalculia. A small number of teachers were misinformed that dyscalculia is math dyslexia and dyscalculia is a learning disability. This finding is in line with the teacher misconceptions about the term dyscalculia identified in Nurkan and Yazıcı's (2020) study. Differently, Nurkan and Yazıcı (2020) noticed that teachers also had the misconception that "dyscalculia is a disease". In our study, in the options of the question "What is dyscalculia?", there is the option "dyscalculia is a joint disorder". However, none of the teachers preferred this option. Different from the study by Başar and Göncü (2018), it was observed that teachers did not have misconceptions that dyscalculia is a joint disease. According to research, dyscalculia can co-occur with inattention or other learning disorders but does not cause inattention (Butterworth, 1999). More than half of the teachers had incomplete knowledge about the fact that dyscalculia causes psychological discomfort to the individual. It was observed that very few teachers were aware that dyscalculic individuals experience discomfort in social life. In Nurkan and Yazıcı's (2020) study, the participants stated that dyscalculic students experienced loneliness and distraction problems. Most of the teachers who stated that they had knowledge about dyscalculia were aware that dyscalculia causes anxiety and failure in educational and professional life. Approximately half of the teachers were aware that dyscalculia negatively affects students' social relations. Similarly, in Sezer and Akın's (2011) study, participant teachers stated that students' being uninterested, unresponsive, and timid towards the lesson negatively affected students' social relations. In other studies on this subject, participant teachers stated that dyscalculia negatively affected students' social relationships (Bevan & Butterworth, 2002; Wadlington et al. 2006).

When the answers to the question about the causes of dyscalculia were analyzed, about half of the teachers knew that dyscalculia has hereditary causes. Very few of the teachers knew that dyscalculia can occur as a result of brain damage. Half of the teachers had the wrong information that attention deficit is a cause of dyscalculia. Few of the teachers had misconceptions that mental retardation can cause dyscalculia and about one-third of the teachers had misconceptions that low quality of education, and social and emotional problems can cause dyscalculia. The misconception that mental retardation causes dyscalculia observed in teachers was also found in Kaçar's study in 2018.

It was observed that some of the teachers who stated that they had knowledge about dyscalculia had misconceptions such as lack of sensory organs, dyslexia, and inability to learn due to lack of education. Most, if not all, of the teachers who had knowledge about dyscalculia, were aware that problems such as difficulty in forward and backward counting, confusion of mathematical signs and symbols, and inability to learn the multiplication table are symptoms of dyscalculia. The symptoms that follow the above-mentioned symptoms in terms of high teacher awareness were not being able to solve problems, doing the four operations very slowly, being surprised when giving change, confusing geometric shapes, lack of attention, and lack of interest in mathematics lessons. Approximately one out of every three teachers who had knowledge of dyscalculia were aware of other symptoms of dyscalculia. The results are in line with some of the results of Baldemir (2020), Kaçar (2018), and Sezer and Akın (2011).

It was observed that the teachers who had knowledge about dyscalculia did not have the knowledge that dyscalculia symptoms can also be seen in the preschool period. It can be concluded that these teachers had incorrect knowledge about the time of onset of dyscalculia symptoms.

It was also noticed that teachers had correct knowledge that dyscalculia can be overcome partially or completely according to the characteristics of the student.

Most of the teachers who thought that they did not encounter dyscalculia argued that when they encountered a dyscalculic student, the student should be referred to the Guidance and Research Center or the school's guidance service. This finding is consistent with Baldemir's (2020) finding that pre-service mathematics teachers wanted to receive expert support when they encountered a dyscalculic student and Sezen and Akın's (2011) finding that teachers see expert help as a need for dyscalculic students. The teachers who are in favor of assessing the student with a special tool to make sure that the student is dyscalculic, guiding the student patiently, using different methods, materials, and repetitive activities while teaching were very few. This result shows that teachers do not have sufficient knowledge about what to do when they encounter a dyscalculic student. This finding is similar to Bevan and Butterworth's (2002) finding that most of the teachers are unaware of being a guide for dyscalculic students and have difficulties in teaching mathematics to dyscalculic students. In addition, this result is also supported by the findings of Wadlington et al. (2006) and Sezer and Akın (2011) that dyscalculic students cannot learn mathematics because they do not have a guide, and as a result, they cannot be successful and make the right career choice. It was noticed that most of the teachers had a feeling of inadequacy in

recognizing dyscalculic students and were not confident in recognizing dyscalculic students. Baldemir (2020) observed in his study that pre-service teachers did not know exactly what to do when they encountered a dyscalculic student. Chinn and Ashcroft (2006) noticed that teachers had insufficient knowledge about how to treat dyscalculic individuals. Tennant and Tennant (2010) found that most of the primary school teachers had insufficient knowledge about the ways and strategies to teach mathematics to dyscalculic individuals.

For the question directed to the teachers who encountered a situation that aroused the suspicion of dyscalculia during their professional lives, the fact that the number of teachers who selected the options of making an education plan suitable for the needs of the students and preparing activities that appeal to as many senses as possible, making plenty of repetition in the lessons, including plenty of home exercises, teaching the subjects hierarchically and providing the necessary motivation to reduce anxiety was low shows that teachers are inadequate in terms of what should be done when teaching mathematics to dyscalculic students. In a study with a similar result, a few of the teachers stated that it was important to have activities and repetition according to the level of the student. It was concluded that classroom teachers were unaware of the methods for teaching mathematics to dyscalculic individuals. Teachers have no knowledge about intervention programs for dyscalculia (Kaçar, 2018; Mutlu et al., 2022). Sezer and Akın (2010) also reached a similar finding. Teachers said that activity-based teaching should be provided to students with mathematics learning disorders, but they said that they could not do it because of the lack of materials in schools. Teachers said that expert support and family support are essential for intervention with dyscalculic individuals.

Considering the two groups of teachers who have and have not encountered a situation with suspicion of dyscalculia during their professional lives, the knowledge level of teachers who have encountered suspicion of dyscalculia is higher in the options other than “I assessed with a special tool to make sure that the child is dyscalculic” about what should be done when teaching mathematics to dyscalculic students. Unlike the findings of this study, Apak (2022) found that the awareness of preschool teachers who had previously encountered learning disabilities did not show a significant difference compared to teachers who had not previously encountered learning disabilities. In addition to the findings, the learning disability awareness of teachers who have students with learning disabilities in their classrooms is higher than teachers who have individuals with learning disabilities in their families. It is concluded that teachers’ awareness of a learning disability does not change according to the situation of encountering a student with a learning disability before, but it changes according

to the place of encountering a learning disability. According to Yılmaz and Yangın (2020), no difference was found in the level of knowledge about the types of learning disabilities of classroom teachers with special education students in their classes compared to teachers without special education students in their classes.

The fact that a few of the teachers who participated in our study thought that dyscalculic individuals could be taught mathematics with peer guidance shows that these teachers have misinformation on this issue. In Kaçar's (2018) study, it was revealed that there are teachers who advocate teaching dyscalculic individuals with peer guidance. There are teachers who argue that correcting the understanding of mathematics will solve the whole problem. It was determined that teachers lacked knowledge about the fact that correcting the understanding of mathematics is important, but it is not a solution in itself. Most of the teachers who participated in our research stated that dyscalculic students can learn mathematics on their own with educational games. Although the teachers' opinions that dyscalculic students can learn mathematics with educational games are correct, the fact that they argue that dyscalculic students can learn mathematics on their own shows that most of the teachers are not aware that dyscalculic students cannot learn on their own. Baldemir (2020) and Nurkan and Yazıcı (2020) found that a few teachers thought that using games would be effective in the education of dyscalculic individuals.

5. Suggestions and Limitations

Considering the results of the research, it is suggested that dyscalculia should be included in special education courses and in-service trainings at universities and intervention programs for dyscalculic students in secondary schools should be implemented for prospective mathematics and primary school teachers in addition to their internship courses in cooperation with the Ministry of National Education. Also, prospective teachers should learn about dyscalculia and its intervention, secondary school mathematics teachers should identify dyscalculic students in their classes in cooperation with the Guidance and Research Center and conduct intervention studies for these students. Furthermore, parents' and high school mathematics teachers' awareness of dyscalculia should be investigated.

The research is limited to the opinions of secondary school mathematics teachers working in Erzurum city center in the 2021-2022 academic year.

The research is limited to the data obtained from the survey developed and applied by the researcher.

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