Aladwan S, Awamleh W, Ershed Alfayez MQ, Shaheen HRA, Abutaha MST. Visual Perceptions Skills and its Association with Written Mathematical Communication Skills among Learning Disabilities Students in Jordan. *Health Psychology Research*. 2023;11. doi:10.52965/001c.89427

General

Visual Perceptions Skills and its Association with Written Mathematical Communication Skills among Learning Disabilities Students in Jordan

Saida Aladwan[1], Worud Awamleh[2], Mona Qutaifan Ershed Alfayez[3], Hassan Rafi' Ali Shaheen[1], Muna Saleem Taha Abutaha[4]

[1] Department of Special Education, Princess Alia University College, Al-Balqa Applied University, [2] Department of psychology and Special Education, Princess Alia University College, Al-Balqa Applied University, [3] Department of Curricula and methods of teaching mathematics, Princess Alia University College, Al-Balqa Applied University, [4] Department of psychology and Special Education, Princess Alia University College, Al-Balqa Applied University

Keywords: Visual perception, Mathematical communication, written communication, learning disabilities.

https://doi.org/10.52965/001c.89427

Health Psychology Research

Vol. 11, 2023

Aim

The present research sought at investigating the association between visual perception skills and written mathematical communication skills among a sample of students with learning disabilities in mathematics in Jordan.

Method

This was a cross-sectional correlational study that included a sample of 90 primary-stage students who were diagnosed as having learning disabilities in mathematics. To collect data, the researchers developed two data collection tools; the visual perception skills test (50 items) and the written mathematical communication skills test (6 items). The tests were validated and ensured for reliability before implementation on the original study sample. The data gathered in this study was analyzed using the Statistical Package of Social Sciences (SPSS).

Results

The results showed that there was a significant statistical association between visual discrimination and Written mathematical communication skills test (r=0.218), visual closing test and Written mathematical communication skills test (r=0.411), shape relationship perception test and Written mathematical communication skills test (r=0.438), Visual Integration and Spatial Relationship Perception Test and Written mathematical communication skills test (r=0.614), Visual information recall test and Written mathematical communication skills test (r=0.154). The results showed that there was a significant positive association between visual perception skills and written mathematical communication skills (r=0.509).

Conclusion

The study ended up with that there is a significant positive association between visual perception skills and written mathematical communication skills among students with learning disabilities in mathematics. The study recommends developing mathematical educational material based on the visual approach and improving these skills among students with learning disabilities to develop their written mathematical communication skills.

INTRODUCTION

Perception, as defined by specialists, is the mental process that follows a sensation, when sensory waves move from the senses to the nerve centers in the brain and mix with the mental components that were previously formed from past experiences.[1] The process of distinguishing the sensible things and giving them a special meaning takes place. Thus, the realization process takes place. Perception usually occurs as a result of the cooperation of more than one sense at the same time.[2]

And since the process of perception takes place only with the integrity of the senses, there is an ability to focus and pay attention, and thus distinguish the subject of percep-

tion, as perception works to organize, build and interpret auditory, visual, and tactile stimuli, the disabilities of perception we find two basic types: difficulty in visual perception and difficulty in auditory perception.[3]

Visual perception is the process of interpreting and interpreting visual stimuli and giving them meanings and connotations.[4] The difficulty here is the child's inability to distinguish, as things do not appear clear and clear to him, so he cannot distinguish between them. Note that children who suffer from visual perception difficulty do not face an organic problem at the level of The eyes,[3,5] and indeed the acuity of vision and eyesight is very normal, but the difficulty we find in some elements, including the difficulty in visual perception that includes the inability to distinguish between differences and similarities between shapes, and this problem clearly shows its negative impact in the child's inability to read and write, because he cannot distinguish between letters and words, and also concerning mathematics, which depends on the mechanism arithmetic and geometric shapes.[6]

The attention of educators and psychologists has not remained focused on studying the necessity of growth and the problems that afflict it, but rather goes beyond it to studying the implications of these problems on other aspects such as problems related to the learning process,[7] as some children suffer from problems in the learning process, which stand as an obstacle to the development of their academic path, and among these problems are disabilities Learning, which is manifested through a decrease in the level of academic achievement in one or more subjects,[8] which may cause the student to fail academically and accumulate his educational problems. Researchers and scholars in this field have attributed such disabilities to disorders at the level of visual perception, which is known as developmental learning disabilities that must be taken into account with children with academic learning disabilities[9].

Mathematics learning disabilities are defined as the educational disabilities that students face during their study of mathematics and make them unable to understand and comprehend mathematics, and its related subjects.[10] Mathematics learning disabilities were also defined by the presence of a group of obstacles that impede the student's learning of mathematics, and these obstacles are mental, classroom obstacles, or psychological obstacles, and these obstacles prevent the student from understanding the nature of mathematics,[11] and therefore the student finds himself unable to understand and solve the basic principles of this subject. And therefore will not be able to solve the problems encountered in class.[12] In addition, another definition of the disabilities of learning mathematics is an innate difficulty in learning or understanding the various mathematical calculations and includes difficulty in understanding numbers and the way they are presented, and how to learn mathematical theories.[13]

The present study sought to investigate the association between visual perception skills and written mathematical communication skills among students with learning disabilities in Jordan.

STATEMENT OF PROBLEM

The results of some studies show that students often suffer from academic learning disabilities (such as difficulty in learning to read and difficulty in learning mathematics) as a result of suffering from one or more developmental learning disabilities (such as difficulty in attention and perception, disabilities in visual perception or auditory perception).[14,15]

These mental cognitive processes (attention, perception, etc.) received great attention from the researchers in their study, in addition to the patterns of information processing, which play a major role in the various activities carried out by the individual.[16] We find that visual perception is one of the most important mental processes that affect mental work.[17] And the cognitive path of the individual, especially concerning the process of learning and retaining or storing information and experiences. Many visual stimuli are necessary for the occurrence of acquisition and storage in any learning during the early stages of the child's educational path. Therefore, any disturbance that occurs in one of the cognitive processes may lead to disabilities in learning. Learning and achievement, especially learning basic skills such as reading, writing, and arithmetic.[18]

Students who suffer from disabilities in visual perception find it difficult to interpret what they see, and they cannot distinguish the relationship between objects and shapes and their relationship to themselves, and they cannot estimate distances, time, and size.[19]

The process of visual perception plays a major role in learning many of the basic skills of students in the primary stage, especially concerning reading, writing, and arithmetic.[20] Good for the process of visual perception, through which the student can recognize the shape of numbers and various mathematical symbols such as addition, multiplication, subtraction, and geometric shapes because the use of this process helps to retain mathematical experiences, the most important of which are mathematical symbols and the speed of their retrieval.[21]

As a result of the findings of the researchers and the results of these studies, which summed up the idea that some children who suffer from disabilities in learning mathematics are often the cause of disabilities in the cognitive process, especially visual perception, This study tries to figure out the association between visual perception skills and mathematical writing skill among students with learning disabilities in Jordan

RESEARCH SIGNIFICANCE

The subject of the study derives its importance from the importance of paying attention to the subject of learning disabilities, especially the difficulty of learning basic academic skills (reading, writing, and arithmetic) and the need to know its causes, some of which appear in disabilities at the level of some developmental cognitive processes such as perception to design remedial methods early because they affect the educational path of the student. It is also a topic that deals with a cognitive and neurological dimension, as

the process of visual perception is considered one of the most important cognitive processes that help the student to learn, while the neurological dimension is represented in the pattern and ability of the individual to process visual stimuli at the level of the brain.

Moreover, the present study paves the way for scholars and researchers in the local and regional context to investigate the association between different perceptual impairments and learning mathematics among students with learning disabilities.

RESEARCH DEFINITIONS

Perception: The process of translating the sensors that transmit the brain in coded messages in an electrochemical language that flows through the sensory nerves that connect the sense organs and the brain.[22] It is a constructive process in the sense that the electrical signals that reach the brain are combined and constitute a comprehensive and meaningful perception.[23]

Visual Perception: Visual Perception is the recognition of environmental stimuli and topics that follow the processes of sensation and attention.[24] It was also defined as the ability to understand and visualize visual stimuli and the spatial relationships between them, such as visualizing things from a different perspective space, and different geometric figures.[25]

Visual Perception Difficulty: Hunt et al[26] explains that visual perception plays a very important role in school learning, and children with learning disabilities find tangible disabilities in tasks that require visual distinction of letters and words, as well as numbers, shapes, geometric designs, pictures, and all forms that are visible or received through the Visual sensory medium.

Written Mathematical Communication: it was defined by Sumargiyani & Nafi'ah[27] as writing about the mathematical content using natural language in describing the mathematical elements, the difference, and the relationship between them.

PREVIOUS STUDIES

Mahfouz et al[28] study aimed to explore the relationship between some auditory and visual perception skills and achievement in mathematics among second-grade pupils in Assiut. The sample of the exploratory study consisted of 50 male and female students from the second grade of primary school, and the basic sample was 75 male and female students. The study used an achievement test in mathematics prepared by the research team, and tests of some auditory and visual perception skills using the computer prepared by the research team. The results concluded that there is a statistically significant positive correlation between the total score and the dimensions of the tests of some auditory and visual perception skills and achievement in mathematics. However, the model is excellent and has a high discriminatory ability for those with a low performance from others, and this decrease is a basic indicator of the fact that these students are at risk of exposure to disabilities in learning achievement in mathematics, and it also means a high predictive accuracy of the tests, and the results also showed a high negative predictive value, which was higher than 90% The prevalence of those at risk of learning disabilities among the total number of students was 45.3%, and the value of the total prediction accuracy of the diagnostic tests for those at risk of learning disabilities in mathematics was 93.3%, which means that the tests can show students with high achievement.

Kunwar[29] believes that visual perception disorders are among the most common behavioral manifestations that affect the performance of students with learning disabilities in mathematics, as these students find it difficult to distinguish money, operation symbols, and clock hands, and disabilities in understanding spatial relationships, which leads to It results in difficulty using the number line, in addition, subtraction, multiplication and division, difficulty in copying shapes, difficulty in writing on a straight line, difficulty in the directional properties of arithmetic operations that appear when solving problems of addition, borrowing, right and left, difficulty in dealing with groups or categories, and difficulty in distinguishing between Positive and negative numbers.

Cronje[30] indicated that students with learning disabilities cannot organize and arrange what they hear, and they also suffer from disabilities in tracking audio-visual and visual-spatial stimuli, which results in disabilities in learning mathematical operations. They are also unable to focus on the paragraph of the question, the shape, or the thing, independent of the visual background surrounding it, and as a result, the student becomes preoccupied with a stimulus other than the target stimulus, and then his attention is distracted, his perception fluctuates, and he makes mistakes in his visual perceptions. They have to distinguish between the target stimulus (the shape) and the competing stimuli (the ground).

Halberda & Feigenson[31] confirmed that the deficit in visual discrimination plays an important role in learning mathematics, in some cases students switch numbers such as 2 instead of 6 because they fail to distinguish the differences between The previous two numbers, or they reflect numbers such as 12-21, 14-41, because they do not distinguish between right and left, so they make reverse errors in reading from right to left in the English language and from left to right in the Arabic language, or they make a mistake in determining the place value for the number (ones, tens, hundreds, thousands), for example, the number 3 in the number 31 has a higher value than the number 3 in the number 13, and therefore they have difficulty in performing arithmetic operations.

Going through the previous studies, it is clear that there is a lack of studies, especially in the Jordanian context, that discusses the association between visual perception skill and written mathematical communication skills, which is considered a strong point of the present study.

METHODOLOGY

RESEARCH DESIGN

This study was a correlational cross-sectional study that investigated the association between the study variables, namely; visual perception skills and mathematical writing. This study design is beneficial when exploring the variables of the study at a specific time point.

RESEARCH POPULATION

The study population represented all primary-stage students enrolled in the public schools of Amman city and were diagnosed with learning disabilities in mathematics.

RESEARCH SAMPLE

Convenient sampling was used in the present study. Convenience sampling was the most appropriate sampling method as it ensured the recruitment of the highest possible of participants in this study. A sample of 90 students who were diagnosed with learning disabilities in mathematics was recruited for this study. The study sample was recruited from different public schools within the geographical and administrative borders of the Jordanian capital city, Amman.

RESEARCH INSTRUMENT

To collect data, the researchers used the following data collection tools:

1. **Visual Perceptions skills test**: The test aims to identify the visual perception skills of students in the primary stage, by monitoring the indicators indicating the different processes for the perception of visual information. This is done by presenting five groups of forms (sub-tests), each of which requires specific tasks from the subject, and through the completion of these tasks, the ability of the subject to perform these necessary operations for visual perception that the test contains is determined. Then, it is possible to identify the visual perception skills of respondents with writing disabilities and compare them with normal subjects. The sub-tests are as follows:
   A. Visual Discrimination Test: The test aims to examine the ability of the subject to both recognize shapes and distinguish them from other shapes, and accurately determine the characteristics of the target visual shape.
   B. Visual Closing Test: The test aims to examine the subject's ability to perceive the missing parts of the shape through visual integration, assembling visual stimuli and assembling shapes, and perceiving the shape through a visual assembly of its components.
   C. Shape-relationship perception test: The test aims to examine the subject's ability to visually analyze shapes and perceive their relationship to their components, selective attention to the components of shapes and accurate visual perception of their details, and visual tracking of shapes.
   D. Visual Integration Test and Spatial Relationship Perception: The test aims to examine the subject's ability to use visual cues in perceiving spatial visual relationships, perceiving body movement in space, and perceiving the sizes of different shapes of stimuli and the relationship between them.
   E. Visual information recall test: The test aims to examine the subject's ability to remember shapes and details of their parts, shapes in a specific order, the relationship between the sizes of the shapes, and the spatial relationships between the shapes and some of them.
   In each sub-test, the subject is presented with (10) items representing a group of shapes, and he is asked to accomplish a specific task related to each group of shapes. Thus, the total number of items for the total test was (50), with one mark for each correct answer and zero for the wrong answer. Thus, the highest score for the test is (50) and the lowest score for the test is (zero).
   The apparent validity was verified by presenting the test items to (10) arbitrators in the field of educational psychology, measurement, and evaluation, to express their opinions about the validity of the test items, and it turned out that all the test items are valid.
   The stability of the visual perception skills test was calculated by applying the test to a group of students previously referred to in the sample of the stability of the observation form. Where the value of the stability coefficient reached from the method of re-application of the test with an interval of two weeks, and the value of the stability coefficient was 0.73
2. The written mathematical communication skills test: prepared by the researchers, included six questions that require explanation and clarification, which measure the extent to which fifth-grade students can write mathematical communication skills, and they represent three skills with two indicators for each skill (a total of six performance indicators) as shown in table (1)

The written mathematical communication skills test was validated throughout submitting the test of many experts and specialists in mathematics education. The test was validated by the experts and assessed for reliability on the same pilot sample used for the visual perceptions skills test. Using Cronbach's Alpha equation, the internal consistency coefficient for the whole test was (0.81). However, for the sub-test, it was 0.84 for "Organizing and representing mathematical ideas and relationships", 0.79 for "Clarify mathematical ideas and relationships" and 0.83 for "Evaluate mathematical solutions and ideas".

Table 1. Components of the written mathematical communication skills test

Skill	Indicator
Organizing and representing mathematical ideas and relationships	The student distinguishes the mathematical relations that are included in the mathematical text The student translates mathematical texts from one form of mathematical expression (words, table, geometric figure, etc...) to another form of it.
Clarify mathematical ideas and relationships	Explain to the student the mathematical relations and ideas contained in a geometric figure or a mathematical representation The student summarizes what she understood of ideas, procedures, and solutions
Evaluate mathematical solutions and ideas	The student judges the mathematical ideas and solutions The student justifies the reason for choosing an answer to a mathematical situation

DATA COLLECTION PROCEDURE

The researchers obtained the official approvals to conduct the study and access the schools to collect data from the students. After that, the researchers prepared the data collection instrument as one package and distributed the instrument to the students who were diagnosed with learning disabilities with the help of the teachers who were responsible for teaching those students. A consent form was ensured to be signed by both the child's guardian and the child to recruit him in the present study. The students received a 10-minute presentation regarding how to complete the data collection tool. Finally, the sheets were collected and used for the data analysis process.

DATA ANALYSIS

To analyze data, we used the Statistical Package of Social Sciences (SPSS) (v. 26, IBM Corp, Chicago, IL, USA). Descriptive statistics and Pearson's correlation coefficient were used to analyze the study participants' responses and answer the research questions. A significance level of ($\alpha \leqslant 0.05$) was used as the significance level in this study.

RESULTS

A total of 90 primary-stage students were enrolled in this study. The results presented in table (2) show the mean scores and standard deviations of the students' scores on the visual perceptions skills test. The results showed that the students with learning disabilities in mathematics had a mean score of (6.85±0.68) on the visual discrimination test, a mean score of (8.41±0.73) on the visual closing test, a mean score of (7.13±0.58) on the shape-relationship perception test, a mean score of (6.18±0.29) in the visual integration and spatial relationship perception test, and a mean score of (7.36±0.55) in the visual information recall test. Finally, it was found that the students' mean score in the total visual perception test was (35.93±0.61).

The results shown in table (3) represent the mean scores and standard deviation of the written mathematical communication test obtained by students who were diagnosed with learning disabilities in mathematics. The results showed that the highest level of written mathematical communication skills was found to be in evaluating mathematical solutions and ideas (2.56±1.10), followed by clarifying mathematical ideas and relationships (2.18±0.77) and organizing and representing mathematical ideas and relationships (1.79±1.06). The overall mean score and standard deviation of the written mathematical communication skills was (2.19±0.64).

The results presented in table (4) represent the Pearson's correlation coefficient values between the visual perception skills test scores and the written mathematical communication skills test score for the students with learning disabilities in mathematics. The results showed that there was a significant statistical association between visual discrimination and Written mathematical communication skills test (r=0.218), visual closing test and Written mathematical communication skills test (r=0.411), shape relationship perception test and Written mathematical communication skills test (r=0.438), Visual Integration and Spatial Relationship Perception Test and Written mathematical communication skills test (r=0.614), Visual information recall test and Written mathematical communication skills test (r=0.154). The results showed that there was a significant positive association between visual perception skills and written mathematical communication skills (r=0.509).

DISCUSSION

The present study sought to investigate the association between visual perception skills and written mathematical communication skills among students who were diagnosed with learning disabilities in mathematics in Jordan. The study recruited 90 students from different public schools and implemented the visual perception skills test and the written mathematical communication skills test.

Our findings revealed that there is a significant positive association between visual perception skills and written mathematical communication skills among students with learning disabilities in mathematics. This result might be attributed to the importance of perception in the field of school learning, whether it is sensory or motor. On this basis, the child who suffers from disabilities in the total perception of the stimuli in front of him in the learning situation may be a result of this deficit or perceptual disorder. Many studies have proven the existence of cognitive disabilities among children. Children with learning disabilities are more than they exist among ordinary children, but these children vary among themselves in the nature and

Table 2. Means and Standard Deviations of the students' visual perception test scores

Visual Perception Test	M	SD
Visual Discrimination	6.85	0.68
Visual Closing Test	8.41	0.73
Shape-relationship perception test	7.13	0.58
Visual Integration and Spatial Relationship Perception Test	6.18	0.29
The visual information recall test	7.36	0.55
Total	35.93	0.61

Table 3. Means and Standard Deviations of the students' written mathematical communication test scores

Written mathematical communication test	M	SD
Organizing and representing mathematical ideas and relationships	1.79	1.06
Clarify mathematical ideas and relationships	2.18	0.77
Evaluate mathematical solutions and ideas	2.56	1.10
Total	2.19	0.64

Table 4. Pearson Correlation coefficients between the visual perception skills test and the written mathematical communication skills test

Variable	Organizing and representing mathematical ideas and relationships	Clarify mathematical ideas and relationships	Evaluate mathematical solutions and ideas	Written mathematical communication skills test
Visual Discrimination	0.316*	0.165*	0.265*	0.218*
Visual Closing Test	0.222*	0.514*	0.384*	0.411*
Shape-relationship perception test	0.514*	0.369*	0.258*	0.438*
Visual Integration and Spatial Relationship Perception Test	0.461*	0.294*	0.514*	0.614*
The visual information recall test	0.420*	0.341*	0.480*	0.154*
Visual Perceptions skills test	0.361*	0.528*	0.248*	0.509*

*Statistically significant at the significance level ($\alpha \leq 0.05$)

type of these disabilities that they suffer from. Some may suffer from disabilities in visual perception, which includes disabilities in organizing and interpreting visual stimuli, and some of them suffer Disabilities or problems in auditory perception, which includes organizing and interpreting auditory stimuli, and some of them suffer from disabilities or problems in motor perception, general coordination, or synergy of body parts, especially during movement and writing, or in visual synergy with the motor system. These children may suffer from more than one perceptual problem at the same time.

Mathematical communication plays an important role in students' learning of mathematics, as students need to integrate, explain and justify their ideas and solutions orally and in writing. Therefore, learning mathematics includes learning to write it, and realize the cycle of expressing it or about it, and the language of mathematics in its various forms plays a vital role in mathematical communication, as this is the oral language that develops communication through dialogue and discussion during the teaching and learning of mathematics, as well as the language that contains what it contains. And the graphic language, which includes graphic representation, and mathematical graphics of all kinds.[32] Then, when the students have mathematical communication skills, they will be able to make models of situations using various algebraic, pictorial, and graphic means and methods, and reflect carefully on the mathematical knowledge, ideas, and mathematical situations that they study.[33]

Lomibao et al[34] summarize the importance of communication in teaching mathematics as follows: thinking about and reflecting on learning activities. Students clarify their thinking, build their understanding of mathematical ideas, learn different ideas and methods from others, use the lan-

guage of mathematics, and support students in their learning. Maulyda et al[35] added that the availability of mathematical communication skills among students will enable them to link the daily language with the mathematical language, and the symbols that they have learned, it also enables them to use mathematical communication skills to interpret, discuss and evaluate mathematical ideas, and to reach answers by guessing while providing convincing solutions, and finally to appreciate the value of mathematical terms and symbols and their role in developing mathematical ideas.

Despite the significant findings reported in this study, still there are a number of limitations that could limit the generalization of the study findings. These limitations include the low sample size, which might be attributed to the difficulty of recruiting a larger sample size due to the nature of the sample size. In addition, the geographical limitations, as this study was performed in the public schools in Amman city. Thus, the findings of the present study might not apply to students from other geographical areas.

CONCLUSION AND RECOMMENDATIONS

The present study concluded that there is a significant positive association between visual perception skills and written mathematical communication skills. Based on the study findings, we recommend developing mathematical activities based on the visual perception approach to improve the written mathematical communication skills among students who were diagnosed with learning disabilities in mathematics. In addition, this study recommends conducting further cross-sectional and correlational studies to assess the association between visual perception skills and written mathematical communication among students with learning disabilities in mathematics.

REFERENCES

1. Wade NJ. Perception: The Pursuit of Illusion. In: *Psychological Concepts*. Psychology Press; 2020:271-298. doi:10.4324/9781003076384-13

2. Guy J, Mottron L, Berthiaume C, Bertone A. A Developmental Perspective of Global and Local Visual Perception in Autism Spectrum Disorder. *J Autism Dev Disord*. 2016;49(7):2706-2720. doi:10.1007/s10803-016-2834-1

3. Alenizi MAK. Effectiveness of a Program Based on a Multi-Sensory Strategy in Developing Visual Perception of Primary School Learners with Learning Disabilities: A Contextual Study of Arabic Learners. *International Journal of Educational Psychology*. 2019;8(1):72. doi:10.17583/ijep.2019.3346

4. Sample KL, Hagtvedt H, Brasel SA. Components of Visual Perception in Marketing Contexts: A Conceptual Framework and Review. *Journal of the Academy of Marketing Science*. 2019;48(3):405-421. doi:10.1007/s11747-019-00684-4

5. Lupyan G, Abdel Rahman R, Boroditsky L, Clark A. Effects of Language on Visual Perception. *Trends in Cognitive Sciences*. 2020;24(11):930-944. doi:10.1016/j.tics.2020.08.005

6. Adaval R, Saluja G, Jiang Y. Seeing and Thinking in Pictures: A Review of Visual Information Processing. *Consumer Psychology Review*. 2019;2(1):50-69. doi:10.1002/arcp.1049

7. Smith K, Hill J. Defining the Nature of Blended Learning Through Its Depiction in Current Research. *Higher Education Research & Development*. 2018;38(2):383-397. doi:10.1080/07294360.2018.1517732

8. Sisk VF, Burgoyne AP, Sun J, Butler JL, Macnamara BN. To What Extent and Under Which Circumstances Are Growth Mind-Sets Important to Academic Achievement? Two Meta-Analyses. *Psychol Sci*. 2018;29(4):549-571. doi:10.1177/0956797617739704

9. Rasmitadila R, Aliyyah RR, Rachmadtullah R, et al. The Perceptions of Primary School Teachers of Online Learning During the COVID-19 Pandemic Period: A Case Study in Indonesia. *J Ethn Cult Stud*. 2020;7(2):90-109. doi:10.29333/ejecs/388

10. Panaoura R. Parental Involvement in Children's Mathematics Learning Before and During the Period of the COVID-19. *Social Education Research*. Published online 2021:65-74. doi:10.37256/ser.212021547

11. Verschaffel L, Schukajlow S, Star J, Van Dooren W. Word Problems in Mathematics Education: A Survey. *ZDM*. 2020;52(1):1-16. doi:10.1007/s11858-020-01130-4

12. Irfan M, Kusumaningrum B, Yulia Y, Widodo SA. Challenges During the Pandemic: Use of E-Learning in Mathematics Learning in Higher Education. *Infinity Journal*. 2020;9(2):147. doi:10.22460/infinity.v9i2.p147-158

13. Menon V, et al. Cognitive Neuroscience of Dyscalculia and Math Learning Disabilities. In: *The Oxford Handbook of Developmental Cognitive Neuroscience*. Oxford University Press; 2020. doi:10.1093/oxfordhb/9780198827474.001.0001

14. Kohli A, Sharma S, Padhy SK. Specific Learning Disabilities: Issues That Remain Unanswered. *Indian Journal of Psychological Medicine*. 2018;40(5):399-405. doi:10.4103/ijpsym.ijpsym_86_18

15. Cabi E. The Impact of the Flipped Classroom Model on Students' Academic Achievement. *International Review of Research in Open and Distributed Learning*. 2018;19(3). doi:10.19173/irrodl.v19i3.3482

16. Çeliköz N et al. Cognitive Learning Theories with Emphasis on Latent Learning, Gestalt, and Information Processing Theories. *Journal of Educational and Instructional Studies in the World*. 2019;9(3).

17. Groblewski PA, Ollerenshaw DR, Kiggins JT, et al. Characterization of Learning, Motivation, and Visual Perception in Five Transgenic Mouse Lines Expressing GCaMP in Distinct Cell Populations. *Front Behav Neurosci*. 2020;14:104. doi:10.3389/fnbeh.2020.00104

18. Caviola S, Toffalini E, Giofrè D, Ruiz JM, Szűcs D, Mammarella IC. Math Performance and Academic Anxiety Forms, from Sociodemographic to Cognitive Aspects: A Meta-Analysis on 906,311 Participants. *Educ Psychol Rev*. 2022;34(1):363-399. doi:10.1007/s10648-021-09618-5

19. Jarodzka H, Skuballa I, Gruber H. Eye-Tracking in Educational Practice: Investigating Visual Perception Underlying Teaching and Learning in the Classroom. *Educ Psychol Rev*. 2021;33(1):1-10. doi:10.1007/s10648-020-09565-7

20. Cui J, Zhang Y, Wan S, Chen C, Zeng J, Zhou X. Visual Form Perception is Fundamental for Both Reading Comprehension and Arithmetic Computation. *Cognition*. 2019;189:141-154. doi:10.1016/j.cognition.2019.03.014

21. Leikin R. Giftedness and High Ability in Mathematics. In: *Encyclopedia of Mathematics Education*. ; 2020:315-325. https://doi.org/10.1007/978-3-030-15789-0_65

22. Lechowska E. What Determines Flood Risk Perception? A Review of Factors of Flood Risk Perception and Relations Between Its Basic Elements. *Nat Hazards*. 2018;94(3):1341-1366. doi:10.1007/s11069-018-3480-z

23. Margot KC, Kettler T. Teachers' Perception of STEM Integration and Education: A Systematic Literature Review. *International Journal of STEM Education*. 2019;6(1):1-16. doi:10.1186/s40594-018-0151-2

24. Parr T, Friston KJ. Attention or Salience? *Current Opinion in Psychology*. 2019;29:1-5. doi:10.1016/j.copsyc.2018.10.006

25. Chundury P, Patnaik B, Reyazuddin Y, Tang C, Lazar J, Elmqvist N. Towards Understanding Sensory Substitution for Accessible Visualization: An Interview Study. *IEEE Trans Visual Comput Graphics*. 2022;28(1):1084-1094. doi:10.1109/tvcg.2021.3114829

26. Hunt JH, Silva J, Lambert R. Empowering Students with Specific Learning Disabilities: Jim's Concept of Unit Fraction. *The Journal of Mathematical Behavior*. 2019;56:100738. doi:10.1016/j.jmathb.2019.100738

27. Sumargiyani S, Nafi'ah B. Analysis of the Mathematical Communication Ability of Pre-Service Mathematics Teachers Through Online Learning During the Covid-19 Pandemic. *Hipotenusa: Journal of Mathematical Society*. 2020;2(2):98-119. doi:10.18326/hipotenusa.v2i2.98-119

28. Mahfouz A et al. Some Auditory and Visual Comprehension Skills Using the Computer and Their Relationship to Achievement in Mathematics for Second Grade Pupils in Assiut. *Journal of the College of Education*. 2020;36(6):290-326.

29. Kunwar R. Impacts of Dyscalculia in Learning Mathematics: Some Considerations for Content Delivery and Support. In: *Learning Disabilities - Neurobiology, Assessment, Clinical Features and Treatments*. IntechOpen; 2022. doi:10.5772/intechopen.99038

30. Cronje LA. *Using Information and Communication Technology to Support Grade 6 Learners with Dyscalculia*. Doctoral Dissertation. University of Pretoria; 2020.

31. Halberda J, Feigenson L. Developmental change in the acuity of the "number sense": The approximate number system in 3-, 4-, 5-, and 6-year-olds and adults. *Developmental Psychology*. 2008;44(5):1457-1465. doi:10.1037/a0012682

32. Schleppegrell MJ. The Linguistic Challenges of Mathematics Teaching and Learning: A Research Review. *Reading & Writing Quarterly*. 2007;23(2):139-159. doi:10.1080/10573560601158461

33. Morgan C, Craig T, Schuette M, Wagner D. Language and Communication in Mathematics Education: An Overview of Research in the Field. *Zdm*. 2014;46(6):843-853. doi:10.1007/s11858-014-0624-9

34. Lomibao LS et al. The Influence of Mathematical Communication on Students' Mathematics Performance and Anxiety. *American Journal of Educational Research*. 2016;4(5):378-382.

35. Maulyda MA, Annizar AM, Hidayati VR, Mukhlis M. Analysis of Students' Verbal and Written Mathematical Communication Error in Solving Word Problem. *J Phys: Conf Ser*. 2020;1538(1):012083. doi:10.1088/1742-6596/1538/1/012083