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IMPROVING VISUAL MEMORY OF PRIMARY SCHOOL STUDENT WITH MATHEMATICS LEARNING DIFFICULTIES: AN ACTION RESEARCH

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Abstract

Students with dyscalculia often face significant challenges in visual memory, which is critical for mathematical learning, particularly in recognizing and differentiating geometric shapes and their properties. This study aims to explore the extent to which an action plan, tailored to the unique learning characteristics of students with dyscalculia, can enhance their visual memory. This study was applied to the visual memory of a second-grade student with learning difficulties in mathematics. Action research, one of the qualitative research designs, was used in the study. The study was conducted over five weeks with unable to read and write student who had received a report of learning difficulties from the Guidance and Research Centre (GRC). A purposive sampling technique was used to identify participant for the study. Pre-test, post-test, action plan, observation notes and records made during the action plan implementation were used as data sources. The data were analysed using descriptive analysis technique. As a result of the implemented action plan, it was observed that the student's visual memory started to improve in the process. It was seen that the student could match the geometric shapes in general but was confused about their names and properties. The student's success rate of 5% in the pre-test reached 40% in the post-test after the action plan was implemented.

Keywords: Primary school, geometric memory, learning disability, mathematics learning disability, visual memory.

INTRODUCTION

Recognizing the uniqueness of each individual, people vary significantly in their learning processes, methods, and pace.The learning varies from person to person; some people learn faster and easier, while others learn slower and more complex. When analysing individuals with slow and difficult learning processes, the concept of "specific learning disability" is encountered (Birol & Aksoy Zor, 2018). Specific learning disability is defined as a neurodevelopmental disorder characterised by low academic achievement in one or more of the existing learning processes of speaking, reading and writing (Taşkın Kuşçu, 2024). Difficulties experienced by individuals with specific learning difficulties in reading are called dyslexia, difficulties in writing are called dysgraphia, and difficulties in mathematics are called dyscalculia (Aracı & Melekoğlu, 2023). In this study, dyscalculia is discussed as a learning disability in mathematics. Within the framework of specific learning disabilities, a mathematics learning disability, namely dyscalculia, reflects difficulties in mathematical performance (İlker & Melekoğlu, 2017). There are many different terms used to describe mathematical difficulties in existing sources. Dyscalculia is a term used to define a learning disability in mathematics, such as 'dyscalculia',

'mathematical disorder' or 'mathematical disability'. In Latin, 'dys' means bad and 'calculia' means counting. Dyscalculia refers to bad counting (Sezgin, 2023).

This study is based on the Cognitive Approach model, which examines the effects of mental processes (attention, memory, perception, problem-solving) on learning. This approach treats learning as an active process and emphasises students' ability to relate new information to their existing knowledge. The cognitive approach emphasises the importance of developing basic learning strategies, information processing models and metacognitive skills for effective teaching (Slavin, 2019). One of the main components of the cognitive approach is the information processing model, which explains the transition of information from sensory memory to short-term memory and then to long-term memory. This model describes how learners perceive, process and store new information. Information perceived in sensory memory is transferred to short-term memory through selective attention. Information processed in short-term memory is stored in long-term memory using strategies such as repetition, encoding and interpretation. Information stored in long-term memory can be retrieved when needed (Schunk, 2020; Woolfolk, 2019).

Research has highlighted the importance of employing differentiated teaching methods that cater to the unique needs of dyscalculic learners. By utilizing multisensory approaches and leveraging assistive technology, educators can develop strategies that assist these students in overcoming the challenges associated with dyscalculia (Wang'ang'a, 2023). The prepared teaching plan should reflect this enhanced understanding and include specific strategies tailored to the needs of dyscalculic students (Kunwar & Sharma, 2020). Additionally, research has shown that individualized training and specific, targeted interventions can be highly effective in improving the accuracy and fluency of dyscalculic students in mathematics (Re et al., 2014).

Dyscalculia is characterized as a multidimensional disability stemming from deficits in numeracy or arithmetic functioning across behavioral, cognitive/neuropsychological, and neural domains (Kaufman et al., 2013).Difficulty with four operations, difficulty numbers, difficulty telling time, difficulty memorising the multiplication table, difficulty understanding the problem and performing its operations, difficulty using and calculating money, difficulty using mathematics in everyday life, insistence on counting with fingers are listed as general characteristics of dyscalculic individuals (Akın & Sezer, 2010; Avcı, 2020; Öztürk et al., 2019). Working memory deficits, problem-solving challenges, and visuospatial difficulties are commonly identified as characteristic traits of students with mathematics learning difficulties. Furthermore, the inability to draw or accurately define simple geometric shapes is frequently observed in students with dyscalculia. (Alkan Nurkan & Yazıcı, 2020). These difficulties experienced by students with mathematics learning difficulties in their educational life can also negatively affect their social life (Büyükkarcı & Akgün-Giray, 2023). Incorrect attitudes by teachers or bullying by peers can make it even more difficult for people with learning difficulties in mathematics, leading to a sense of learned helplessness, a loss of self-confidence, avoidance of situations involving mathematics such as shopping and calculations in everyday life, and mathematics anxiety (Yılmaz et al., 2024).

Geometry is an important area of mathematics that enables individuals to understand the world and develop critical thinking skills. The primary goal of effective geometry instruction is to enhance students' visual thinking and spatial abilities, enabling them to conceptualize and visualize the abstract concepts and relationships inherent in mathematics. (Cantürk Günhan et al., 2022). Geometry education should develop students' memory for shapes and enable them to form mental images of geometric shapes. Moreover, the richness of students' conceptual images of geometric shapes and the interaction between shape and mathematical knowledge are believed to positively support the development of spatial skills (Baş et al., 2015). Starting from early childhood, students who recognise geometric shapes and form them in their minds acquire classification skills by recognising geometric shapes at an early age (Tortop & Bahadır, 2023). Shape, which is the basis of many fields, is an important concept that needs to be acquired (Kesicioğlu et al., 2011). As the understanding of basic shapes forms the foundation for students' future geometry studies, teachers should prioritize fostering this conceptual

understanding by focusing students' cognitive processes on shape groups during instruction (Ölekli, 2009).

Geometric memory includes the ability to recognise shapes, match shapes, remember them, distinguish them, know and compare their properties, and compare their appearance (Olkun et al., 2024). A review of the literature shows no studies on the development of geometric memory. Therefore, there was a need for a study on the development of geometric memory in a student with learning difficulties in mathematics. With the findings of this study, it is believed that the academic achievement of students with mathematics learning difficulties can be increased, and this study can be a guide for teachers who have mathematics learning difficulties in their classrooms (Koç & Korkmaz, 2019). Students with mathematics learning difficulties lag behind their peers in terms of level from primary school, and this difference continues to increase in the future. Early diagnosis and appropriate educational interventions are crucial for fostering an understanding of complex mathematical subjects and concepts. (Mutlu et al., 2019; Filiz, 2021). As the grade level progresses, students with mathematics learning difficulties have more difficulties due to the difficulty of mathematical concepts. Therefore, differences and changes should be made in the teaching process for students with mathematics learning difficulties. This study is important because it shows that dyscalculic students can improve their geometric memory with an action plan prepared according to their learning characteristicsAccordingly, this study aims to enhance the geometric memory of a second-grade student experiencing mathematics learning difficulties.In line with this purpose, the problem of the study was defined as follows: How can a second grade primary school student with mathematics learning difficulties improve his geometric memory using an action plan designed for him?

METHOD

The study used action research, a qualitative research design. Action research is a qualitative research design used in education to improve teaching processes. This method allows teachers and researchers to take a systematic approach to solving a specific problem. Action research helps practitioners to evaluate their own practices and to create a continuous feedback loop with the data obtained in the process (Büyüköztürk et al., 2022). This study involved the development of an action plan to enhance the geometric memory of second-grade students with mathematics learning difficulties, employing an action research model aligned with this objective.

Participant

In this study, the participant was identified through convenient sampling method. Convenient sampling method is defined as collecting data from a sample that is easily accessible to the researcher (Büyüköztürk et al., 2022).

The characteristics that were considered in determining the participant were as follows:

- ✓ No diagnosed mental and auditory problems and no visual problems,
- ✓ As a result of the interview with the class teacher and the pre-test conducted according to his/her level, it was understood that he/she did not have sufficient knowledge about geometric shapes.

Characteristics of the Participant

A student in the second grade of a primary school affiliated with the Ministry of National Education in the Dulkadiroğlu district of Kahramanmaraş province was selected for the research. The student suffers from 'convulsions due to fever'. He has not had any accidents or problems with his eyesight or hearing. He has no disability. No one in his family is physically or mentally handicapped. His mother is a housewife and his father is a jeweller.

The pupil attended preschool for 1 week and then did not continue due to medication. He started school at the age of 6. He changed schools and teachers. He cannot read or write. He only knows the letter 'e', but he is not able to combine it. He cannot count numbers correctly and in sequence. His literacy and numeracy skills are very low compared to his peers. At the request of the family, the student was sent to the GRC, and the GRC gave a report to the student. Since the report was issued, the student has

attended a special education and rehabilitation centre for 3 hours and 40 minutes twice a week. The pupil's motor skills are at a very low level. He is not confident in mathematics. While determining the participant student, the opinions of the student's class teacher and family were taken and the participant was selected according to the results of the relevant field research. Permission for the study was obtained from the participant's family, and the family was informed of the application. Through individual interviews, the researcher established the student's personal and academic status with the class teacher and the parents of the participating student. The student's real name was not used in the study and her pseudo name was determined as Ayşe. The action plan prepared by creating appropriate conditions in the student's home environment was implemented.

Data collection tool

In action research, data can be collected using both quantitative and qualitative methods (Büyüköztürk et al., 2022). In this study, pre-test, post-test, action plan, observation notes and records from the implementation process were utilized as data collection tools. Additionally, expert opinions were sought from two specialists during the preparation of the teaching plan and tests.

RESULTS

The study follows the steps of preparing action plans, implementing the prepared plans, collecting data and analysing the collected data. The study process was started by obtaining the necessary permissions. The participating student's family was interviewed, necessary information about the study was given and the study process was planned. Before implementing the action plan, the researcher prepared a pre-test on geometric shapes to measure the student's geometric memory level. As a result of the pre-test, it was found that the student was not at his/her grade level and the following results were obtained: The student did not know any geometric shapes. Rather than using the proper names of geometric shapes, he referred to them by the names of similar objects.He does not know the properties of shapes and his perception of shapes is very weak. He could not say the word 'rectangle'. Considering the purpose of the study and the participating student's prior knowledge, an action plan was prepared considering the student's needs and deficiencies.

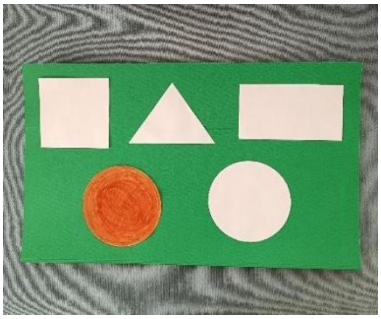
The researchers developed the 20-question measurement tool used as a pre- and post-test. The questions used shapes and symbols that students up to grade 2 should know or be able to simulate. Again, worksheets and digital games appropriate to the grade level were used. A 5-week action plan was prepared and implemented weekly, as shown below.

Action Plan

Week 1

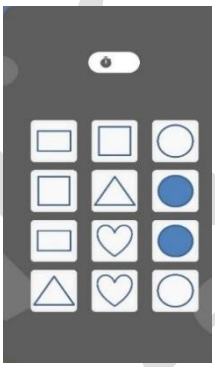
- Watch a story about geometric shapes.
- https://youtu.be/gj-UbbM66Wg?si=udmORFo7k07ByI0m

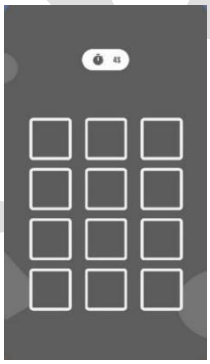
- Talking about geometric shapes and asking questions about the story
- Presentation of the geometric shapes poster and introduction to geometric shapes



- Playing the 'Match Shapes' game via the Learning Apps application https://learningapps.org/view14743880

- Playing the 1st level of the "Geo-Memory" game, which is the software developed by Olkun and his friends
- https://diskalkuli.com/geobellek//

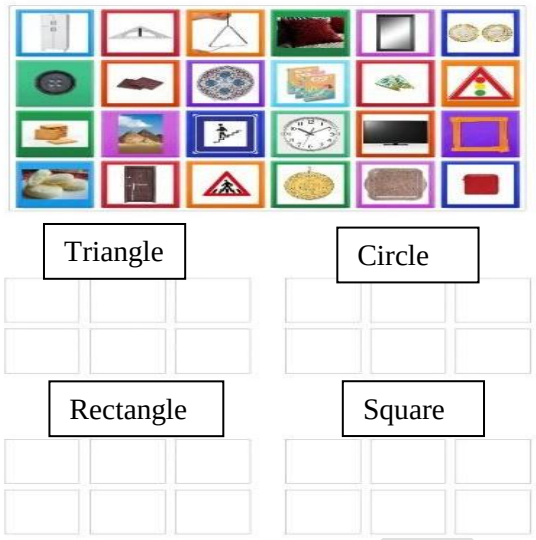




Week 2

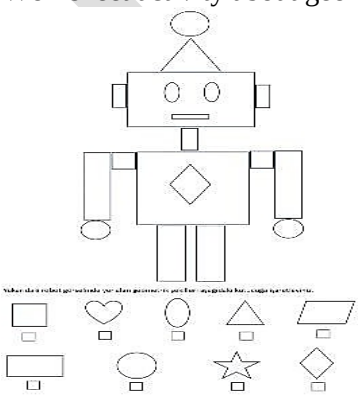
- Opening of the "shapes song" about geometric shapes and drawing of geometric shapes
- https://youtu.be/kZvsvVntB1c?si=ertWyHXRRM-JY-gn

- Opening an activity about geometric shapes on Wordwall https://wordwall.net/tr/resource/27325603



- Playing 'Shape Colouring' game via Matific application https://www.matific.com/tr/tr/home/maths/episode/colouring-shapes/?curriculum=matematik-dersi-%C3%B6%C4%9Fretim-programi-2018&grade=grade-2

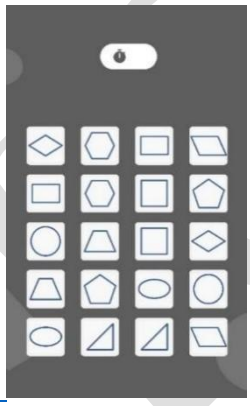
- Worksheet activity about geometric shapes

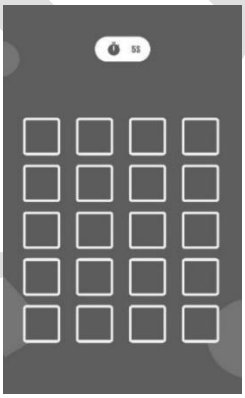


Week 3

- Preparation of the activity of matching of the shapes in the cardboard glass

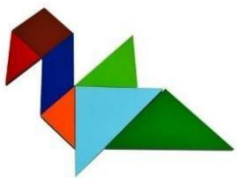
- Making "Geometry Strip" activity
- The second level of the game 'Geo-Memory,' developed as part of the software project by Olkun and his colleagues, was played. https://diskalkuli.com/geobellek//





Week 4

- Create house, cat and bird shapes with Tangram Activity.



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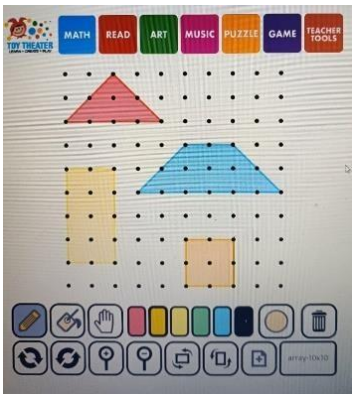
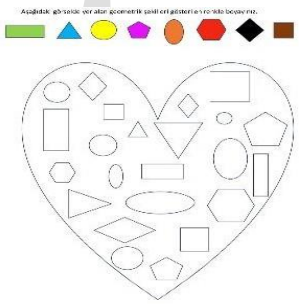
- Activity on the virtual geoboard
- https://toytheater.com/geoboard-shape/



- Play the Geo Bingo game designed by Olkun and shown on the YouTube channel https://youtu.be/20Z9C3siv3Q?si=dQEyeaUaFuio_RCB

Week 5

- Making the activity of colouring the shapes



- Making the activity in the video "We learn geometric shapes and their properties with storage box, van Hiele 1 to 2" shown by Olkun on You YouTube channel
- https://youtu.be/WJ51itqsuJ0?si=Q3oxRoi9IUCBQob8

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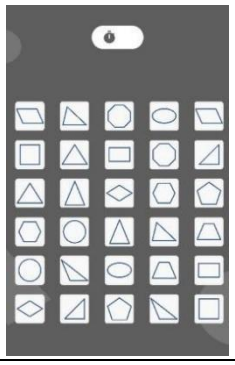
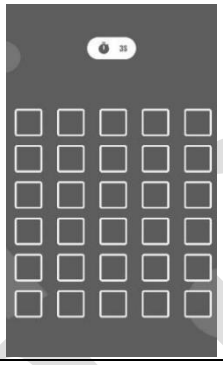
- Playing the 3rd level of the "Geo-Memory" game, the software developed by Olkun et al.
- https://diskalkuli.com/geobellek//





Week 1: The first lesson started with listening to the story to get the student's attention. After watching the story, the student was asked questions about the story and discussed geometric shapes (the link to the story is given below). The student generally gave incomplete and incorrect answers to the questions about the story. After the story, a poster with examples of geometric shapes was shown. The names of the geometric shapes were given to the student, and the student repeated the names. Ayşe tried to understand the shape of the geometric shapes by touching their edges. It was found that Ayşe could not say the word 'rectangle' among the geometric shapes, and she was made to repeat the word 'rectangle'. It was found that the student could not remember the geometric shapes and their names and forgot them very quickly. The story is shown in Figure 1, and the poster in Figure 2.

Figure 1. Story Activity (https://youtu.be/gj-UbbM66Wg?si=udmORFo7k07ByI0m)

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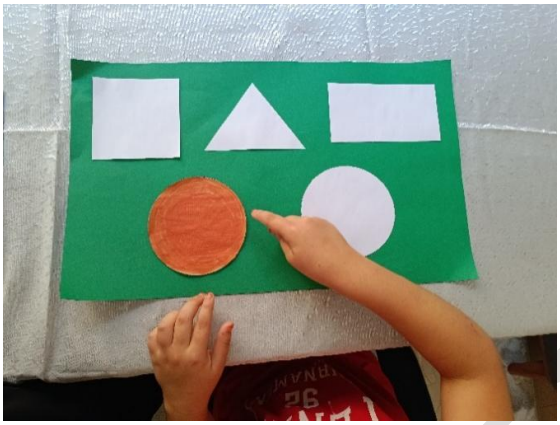

Figure 2. Poster

In the second lesson, the 'Match Shapes Game' was opened through the Learning Apps application, one of the Web 2.0 tools (the link to the game is provided below). The student was asked to match the shapes of square, rectangle, triangle and circle in the game. The student correctly matched square and triangle but incorrectly matched rectangle and circle. Later, the student realised his mistake and matched the rectangle and circle with their correct pairs. After the activity, the 1st level of the 'Geo-Memory' game, which is the software developed by Olkun et al. (The link of the 'Geo-Memory' game is given below). After the student was shown how to play the game by making a sample application, the student started the game. It was observed that the student correctly matched the geometric shapes, albeit slowly, and the total matching time was 140 seconds. The student liked the Geo-Memory game and wanted to play it again. The results are shown in Figure 3 and Figure 4.

Figure 3. "Match Shapes" Game (https://learningapps.org/view14743880)

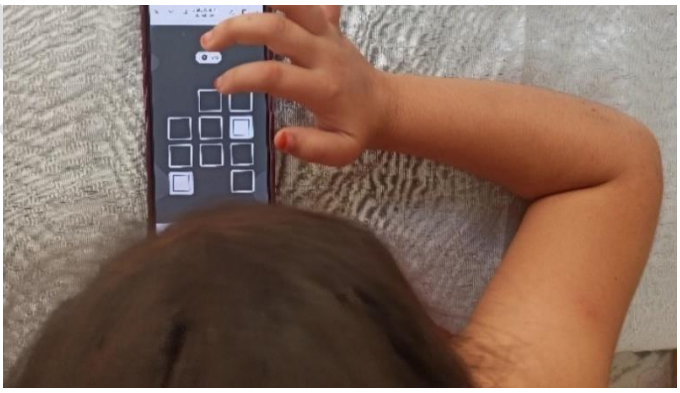

Figure 4. "Geo-Memory" Software(https://diskalkuli.com/geobellek//)

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Week 2: 'Shapes Song' about geometric shapes is opened (Video link is given below). The student is shown how geometric shapes are drawn on video. Following the drawing of each geometric shape in the video, the video is paused, and the student is prompted to replicate the shape and state its name. The student created the general form of geometric shapes but could not draw geometric shapes properly. Then, an activity related to the subject is opened on Wordwall, one of the web 2.0 tools. After a sample application is made in the activity and the student is shown how it should be done, the student is asked to place the objects in the box with similar geometric shapes. The student cannot correctly express which geometric shapes the given objects resemble. With the hints and support provided, the student completed the activity in a challenging and long time. It is shown in Figure 5 and Figure 6 with their connections.

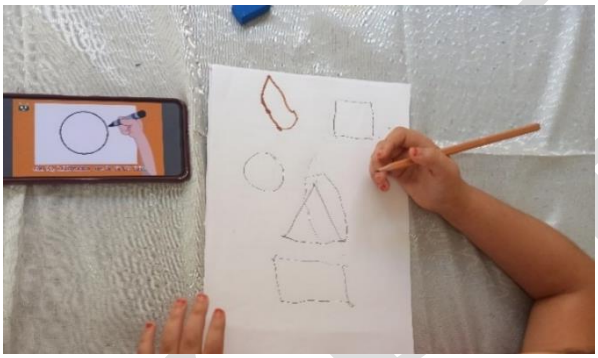

Figure 5. Geometric Figure Drawing Activity
(https://youtu.be/kZvsvVntB1c?si=ertWyHXRRM-JYgn)

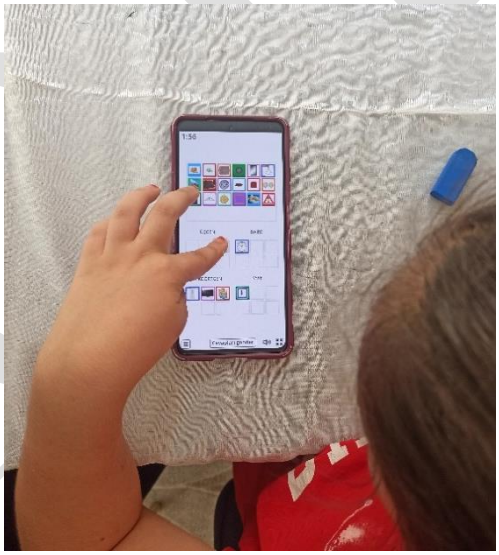

Figure 6. Word wall game (https://wordwall.net/tr/resource/27325603)

Then the 'Shape Colouring' game was played using the Matific application, one of the Web 2.0 tools. (The link to the game is given below). It was observed that the student had great difficulty in finding the geometric shapes required in the visual activity, his attention was constantly distracted and he was very bored. It was observed that the student could not discriminate the geometric shapes in the visual field. It was observed that the student could not do the activity, butthe student was helped to do it. The student was given a worksheet with a robot visual as a final activity. The student was asked to find and mark the geometric shapes in the robot visual from the geometric shapes below. It was observed that the student successfully completed the activity following the hints and feedback given. It was observed

that the student had great difficulty recognising and distinguishing the geometric shapes during the activity and was frequently distracted. This is illustrated in Figure 7 and Figure 8.

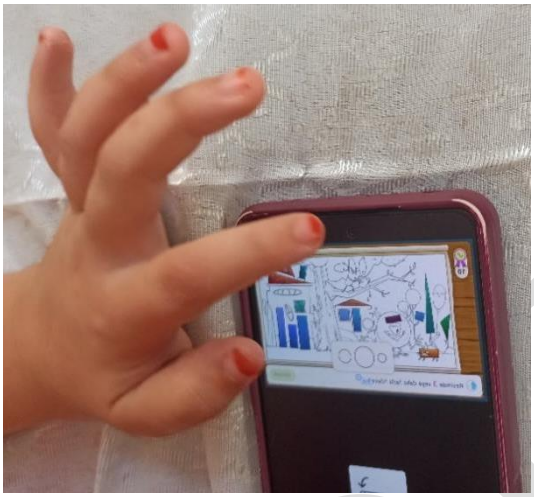

Figure 7. "Shape Colouring" game from Matific Application (https://www.matific.com/tr/tr/home/maths/episode/colouring-shapes/?curriculum=matematik-dersi-%C3%B6%C4%9Fretim-programi-2018&grade=grade-2)

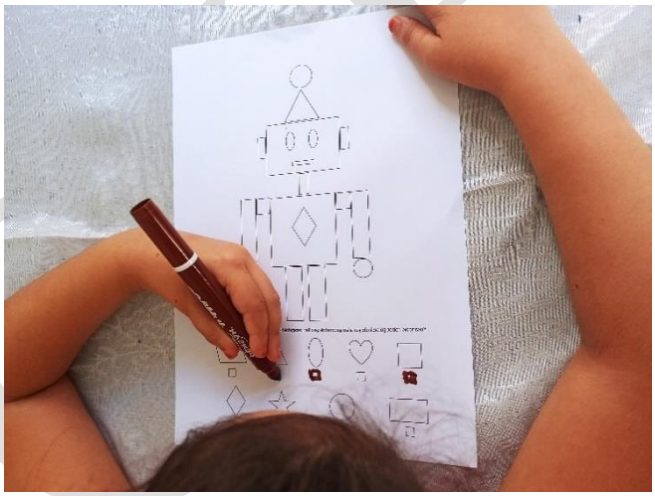

Figure 8. Worksheet

Week 3: The first lesson started with an activity aimed at improving the student's ability to memorise geometric shapes to motivate the student. The student was shown triangle, square, rectangle, circle, star, heart, pentagon, hexagon and octagon shapes glued to cardboard cups for 15 seconds and asked to match the card drawn from the side with the same shape on the cardboard. The pupil, who said he liked the activity, had no difficulty and easily found the matches by distinguishing the properties of the shapes.

In the second lesson, the 'Geometry Strip' activity was carried out with the student to visualise geometric shapes in the mind and combine the mental image with the external image. The student was asked to create geometric shapes such as triangles, squares, rectangles, rhombus, pentagons and hexagons using a Geometry Strip. The pupil, who stated that he liked making shapes with the Geometry Strip very much, made the geometric shapes correctly. This is shown in Figure 9, Figure 10 and Figure 11.

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Figure 9. Cardboard Cup Activity

Figure 10. Geometry Strip Activity-A

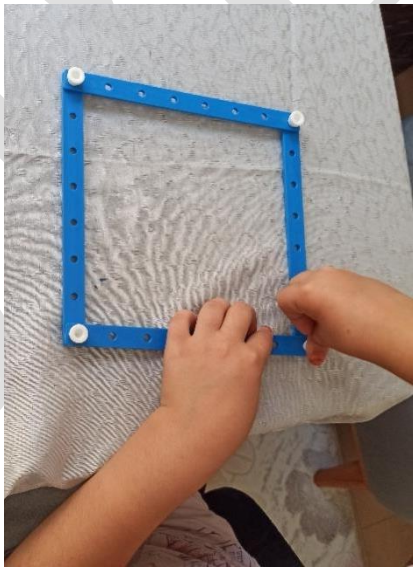

Figure 11. Geometry Strip Activity-B

In the continuation of the second lesson, the second level of the 'Geo-Memory' game, a software developed by Olkun et al. to develop geometric memory, was played (the link to the game is given below). The game was used to improve students' shape perception and visual memory. In this single-player game, the student is tasked with flipping two cards in succession and matching identical shapes by recalling the images on the cards.Ayşe tried to reach the maximum number of card matches using her memory. The student completed the 2nd level of the game in 149 seconds. It was observed that the student, who said that she liked the game and had fun playing it, had difficulties in keeping the shapes in her memory during the game, but she completed the game despite the difficulties. This is shown in Figure 12.

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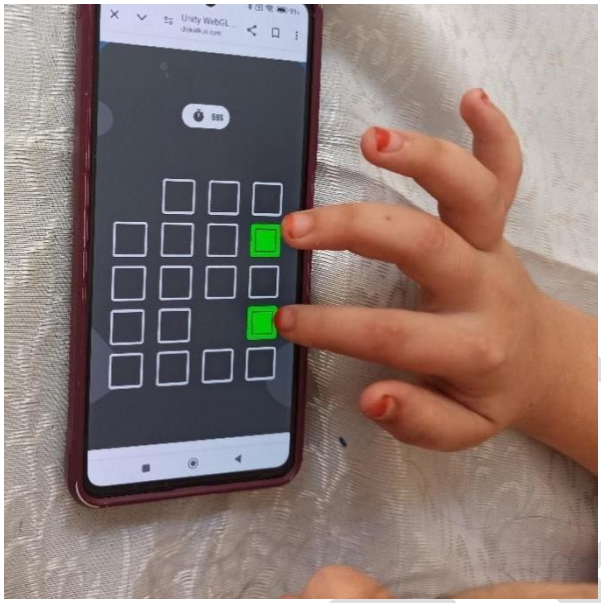

Figure 12. "Geo-Memory" Software (https://diskalkuli.com/geobellek//)

Week 4: Tangram activities were conducted to help students discover the properties of shapes through touch, create new shapes by combining shapes, and develop visual memory. Tangram activities allow students to compare and discuss the properties of geometric shapes such as size, similarity and difference (Hacıömeroğlu & Apaydın, 2009). The students were asked to create pictures of a house, a cat and a bird using the shapes on the tangram. The student who expressed that he liked the activity had difficulty distinguishing the shapes and saying their names, but with the help and hints given, he created the shapes of a house, cat and bird. Figures 13, 14 and 15 show the shapes created.

Figure 13. Tangram Activity-A

Figure 14. Tangram Activity-B

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Figure 15. Tangram Activity-C

In the second lesson an activity was carried out for the student to draw and recognise geometric shapes in a virtual environment (the link to the activity is given in Figure 16 along with the visual). The student, whose fine motor skills were very weak, struggled to draw the shapes in the virtual environment. The student was helped to create shapes such as squares, rectangles and triangles by holding the student's hand.

In the second lesson, the Geo-Bingo game (https://youtu.be/20Z9C3siv3Q?si=dQEyeaUaFuio_RCB) designed by Olkun and shown in the video was played to recognise geometric shapes, distinguish them from others and improve visual memory. Students are given a long strip of geometric shapes on a stick. The students are asked to place the geometric shapes on this long strip where the geometric shapes are side by side. The students are expected to place the shapes on the card they chose on the strip's geometric shape. It was observed that the students found it easier to match the shapes according to the number of sides and corners. The pupils placed the visually reversed shapes on the correct shape by turning the card in their hands. The pupil who enjoyed the activity was able to match the shapes correctly but was confused the names of the shapes. Figures 16 and 17 show the visuals of the activities.

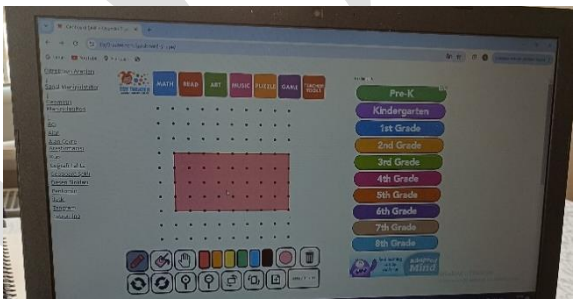

Figure 16. Geoboard (https://toytheater.com/geoboard-shape/)

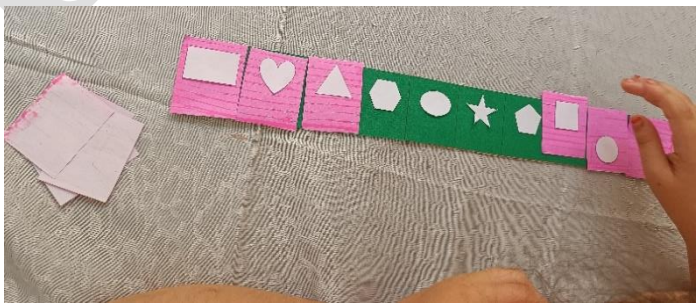

Figure 17. Geo Bingo game

Week 5: The last week started with the colouring the shapes activity to get the student's attention. In the coloring activity, the student was instructed to color the geometric shapes in the picture using the

colors provided. The aim of this activity was to help the student recognize the shapes, understand their properties, and differentiate them from other shapes. During the activity, it was observed that Ayşe faced additional challenges due to her difficulty in identifying the names of the colors. The pupil recognised the shapes but could not say their names. In addition, she could not see that the large or small form of the shapes was the same shape and she usually carried the colour out of the shapes. She is shown in Figure 18.

Figure 18. Drawing Activity

The second lesson started with the activity in the video 'We learn geometric shapes and their properties with storage box, van Hiele 1 to 2' (https://youtu.be/WJ51itqsuJ0?si=Q3oxRoi9IUCBQob8) shown by Olkun on the YouTube channel. Some different geometric shapes are thrown into the storage box and the geometric shape that is the mate of one of the geometric shapes thrown into the box is shown to the student on the box. The pupil is asked to find the shape shown by touching it without looking at the shapes in the box. The student, who enjoyed the activity, found the shapes correctly by touching them. In this activity, the pupil distinguished the shape shown from the other shapes and discovered the properties of the shapes by touching them. This is shown in Figure 19.

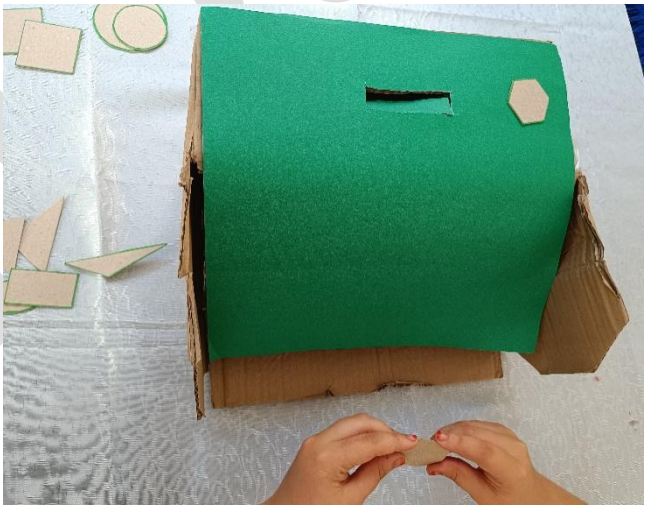

Figure 19. Memory Box Activity

In the second lesson, the 3rd level of the 'Geo-Memory' game was played, a software developed by Olkun et al. to improve geometric memory (the link to the game is given below). The objective of the Geo-Memory game was to help the student develop a mental representation of geometric shapes, recall those shapes, and identify their matching pairs.The student is asked to open two cards and match the

same shapes by keeping the shapes on the card in mind. The student completed the 3rd level of the game in 501 seconds by matching all the shapes. The student who liked the game could not remember most of the shapes during the game and played randomly. This is shown in Figure 20.

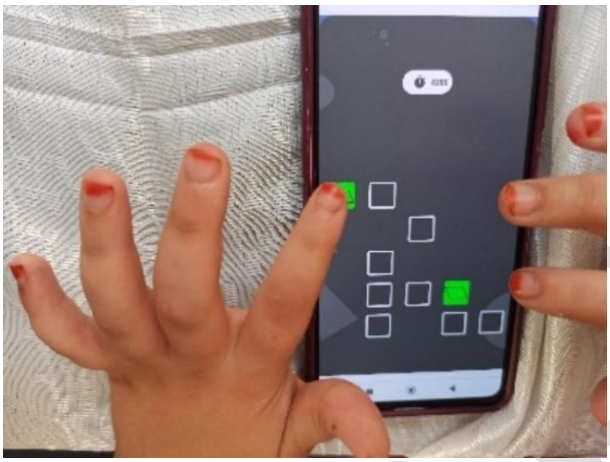

Figure 20. "Geo-Memory" Software (https://diskalkuli.com/geobellek)

The action plan developed in this study aimed at improving the geometric memory of a second-grade student with learning difficulties in mathematics. The implementation of this plan spanned five weeks and was designed to engage the student through activities that were both appealing and participatory. In crafting the activities, careful consideration was given to the developmental and learning characteristics of the student, including their level of readiness and learning speed. This tailored approach is supported by research indicating that personalized learning experiences can significantly enhance educational outcomes for students with learning difficulties (Dewi, 2023).

To effectively enhance geometric memory, the teaching process integrated a variety of instructional strategies and materials. These included storytelling, which has been shown to facilitate cognitive engagement and retention of mathematical concepts by providing relatable contexts for students (Fatemi et al., 2012). Additionally, the use of Web 2.0 games was incorporated, which can promote interactive learning and foster a collaborative environment among peers (Alkhateeb & Al-Duwairi, 2019). The inclusion of concrete materials, such as geometry strips and tangrams, aligns with the findings of Gurung and Chaudhary, who emphasize the effectiveness of manipulative materials in improving geometry learning achievements (Gurung & Chaudhary, 2022). Such materials allow students to visualize and physically manipulate geometric shapes, thereby enhancing their understanding and memory of these concepts.

Moreover, the action plan utilized the 'Geo-Memory' software developed by Olkun et al., which is specifically designed to support the learning of geometric concepts through interactive and engaging activities. The effectiveness of dynamic geometry software in improving mathematical achievement has been documented in systematic reviews, indicating that such tools can significantly enhance students' understanding of geometry (Chan & Leung, 2014). Worksheets were also employed as a supplementary resource, providing structured practice that reinforces the concepts learned through more interactive methods.

In summary, the action plan's multifaceted approach, which included storytelling, interactive games, concrete materials, specialized software, and worksheets, was strategically designed to cater to the unique needs of the student. This comprehensive strategy not only aimed to improve geometric memory but also sought to create a positive and engaging learning environment. The findings from this study contribute to the growing body of literature advocating for personalized and interactive instructional methods in mathematics education for students with learning difficulties (Dewi, 2023; Fatemi et al., 2012).

Different activities in the teaching process attracted the students' attention and supported the development of geometric memory. In general, it was observed that the students liked the activities used, but they liked the activities using concrete materials more by using their fine motor skills by touching them. The use of concrete materials to represent abstract mathematical concepts facilitates students' understanding and enhances the retention of these concepts in their memory. (Pişkintunç, Durmuş, & Akkaya, 2014). In addition, the students liked the memory game "Geo-Memory", the software developed by Olkun et al. in the action plan process as level 1, level 2 and level 3. While finding the matching shapes, she had the opportunity to compare the shapes in terms of appearance, and she did not get bored with the game and continued until she completed the game. Saygı and Alkaş Ulusoy (2019) summarised the thoughts of pre-service teachers on the contribution of memory games to mathematics education with themes such as ensuring the development of mathematical skills, learning mathematical concepts in a meaningful way, contributing to thinking and memorising, developing time control and fast thinking. This supports the results of this study.

DISCUSSION, CONCLUSION, and SUGGESTIONS

The findings of the study indicate that the action plan designed specifically for the participant was effective in enhancing the geometric memory of a second-grade student with mathematics learning difficulties.As a result of the implementation of the action plan, it was concluded that the participant's geometric memory improved and that he was generally able to match the geometric shapes during the teaching process, but confused their names and characteristics. The participant student generally had difficulty remembering the names of the geometric shapes during the process and the student was constantly reminded of the names of the geometric shapes. Similarly, in the study of Fırat and Erdem (2020), it was found that students who had difficulties learning mathematics in the first and fourth grades had difficulties learning the concept of geometric shapes. The student success rate, which was 5% in the pre-test before the application, increased to 40% in the post-test after the application. When the pre-test and post-test were evaluated, the student made fewer mistakes after the application, had less difficulty recognising geometric shapes compared to the beginning of the process, formed a mental image of geometric shapes and improved his ability to retain images in his memory.

At the beginning of the process, the student who did not know the names of the geometric shapes at all and had no shape memory was able to say the names of the shapes with the support given at the end of the process and shape perception began to form. The result of the study shows that geometric memory skills can be developed according to the speed of learning with an individualised education plan and enriched learning environments within the action plan prepared according to the developmental and learning characteristics of the student. Similarly, Koç and Korkmaz (2019) concluded in their action research that students with learning disabilities can reach the level of students with normal developmental levels with sufficient time, individualised education and enriched environments according to their developmental characteristics. The results of the study support the findings of this study.

Research has shown that individualized education plans (IEPs) and enriched learning environments can have a significant impact on the learning outcomes of these students (Galitskaya & Drigas, 2023). Recent studies have identified several effective interventions for teaching geometry to students with learning disabilities. For example, Liu et al. (2019) conducted a comprehensive synthesis of geometry interventions and found that instructional strategies such as visual aids, manipulatives, and technology-assisted learning tools significantly improved the geometric understanding of students with learning disabilities. Similarly, Galitskaya and Drigas (2023) highlighted the role of mobile and ICT-based interventions in facilitating geometry learning, suggesting that technology can help bridge gaps in understanding for students with learning disabilities. Kusumah et al. (2020) showed that the use of GeoGebra, a dynamic mathematics software, in learning three-dimensional geometry improved students' mathematical communication skills and that interactive tools can promote a deeper understanding of geometric concepts. In addition, Shahbari and Daher (2020) investigated the integration of ethnomathematics in the teaching of congruent triangles, which proved to be effective in

helping students with mathematical difficulties understand basic geometric concepts. Despite promising interventions, students with learning disabilities often face significant difficulties in geometry. Factors such as working memory limitations and misconceptions about geometric concepts can hinder their learning (Abdurrahman & Nofriyandi, 2022).

When the relevant literature was examined, no studies were found on "geometric memory". Şimşek and Arslan (2022) also reviewed the studies conducted in Turkey on mathematics learning difficulties and concluded that topics related to learning numbers and operations were preferred in the studies. Similarly, Saygı (2023) found that in studies focusing on mathematical topics related to dyscalculia, numbers were mostly studied and stated that due to the lack of literature, researchers need to choose topics from learning areas such as geometry, etc. in their studies in this area. As a result of the findings from the studies, it is believed that conducting studies on mathematics learning difficulties in different learning areas, such as 'geometry' will contribute to the field. Geometric memory refers to the ability to recognize, remember, and use geometric shapes and their properties. This skill is essential for various mathematical tasks such as spatial reasoning, problem solving, and understanding geometric relationships. Given the fundamental role of geometry in mathematics, the lack of research in this area may hinder the development of effective teaching strategies for students with learning disabilities.

The existing literature reveals a significant gap in research that specifically focuses on geometric memory and its development in students with learning disabilities. As Kpotosu (Kpotosu, 2024) notes, there is an urgent need for studies that examine geometric concepts beyond numerical operations. In summary, although effective interventions for teaching geometry to students with learning disabilities exist, there are significant gaps in the literature. This synthesis highlights the importance of special education strategies and the need for more research on geometric memory and implications for instructional practice. By addressing these gaps, educators can better support students with learning disabilities in developing basic geometric skills.

In line with the results of this study, it is recommended that action research on the development of geometric memory of students with learning difficulties in mathematics should be increased and conducted over a longer period.

- To teach geometry to students diagnosed with dyscalculia, teaching geometry concepts using visual materials (pictures, graphs, models) and sensory experiences (making models, using manipulative materials) can help students better understand the concepts.
- Simple and step-by-step teaching, breaking the concepts into simple parts and teaching them step-by-step can reduce students' difficulties.

Repetition and recall through diverse activities can support students in reinforcing and retaining concepts more effectively. Customized learning plans tailored to the student's specific needs can significantly enhance the effectiveness of their learning process.

Ethics and Conflict of Interest

Permission number E-81100045-020-357580 (October 20, 2024) was obtained from the Kahramanmaraş Sütçü İmam University Ethics Committee for the study (22.10.2024-357580). This study was presented as an oral presentation at the 2nd International Mathematics Learning Disability Congress hosted by Ankara University on September 19-21, 2024. The authors followed the research ethics guidelines. There is no potential conflict of interest between the authors.

Author Contributions

All authors' contributions to the article are equal in every aspect. All authors have read and agreed to the published version of this work.

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