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Research Article

Evaluation of activity-based mathematics teaching to students with learning disabilities in out-of-school learning environments

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This study aimed to support primary school students with learning difficulties in out-of-school learning environments with artistic or sportive activities. The case study method, one of the qualitative research methods, was used in the study. The activities prepared for students with learning difficulties were shaped by considering four learning areas (numbers, geometry, measurement, and data processing). Each learning area was associated with music, visual arts, sports, and drama methods, respectively. The prepared activities were implemented for four days between 16-19 April 2023, when schools were on holiday. The activities were applied to students in 20 lessons in five lessons of 40 minutes each day. The project's target group consisted of 24 students officially diagnosed with learning disabilities and attending the third and fourth grades of primary school. This study collected data from interviews, observation, document review, and curriculum-based evaluation methods. The content analysis method was used for data analysis. The results of the study show that activity-based mathematics teaching has a positive effect on student learning. Artistic or sportive activities can be added to school programs for students with learning difficulties to learn in real-life environments.

Keywords: Learning disabilities, maths education, out-of-school learning environment, arts or sports activities

1. Introduction

Individuals with learning disabilities struggle with basic academic skills such as reading comprehension, writing, and mathematics. When the reports of international assessment organizations are examined, the proportion of students who cannot meet the minimum competencies in basic skills such as reading and mathematics is increasing (The World Bank [WB], 2018; United Nations [UN], 2018). When PISA 2018 data were analyzed, it was reported that 26% of the students continuing their education in Turkey could not meet the minimum proficiencies in reading and 37% in mathematics (Gençoğlu, 2019). These rates indicate that students need support for basic reading and mathematics skills.

Students with learning difficulties (LD) have difficulties in mathematical concepts and skills, acquisition of number concepts, remembering and making sense of numbers (Geary, 2011). In addition, these students have difficulties understanding the relationships between fundamental arithmetic operations and performing arithmetic operations, understanding and interpreting verbal problems (Geary & Hoard, 2005; Sharma, 2015). In daily life, students with LD face certain difficulties in shopping with money, reading and telling the time, finding directions, and giving directions (Butterworth, 2005). Such difficulties cause students with LD to fall behind academically and experience social and emotional difficulties (Hacısalihoğlu-Karadeniz, 2020).

As the grade level of students with LD increases, the achievement gap between them and their typically developing peers gradually widens (Bender, 2016). This situation, expressed by the concept of cumulative deficit, causes students with LD to fall behind their typically developing

peers (Bender, 2016). Learning disability is not a condition that disappears spontaneously without intervention. Students with LD can contribute to their education by organizing support activities by taking into account their characteristics. Indeed, students with LD learn slowly and differently compared to their typically developing peers. In addition, when these individuals are not supported with early and effective intervention programs, they face negativities in their further education.

In out-of-school learning environments (OSLEs), students can experience what they learn in the classroom by applying it in their natural environment (Şen et al., 2021). In this way, students can more closely associate the knowledge they learn in the classroom with daily life. In this respect, in-school and OSLEs should be planned to complement each other (Ames, 2013). OSLEs can potentially support and strengthen mathematics education in the classroom (Van Dijk-Wesselius et al., 2020). Embodied learning experiences in such environments can support students' mathematics education.

OSLEs are learning environments where interdisciplinary relationships and interactions are effectively observed (Altan & Ünaldı, 2021; Bakar et al., 2021). Although OSLEs are preferred more frequently in social sciences and sciences than in other fields, they can also be selected in other disciplinary fields to complement the educational activities carried out in the classroom (Saraç, 2017). OSLEs are widely used in teaching subjects such as reading, writing, mathematics, science, arts, drama, and environmental education (Van Dijk-Wesselius et al., 2020). In this respect, OSLEs can be used in mathematics learning and teaching as a discipline directly related to real life. Mathematics education in OSLEs can support what students with learning difficulties learn in the classroom.

Students can experience what they have learned in the classroom in real life through OSLEs (Şen et al., 2021). In addition, students can associate prior knowledge with new knowledge. In general, OSLEs offer students interactive learning environments and meaningful learning opportunities outside of formal education environments (Rennie, 2014). Research has indicated that these settings have a beneficial impact on academic performance (Andersson & Johansson, 2013) and enhance students' capacity for scientific thinking (Browning & Rigolon, 2019; Şen et al., 2021). OSLEs improve students' motivation (Waite et al., 2016), creativity, and interest in science learning (OECD, 2012). OSLEs can primarily support children with learning difficulties and students without classroom instruction (Fiskum & Jacobsen, 2012; Kuo et al., 2018).

Despite the potential of OSLEs, it has been determined that studies in this field are limited, and teachers do not prefer such environments (Feille & Nettles, 2019; Van Dijk-Wesselius et al., 2020). Teachers' lack of experience and knowledge about OSLEs, the curriculum, and the heavy workload on teachers create obstacles to the use of such environments (Van Dijk-Wesselius et al., 2020). Learning in OSLEs is considered freer than in-class learning. In this respect, OSLEs should be used in teaching mathematics to students (Davies & Hamilton, 2018).

It is anticipated that this study will have different expected effects. Firstly, it is known that individuals with learning disabilities have generalization problems (Fletcher et al., 2018). In other words, they have difficulty transferring the new information they have learned to different environments and situations. This situation also prevents students from integrating new knowledge with previous knowledge. Students supported in OSLEs can overcome the difficulties they experience and transfer the knowledge they learn in the classroom to real life. Secondly, students with LD are slow learners and need different learning strategies than their typically developing peers (Kirk et al., 2014). Learning environments created outside the school can contribute to the mathematics teaching of students with LD. Activities prepared for teaching mathematics to students with LD whose content is supported by artistic or sportive activities can be implemented by classroom teachers in OSLEs.

21st-century mathematics, among the basic subjects, is one of the essential subjects that should be taught to students. This study reveals the reflections of activities prepared with an interdisciplinary approach, including artistic or sportive activities, on students' mathematics learning. This study is essential in terms of contributing to teaching 21st-century basic subjects by

focusing on the teaching of mathematics subjects. In addition, it is thought to support students' communication and cooperation, critical thinking, and problem-solving skills through artistic or sportive activities.

This study aims to academically support primary school students with learning difficulties in OSLEs with activities that include artistic or sportive activities. In this respect, it reveals what kind of reflections the activity-based mathematics teaching in OSLEs has on students' learning of the subjects selected from the learning areas of numbers, geometry, measurement, and data processing. In this context, answers to the following research questions were sought.

RQ 1) What are the difficulties encountered and solutions applied in activity-based mathematics teaching in OSLEs?

RQ 2) What are the teaching and learning experiences of instructors and students regarding activity-based mathematics teaching in OSLEs?

2. Method

The study was designed according to the special case study method, one of the qualitative research methods. This study was conducted with the special case study method because it aimed to examine in depth the reflections of activity-based mathematics teaching applied in OSLEs on the learning of primary school students with LD on the subjects selected from the learning areas of numbers, geometry, measurement, and data processing. A special case study is a systematic research design that allows in-depth examination and description of a special case in its context in a multidimensional way (Yin, 2017). It is also a qualitative approach in which the researcher collects in-depth data about a special case through interviews, observations, and audiovisual materials and presents themes (Creswell, 2013; Patton, 2021).

2.1. Preparation and Implementation of Activities

The activities prepared for students with learning difficulties were shaped by considering four learning areas (numbers, geometry, measurement, and data processing). Each learning area was associated with music, visual arts, sports, and drama methods, respectively. In this context, critical topics from each learning domain that students with LD have difficulty with were determined by considering the literature (see Table 1). While determining the issues, it was paid attention that they could be associated with music, visual arts, sports, and drama methods.

The activities were prepared and implemented by expert trainers. A total of 2 researchers, 7 trainers, one health personnel, and 10 undergraduate students participated in this study. The researchers have studied primary school mathematics education and the preparation, implementation, and evaluation of intervention programs for students with mathematics learning difficulties. The trainers consisted of instructors who have studies on primary school mathematics education, the application of interdisciplinary methods, and the preparation and implementation of activities for students with learning difficulties. Two faculty members supported the implementation and evaluation of drama and orienteering procedures. The trainers are experts who have participated in certification training in related fields and have the necessary experience. Another one of the trainers is a faculty member who has studies in the field of music education.

Each activity was prepared and implemented by at least two trainers. One of the trainers is an expert in the field of primary school mathematics education and the other one is an expert in the application of music, visual arts, sports and drama methods and has studies in any of these fields. Therefore, the content of the activities was prepared with an interdisciplinary approach, including artistic and sportive activities. The prepared activities were implemented for four days between 16-19 April 2023, when schools were on holiday. The teaching of activities for four learning areas lasted four days, with one learning area per day. The activities were applied to students in a total of 20 lessons in five lessons of 40 minutes each day.

The activity teaching started with drama practice and then continued with music, visual arts, sports, and drama activities, respectively. 24 participant students were divided into four groups of

Table 1

Prepared activities and application information

Date and Hours	*Activity*	*Mathematic content*	*Field*	*Content Area*	*OSLEs*
16/04/2023					
09.30 – 10.10	Getting to know my friends through drama	Warming up	Drama	Numbers	Fatih Faculty
10.20 – 11.00	Bringing our objects together	Repeated addition in multiplication	Visual arts		of Education
11.10 – 11.50	Let's reinforce multiplication with musical rhymes	Repeated addition in multiplication	Music		
13.00 – 13.40	Rhythmic counting through sport	Rhythmic counting	Sport		
13.50 – 14.30	Rhythmic counting with fun	Evaluation	Drama		
17.04.2023					
09.30 – 10.10	Rounding numbers	Warming up	Drama	Geometry	Zağnos Valley
10.20 – 11.00	We Decorate Completely	Pattern creation	Visual arts		
11.10 – 11.50	Fun patterns	Completing an incomplete pattern	Music		
13.00 – 13.40	Orienteering!	Spatial relationships	Sport		
13.50 – 14.30	Creating my own pattern	Evaluation	Drama		
18.04.2023					
09.30 – 10.10	1-2-3Gen	Warming up	Drama	Measurement	Sera Lake Park
10.20 – 11.00	Estimate, Measure, Draw	Measuring length	Visual arts		
11.10 – 11.50	Tiny metres inside the metre	The relationship between metres and centimetres	Music		
13.00 – 13.40	Time in Oryatiring	Time measurement	Sport		
13.50 – 14.30	Measuring length and time	Evaluation	Drama		
19.04.2023					
09.30 – 10.10	Collecting Data	Warming up	Drama	Data	EYOF Park
10.20 – 11.00	I ask my question, I make my graph	Data collection and evaluation	Visual arts	Processing	
11.10 – 11.50	Analyse, Tally, Table	Creating and interpreting tables	Music		
13.00 – 13.40	Can rhythm have a graph?	Creating and interpreting graphs	Sport		
13.50 – 14.30	Data collection and evaluation	Evaluation	Drama		

six. The groups were formed randomly. Each group was guided by two undergraduate students, one from the classroom teaching program and the other from the special education teaching program. The undergraduate students were responsible for the students with LD. In the study, necessary precautions were taken considering the student's characteristics. In particular, students with LD were followed up one-on-one by undergraduate students and instructors. Close communication was established with the families of these students. In this way, possible negativities were prevented, and students were provided to receive their education healthily.

2.2. Out-of-School Learning Environments and Activities

On the first day, activities focussed on the learning domain of numbers and operations were applied to students with LD. In the first lesson, activities were implemented by the drama leader for students and instructors to meet and mingle with each other. In the second activity, an educational game made students realize multiplication means repeated addition. In the third activity, two instructors, one from mathematics education and the other from music education taught the students that multiplication means repeated addition through activities that included artistic activities with music education. In the fourth activity, students did rhythmic counting with sportive activities. In the last activity of the day, students were evaluated using the drama method.

On the second day, activities focused on the geometry learning domain were applied to the students with LD. In the first lesson, activities were implemented by the drama leader for students and instructors to meet and mingle with each other. In the third activity, the topics of identifying and completing the missing elements in a repetitive geometric pattern using triangle, square, rectangle, and circle materials were conveyed to the students. In the fourth activity, students were encouraged to use mathematical language to indicate location, direction, and movement in the orienteering process. In the last activity of the day, students in two groups completed the patterns with pre-prepared geometric pattern cards and created their own patterns.

On the third day, activities focused on the measurement learning domain were applied to students with LD. In the day's first activity, the drama method was used to prepare the students for the subject. In the second activity, students with LD were supported in measuring length. It was ensured that the students estimated a length that they could measure directly with the most appropriate unit of length measurement and checked their estimation by measuring. The third activity aimed for students to explain the relationship between meters and centimeters and write a given length in meters and centimeters. In the fourth activity, students were asked to read and write the time in minutes and hours during the orienteering process. In the last activity of the day, the drama method was used to evaluate what the students learned during the day.

On the fourth day, activities focused on the data processing learning domain were applied to students with LD. In the first activity of the day, learning about data processing learning domain was carried out with drama method. In the second activity, students were supported with the topics of data collection, classification, creating a tally or frequency table, and creating object and shape graphs. In the third activity, students were asked to keep a tally table and then convert the tally tables into frequency tables. In the fourth activity, students were asked to make rhythmic sounds with the materials they found. The student who completed the application was asked to stick as many counting sticks as the number of sounds he/she made on the previously prepared tally table.

2.3. Participants

The project's target group consisted of 24 students officially diagnosed with learning disabilities and attending the third and fourth grades of primary school. Criterion sampling method, one of the sampling methods, was preferred in determining the target group. In this sense, the following criteria were taken into consideration in determining the students:

- Have a student who has been officially diagnosed with a learning difficulty by the Guidance Research Centre [GRC],
- Being a student attending the third or fourth grade of primary school,

- No health problems accompanying the learning disability,
- There is no other special education diagnosis with learning difficulty,
- Being a student attending school

In determining the target group, firstly, the names and school information of the students diagnosed with learning disabilities were obtained from the Trabzon Guidance and Research Centre. Secondly, among these students, third- or fourth-grade students were identified as the target group. Thirdly, schools were visited, and interviews with school administration, teachers, parents, and students were conducted. Fourthly, 24 students whose parents volunteered were identified as the target group. In this context, parental consent forms were obtained from the students' families.

2.4. Data Collection Tools

This study collected data from interviews, observation, document analysis, and curriculum-based assessment methods. In addition, video recording, field notes, and the researcher's diary were used to collect data. The reflections of activity-based mathematics teaching on the learning of the subjects that students with LD have difficulty in were revealed through interviews. Using the evaluation form prepared by the researchers and instructors, interviews were conducted with instructors (n=7) and students with LD (n=24) at the end of the day. In this context, the trainers were asked to answer four open-ended questions: (1) How would you describe teaching in an OSLE? (2) What kind of teaching did you do? Was the teaching fun? (3) What kind of difficulties did you encounter? (4) What solutions did you develop to overcome these difficulties? In the interview with students with LD, students were asked to answer five open-ended questions: (1) Which activity did you like? Why did you like this activity? (2) In what words would you describe your experience of today's activities? (3) Did you learn anything for the first time today? (4) What would you say when you compare the activities in the classroom with the activities in the project? (5) If you could change one of today's activities, which would it be? Interviews with both instructors and students were conducted face-to-face and recorded.

The second method used for data collection was observation. In the study, all activities were observed by two researchers and recorded with photographs. At the same time, critical situations were recorded by video. In this way, the reflections of activity-based mathematics teaching on student learning were observed. The first researcher recorded the observations in the form of a researcher diary. Video recordings and the researcher's journal were used to support the data obtained from the interview.

The third method used for data collection is the document analysis method. For the evaluation of activity-based mathematics teaching, the products obtained from the activities applied to the students were used within the scope of document analysis. The products (worksheets, posters, pictures, song lyrics, etc.) produced by the students during the activities were used to support other data collection tools about how the students changed academically. The worksheets used in the implementation and evaluation of the activities consist of the products prepared by the instructors in advance and worked on by the students.

All of the instructors participated in the drama activities at the end of the day, and the students were evaluated within the scope of the curriculum-based assessment. In this type of assessment, student performance is determined through materials taken from the curriculum that the student follows at school (Hintze et al., 2006). Curriculum-based assessment is an assessment method that is generally used effectively when deciding on an appropriate teaching method for the student. In this study, curriculum-based assessment was used to determine the reflections of activity-based mathematics instruction on the learning of students with LD.

2.5. Data Analysis

The data were analyzed using content analysis method. The answers given to each open-ended question in the evaluation form were coded by the first researcher and grouped according to categories and themes. The answers to each question were read separately and coded with a few

words. These codes were compared to form categories and themes. Then, the data obtained by using inductive and deductive cycles were systematically assigned to codes, categories, and themes. This process was carried out separately for each research question. In addition, instructors' teaching experiences and students' learning experiences were analyzed using word clouds. After all analyses were completed, the second researcher coded the codes, categories, and themes, and the analysis was finalized.

To minimize researcher bias, it is essential to perform a second coding by a different coder. The harmony between the coders contributes to the reliability of the research (Baltacı, 2017). In this direction, the agreement between the coders should be 80% and above (Patton, 2021). In the analysis of the data, Miles and Huberman's (1994) reliability formula (the ratio of agreement to the sum of agreement and disagreement) was preferred as the reliability formula, and the agreement rate between the two coders was calculated as 87.7%. The researchers discussed and discussed the conflicting codes, categories, and themes and reached a consensus on the conflicting issues.

The trainers and the researcher whose opinions were consulted were coded in the presentation of the findings. Considering their duties in the study, they were coded by giving the initials of their duties and a sequence number (For example, trainers were coded as T1, T2). Information about the experts and researchers and coding information are presented in detail in the table (see Table 2).

Table 2
Participants whose opinions were taken within the scope of the study

Expert/ Trainer	*Area of Expertise*	*Contribution to the study*
E1	Primary school mathematics education and preparing an intervention program for students at risk of mathematics learning difficulties	Evaluated the suitability of activities with artistic or sportive activities in their content for students with learning difficulties and primary school mathematics teaching
T1	Drama method	Preparation and implementation of drama activities Drama Evaluation of students with drama method
T2	Primary school mathematics education	Preparation and implementation of maths activities
T3	Primary mathematics education	Preparation and implementation of maths activities Associating activities with visual arts
T4	Primary mathematics education	Preparation and implementation of maths activities
T5	Music Education	Associating the activities with the music method Preparation and implementation of maths activities
T6	Orienteering method, Primary school mathematics education	Associating activities with orienteering method
T7	Assessment in OSLEs	Preparing, implementing and evaluating activities for students in OSLEs

2.6. Validity and Reliability

In qualitative research, validity and reliability are ensured by credibility, confirmability, transferability, and consistency (Merriam, 2009). In this study, various measures were taken by the researchers to ensure validity and reliability (Yıldırım & Şimşek, 2016). In this context, direct quotations consisting of participant opinions were included. At least two expert trainers examined data collection tools. At the same time, the same questions were asked to all participants and recorded. Two expert researchers coded the data obtained, and the agreement rate between the

researchers was calculated. In addition, the validity and reliability of the study were ensured by providing data triangulation.

3. Findings

In this study, the effects of activity-based mathematics teaching in OSLEs for learning the learning domains of numbers, geometry, measurement, and data processing were evaluated in line with the views of instructors and students. Firstly, the findings obtained from the instructors' views on the difficulties and solutions encountered in activity-based mathematics teaching to students with LD were presented. Then, the findings related to instructors' and students' teaching and learning experiences regarding activity-based mathematics teaching were presented.

3.1. Challenges and Solutions

The difficulties encountered in the teaching process and the solutions developed to overcome these difficulties are presented under four themes (see Table 3). The problems experienced by the instructors and their solutions were expressed as frequency and percentage. The most frequently expressed difficulties were weather conditions in the physical conditions theme and assessment difficulties in the out-of-school learning theme. These challenges were followed by challenges such as focusing attention and managing student behavior.

Table 3
Difficulties experienced by trainers and solutions

Student characteristics		*Physical conditions*		*Trainer*		*OSLE*	
Challenges							
Focusing attention	6 (%85,71)	Weather conditions	7 (%100)	Loss of control	5 (%71,42)	Lack of communication and co-operation	4 (%57,14)
Lack of motivation and interest	3 (%42,85)	Sound and noise	4 (57,14)	Managing student behaviour	6 (%85,71)	Lack of time	3 (%42,85)
Lack of prior learning	5 (%71,42)					Difficulty of evaluation	7 (%100)
						Lack of teaching materials	2 (%28,57)
						Lack of parental involvement	2 (%28,57)
Solutions							
Benefit from artistic or sporting activities	7 (%100)	Identify sheltered areas	5 (%71,42)	To provide guidance and supervision	6 (%85,71)	Alternative assessment	5 (%71,42)
Preparing and implementing interactive activities	7 (%100)			Establish regular communication	5 (%71,42)	Making plans and programmes	3 (%42,85)
				Using different methods and strategies	7 (%100)	Parental information	2 (%28,57)
						Small group teaching	7 (%100)

In the following sections, the challenges and solutions for each of the four themes will be discussed in detail in line with the trainers' views.

3.1.1. Theme 1: Student characteristics

During activity-based mathematics teaching, the instructors encountered difficulties arising from student characteristics such as focusing attention, lack of prior learning, lack of motivation, and lack of interest (see Table 3). The low academic achievement of students with LD may cause them to lack motivation and interest. In addition, students with LD lag behind their peers academically and experience learning loss. This situation may cause students to lack prior learning. Students with previous learning deficits have difficulty in learning later mathematics subjects. An instructor who encountered difficulties arising from the lack of prior learning expressed this and its solution as follows: "The inadequacy of the existing knowledge of a few of my students causes them to be unable to do what is asked of them. The student was guided in this process, and clues were provided (T4)." Students with LD experience behavioral problems such as attention deficit and hyperactivity. This situation causes students to have attention problems. For example, an instructor expressed the problem and solution she experienced:

> ADHD prevents students from focusing on the activities and causes them to be busy with other tasks. To overcome this situation, I removed distracting items from the environment and asked the undergraduate students to deal with the student one-on-one (T6).

To overcome the difficulties arising from student characteristics, the instructors utilized artistic or sportive activities and implemented interactive activities. The trainer who stated that artistic activities attracted the attention of students with LD expressed his solution: "When interactive activities based on artistic activities are applied to students who are often distracted and have low interest, they are interested in the subject and learn better (T1)."

3.1.2. Theme 2: Physical conditions

During the activity-based mathematics teaching, the instructors encountered difficulties arising from physical conditions such as weather conditions, noise, and noise (See Table 2). To overcome these difficulties, the instructors conducted the activities in sheltered areas where necessary precautions were taken. An instructor who stated that weather conditions affected the students expressed the difficulty and solution he encountered: "Since the weather was very hot, students were affected by the sun outdoors. Families were asked to take precautions to protect children from the sun (e.g., dressing them in appropriate clothes and making them wear hats) (T3)." In OSLEs, being affected by weather conditions in outdoor teaching is seen as a possible limitation. In addition, students are likely to be affected by sound and noise in outdoor teaching. This may distract students' attention and hinder learning. An instructor expressed the difficulty and solution he encountered regarding sound and noise:

> The amusement park in the park makes a lot of noise and distracts students. It makes it difficult for students to learn, especially in musical activities. The vehicles in the amusement park were stopped by talking to the staff until the end of the activity (T5).

3.1.3. Theme 3: Trainer

The instructors encountered classroom management challenges (see Table 2), such as losing control and managing student behavior during activity-based mathematics teaching. Since teaching in OSLEs takes place outdoors, classroom management becomes more difficult. The instructors were experienced in preparing and implementing activities and teaching mathematics to students with LD. Although the trainers were experienced experts, they had difficulties in classroom management because activity-based mathematics teaching was conducted outdoors. To overcome these difficulties, the instructors applied solutions such as regular communication, using different methods and strategies, and providing guidance. An instructor who had difficulty managing student behavior expressed the difficulty and the solution she applied:

> One of the students was overly active, irritable, and easily distracted. The tools and materials used in the activities distracted the student's attention. He would cry when an object he wanted, especially paper, was not given. This student's education was carried out with the participation of parents and individual education (T4).

Since each student with LD exhibits different characteristics, different behavioral problems may likely be observed during teaching. This situation makes student control difficult. An instructor with difficulty in student control expressed the problem he experienced and the solution he applied as follows:

> Since the trainings were held outdoors, it was difficult to focus the students on the lesson. Also, working with 24 students with LD made classroom control difficult. To overcome this difficulty, students were divided into small groups, and support was received from undergraduate students to follow the students (T2).

3.1.4. OSLEs

During the activity-based mathematics teaching, the instructors encountered difficulties arising from the OSLE, such as lack of communication and collaboration, lack of time, difficulty in assessment, lack of teaching materials, and lack of parental involvement (See Table 2). To overcome these difficulties, the instructors developed solutions such as alternative assessment, small group teaching, informing parents, and making plans and programs. In teaching in OSLEs, alternative assessments are needed instead of traditional assessments. An instructor expressed the difficulty she experienced and the solution she applied in terms of assessment difficulty as follows: "It is tough to assess students with tests and similar assessment tools. Alternative assessment tools, such as projects that reveal students' performance, were utilized (T7)." In outdoor education, using the teaching materials used in the classroom becomes difficult. One of the trainers expressed the difficulty he experienced and the solution he applied regarding the lack of teaching materials: "Since outdoor education was carried out, there was no access to the materials used in schools. Therefore, students created materials from objects they found in nature (T2)." Activities prepared with an interdisciplinary approach attract students' interest and attention because they are associated with multiple fields (e.g., drama, music, painting). Still, it is challenging to implement the activities within a certain time interval. One of the trainers expressed the difficulty and solution she experienced regarding lack of time:

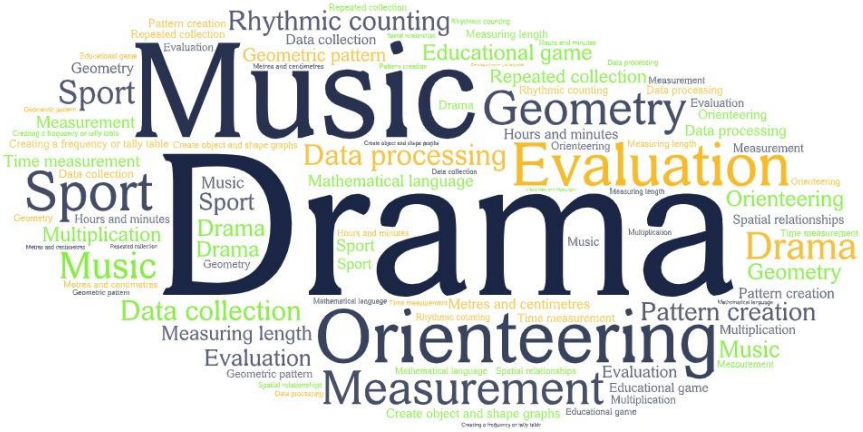
> Since the activities are created with an interdisciplinary approach, they consist of practice-based activities. Time is needed for all students to implement the activity. Most of the time, one lesson hour was not enough for this. To overcome this situation, the number of students can be reduced, or the intensity of the activities can be reduced (T5).

3.2. Teaching and Learning Experiences

Under this heading, firstly the teaching experiences of the instructors are presented and then the findings of the students' learning experiences are presented. The findings of the questions "*What kind of teaching did you do and how would you describe this teaching?*" are presented as a word cloud (see Figure 1).

When Figure 1 is analyzed, it can be stated that instructors used artistic or sportive activities such as drama, music, and sports to teach students with LD various subjects from the learning domains of numbers, geometry, measurement, and data processing. As a result of the trainer and expert interviews, it was determined that activities with artistic or sportive activities in their content positively support student learning in OSLEs.

Figure 1
Word cloud of trainers' teaching experience



This study observed that the use of real objects found outdoors by students with LD positively affected student learning. In this regard, T2, one of the instructors, said: "In the activity using stones, tree leaves, and twigs, students enjoyed working with real objects and understood the meaning of multiplication as repeated addition." At the same time, real objects in the open air positively supported student learning in creating geometric patterns and determining the pattern rule and the missing part in the pattern. One of the trainers expressed the following opinion on this issue: "Creating a pattern on craft paper with leaves found in the park attracted students' attention and facilitated their understanding (T3)." It was observed that the objects in the open air positively affected the learning of students with LD in creating frequency and tally tables. In this regard, T5, one of the trainers, stated, "Students can learn about data processing when they are supported with real outdoor objects."

Using musical instruments in teaching mathematics to students with LD and performing rhythm-based teaching positively affected student learning. One of the trainers expressed the contribution of rhythm-based teaching to student learning: "Rhythmic counting using musical instruments attracted students' attention. Repeating the lyrics prepared beforehand with the students and keeping rhythm at the same time contributed to the students' rhythmic counting (T5)." It was observed that music-supported activities facilitated teaching subjects such as rhythmic counting, multiplication, and patterns.

Orienteering-orientated activities were observed to support students in time measurement and spatial relations. It positively affected expressing time in hours and minutes and students' use of mathematical expressions indicating location and direction. It was observed that teaching using the orienteering method positively affected student learning. In this regard, the instructor coded T6 stated, "Orienteering-based activities were interesting because they allowed students to move. At the same time, it supported students to tell time in hours and minutes, read and write."

Using the meter as a concrete object as a measuring tool supported the students in measuring length. In this regard, the trainer coded T3 said: "The student's use of the meter to measure the benches in the park and the distances between the benches supported the students in measuring length. Students measured different items with meters." One of the trainers stated that concrete objects effectively comprehended the relationship between meters and centimeters: "The activity using colored cardboard and meter helped students to comprehend the relationship between meter and centimeters (T4)."

As a result of the expert opinion, it was determined that activity-based mathematics teaching in OSLEs had a positive effect on the learning of primary school students with LD on the subjects selected from the learning areas of numbers, geometry, measurement and data processing. The following sentences from the expert opinions support this statement: "As a result of the activity carried out in relation to visual arts, a significant awareness of pattern and ornamentation was realised in students (E1)." In the same way, a different statement was made: "Teaching with

concrete objects such as metres enabled students to comprehend the relationship between metres and centimetres (E1)." In a different statement, the effect of teaching with drama method on students was expressed as follows: "Activity-based teaching with drama method and evaluation studies at the end of the day have a positive effect on students' cooperation and communication skills (E1)."

Curriculum-based assessment using the drama method revealed that students with LD can learn when supported by artistic or sportive activities in the OSLE. The station technique was utilized to assess the topics in the learning domain of numbers. Students with LD were assessed by playing songwriting, collective picture creation, rhythm keeping with music accompaniment, rhythmic counting, game hopping at the music, painting, sports, and game stations created beforehand. As a result of the evaluation, it was observed that the students could perform rhythmic counting and comprehend the meaning of multiplication as repeated addition.

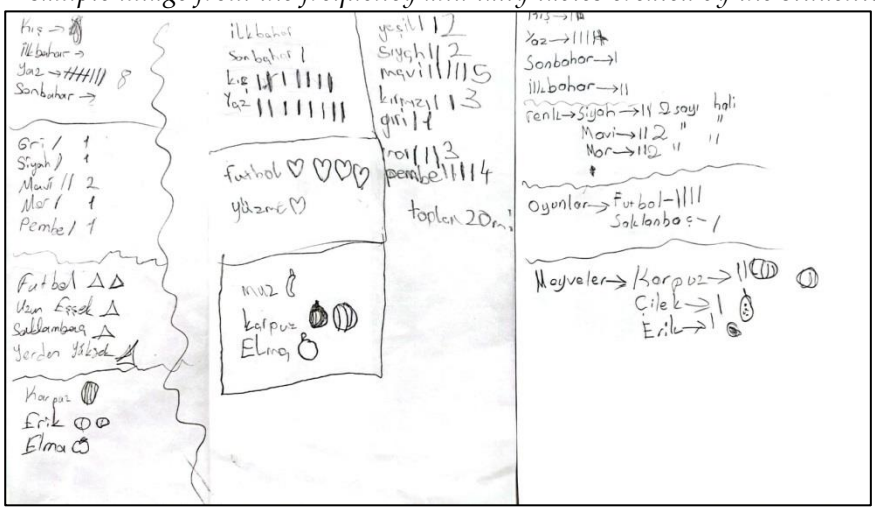
In order to evaluate the topics in the geometry learning area, students were evaluated with geometric pattern cards and pattern guides prepared in advance. In addition, students created their own patterns with crayons and A4 papers given to them. As a result of the evaluation, it was seen that the students were able to create patterns and complete the missing part of the pattern. The instructor responsible for the evaluations on this subject stated the following: "Since the students created their own patterns using crayons, they understood the subject better (T7)."

The drama method evaluated the subjects in the measurement learning domain. In measuring length, students were asked to estimate the sizes of objects found in nature and then measure the thing with a standard measuring tool. In calculating time, students were asked to complete the clock with a collective drawing activity. As a result of the evaluation, it was observed that students with LD could tell the time in hours and minutes and measure the objects around them using length measurement tools. One of the trainers expressed her experience in measuring length: "The student who took the meter in his hand did not want to put it down; he wanted to measure and record the length of everything he saw (T3)."

To assess the topics in the data processing learning domain, students were asked to collect data, categorize them, and create frequency and tally tables. Then, students were asked to interpret the graphs and tables they created (see Figure 2).

Figure 2

A sample image from the frequency and tally tables created by the students



The findings of the questions "*Which activity did you like?*" and "*With which words would you describe your experiences about this activity?*" are presented as a word cloud (see Figure 3).

Figure 3
Word cloud of learning experiences of students with learning disabilities

When the students' learning experiences were analyzed, it was found that different types of activities were applied in activity-based mathematics teaching, and the activities were defined as fun, instructive, active, exciting, and pleasing by the students.

4. Discussion and Conclusion

This study reveals what kind of reflections activity-based mathematics teaching in OSLEs has on the learning of primary school students with LD on selected topics from the learning domains of numbers, geometry, measurement, and data processing. In this context, the findings related to the difficulties encountered in activity-based mathematics teaching and solutions were discussed. Then, the findings related to instructors' and students' teaching and learning experiences regarding activity-based mathematics teaching were discussed.

In this study, four themes related to the difficulties and solutions encountered in activity-based mathematics teaching were reached in line with the instructors' opinions. As a result of the study, it was determined that the instructors encountered difficulties in activity-based mathematics teaching, such as lack of attention focus and pre-learning due to student characteristics and adverse weather conditions due to physical conditions. In addition, it was determined that the instructors encountered difficulties such as evaluation difficulties, lack of communication, and cooperation arising from the out-of-school learning environment. In addition, it was found that the instructors had difficulties, such as losing control and managing student behaviors during activity-based mathematics teaching. Such challenges are similar to those identified in previous studies (Van Dijk-Wesselius et al., 2020). In a study that identified factors that hinder teaching in OSLEs, it was found that obstacles such as lack of appropriate resources, staff expertise, child-staff ratio, adverse weather, and formal assessment of children were encountered (Davies & Hamilton, 2018). The same study found that teachers preferred an in-class assessment rather than an outdoor assessment. This situation indicates that teachers are inadequate in alternative assessment. In the existing literature, weather is one of the main problems encountered in OSLEs (Maynard & Waters, 2007). Although it is stated that this situation is overcome by providing appropriate clothing and resources, weather conditions may pose a problem for students due to the participants' personal characteristics. This study identified scorching weather and students' discomfort with the sun as weather-related problems.

As a result of this study, it was found that the instructors used interactive activities, including artistic or sportive activities, alternative assessment, and small group teaching to overcome the difficulties they encountered in activity-based mathematics teaching. Using alternative assessment tools to assess students with LD can enable teachers to make more effective decisions about student learning. Alternative assessment methods such as portfolios, performance tasks, and peer and self-assessment support students with LD. Alternative assessment methods contribute to student learning by allowing peer interaction in small-group teaching (Woodward et al., 2001). In addition, implementing activities in the form of small group teaching can be effective in teaching

mathematics to students with LD. It is stated that instructional interventions that effectively teach mathematics to students who have difficulty learning mathematics are presented to students in the form of small-group instruction (Powell & Fuchs, 2015).

As a result of the expert and instructor opinions, it was found that the reflections of activity-based mathematics teaching in OSLEs on the learning of primary school students with LD on the subjects selected from the learning areas of numbers, geometry, measurement, and data processing were positive. This result is similar to the effects of previous studies. For example, a study investigating the benefits of OSLEs in teaching science and mathematics to young children showed that these environments benefit students with learning disabilities (Davies & Hamilton, 2018). In OSLEs, students see themselves as more independent. In addition, walking, moving, and running outdoors can benefit students with LD who are mobile. Studies have shown that learning in OSLEs positively affects students' academic development (Davies & Hamilton, 2018; Karamustafaoğlu & Pektaş, 2023; Van Dijk-Wesselius et al., 2020). On the other hand, it should not be generalized that OSLEs are always beneficial in the education of mobile students (Davies & Hamilton, 2018). Indeed, mobile students may be distracted in such environments and have difficulty focusing on the lesson. It can be stated that more studies on the effects of such environments on students with LD are needed.

As a result of this study, it was determined that the use of real objects outdoors and the use of concrete objects in activity-based mathematics teaching positively affected student learning. There are many studies on the positive effects of concrete objects on students' learning, however, realistic mathematics teaching argues that the use of real life in the mathematics learning process also has positive effects.

As a result of this study, it was determined that using musical instruments, organizing orienteering-oriented activities, and using drama methods in activity-based mathematics teaching positively affected student learning. Orienteering-oriented activities can contribute to the development of spatial thinking, problem-solving, measurement, and data analysis skills of students with LD. For example, Uzuner and Ekiz (2023) showed that the steps in Polya's problem-solving method can be used for problem-solving in the orienteering process. It is stated that problem-solving and spatial relationships can be improved with the orienteering method (Kelly, 2012). Another study determined that the orienteering method was effective on the attention, metacognition, and problem-solving skills of students with attention deficit and hyperactivity disorder (Uzuner & Şahin, 2021). On the other hand, it is stated that there are common relationships between music and mathematics (Doğan & Akman, 2019). It is emphasized that mathematical and musical concepts such as rhythm, pattern, numbers, and ratios between the two fields have similar characteristics. Therefore, music activities can support mathematics teaching. It has been found that the academic achievement, spatial perception skills (Aheadi et al., 2010), abstract thinking, and problem-solving skills of students participating in music-supported teaching improve positively (Doğan & Akman, 2019). Another method that positively affects student learning in activity-based mathematics teaching is the drama method. Studies examining the effectiveness of the drama method in mathematics teaching determined that it developed a positive attitude toward mathematics and improved academic achievement (Ereke & Obeka, 2021; Stanton et al., 2018).

According to the students' opinions, it was seen that the students had positive opinions about the activities carried out in OSLEs. As a result of the study, students with LD realized that their mathematical knowledge improved thanks to activity-based mathematics teaching. The fact that students learn through real-life experiences can be seen as a reason for this difference. Similarly, a study aiming to improve students' problem-solving skills with STEM activities determined that the activities applied outside the school supported students' problem-solving abilities (Karamustafaoğlu & Pektaş, 2023).

5. Suggestions

As a result of this study, it was determined that activity-based mathematics teaching in OSLEs positively affected the learning of primary school students with LD in the subjects selected from the learning areas of numbers, geometry, measurement, and data processing. Therefore, artistic or sportive activities can be included in school programs for children with learning difficulties to learn in real-life environments.

Activity-based mathematics teaching was presented to students with learning disabilities in 5 daily 40-minute lessons. The five-hour lesson was intensive for students with learning difficulties. In this context, activities can be planned by considering this intensity in future studies. In addition, alternative assessment and evaluation methods can be used for student assessment in OSLEs in a future study.

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