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Research Article

Descriptive analysis of dyscalculia articles published in Turkiye and a music-supported model proposal for dyscalculia education

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Abstract

Learning disabilities could create some important problems that affect the daily activites of individuals who experience this condition. These problems affect individuals as well as their families. Qualified training applied by scientific methods can minimize these negative effects. "Dyscalculia", which is the numerical dimension of specific learning difficulty, can prevent individuals from revealing their true potential. It is extremely important to know what dyscalculia is, to diagnose it correctly and to know the correct teaching methods by educators. In this study, it was aimed to examine the studies on dyscalculia and to reveal the orientation related to these studies and to make the literature more known. In addition, a model suggestion was made regarding the use of music in the education of dyscalculic individuals. The sample of this research consists of articles published in TR Dizin between 2011-2022. The keywords "dyscalculia, math difficulty, math learning difficulty" were searched in both Turkish and English in the TR Dizin. Sixteen articles reached by scanning were determined to be analyzed as samples. An article review form was created by the researchers with the themes determined by expert opinion. The data were prepared and analyzed with the help of the document review method and this form. In the study, it was concluded that dyscalculia is a subject that has not been studied sufficiently in Türkiye. It is thought that multidisciplinary studies may contribute to the field in future studies.

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Introduction

Today, in order to keep up with the world in the best way in every sense, the education, which is the desired behavior development process in the individual, must be carried out in the most efficient way. This can be seen as the most important responsibility of educators and scientists. In order for countries and civilizations to exist and develop, they need production and technology, and for this, they need working and producing manpower (Ceylan, 2010). In order to meet this need, people need to have qualified training. Nowadays, while science is rising rapidly, the need for qualified educated people is increasing at the same rate. Specific learning disability is a developmental disorder that can be observed with differences in learning processes and various difficulties in perception. Individuals with specific learning disabilities (SLD) have a normal level of intelligence and have a disorder in one or more of the psychological processes that involve using and understanding speech and writing language. These may be disorders in listening, speaking, reading(dyslexia),

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writing(dysgraphia), spelling and arithmetic(dyscalculia) (Dadandi, 2015). According to studies, an average of 5% of primary school children in the world struggle with these difficulties.

Numerical skills are an integral part of both our work and school life. In researches conducted in the world, approximately 3% to 6% of children experience developmental dyscalculia (DD) (Kucian & von Aster, 2015). In short, this learning disability, called “Dyscalculia”, becomes evident especially in primary school students (Desoete, Roeyers, & Declercq, 2004). When dyscalculic students are involved in the same teaching processes with their peers, their school success may be adversely affected. The reasons why these students fail in mathematics course vary. First of all, these students fail because they do not receive appropriate individual education. Considering the findings of scientists, the main causes of failure in mathematics include ineffective teaching, ignoring students' individual learning processes, visual-spatial problems, lack of attention, verbal language problems, problems with motor skills, cognitive problems and problems with memory (Koc, 2018). As a result, there may be differences in perception that may vary from person to person in dyscalculia. It is also thought that dyscalculia can be seen at different levels.

Medical diagnosis of dyscalculia in Türkiye is carried out by specialist doctors in the field of pediatric mental health and diseases in full-fledged public hospitals or in education and research hospitals affiliated to universities. With the "Specific Learning Difficulty (SLD)" report obtained from these institutions, an educational evaluation is made for the students who go to the Ministry of National Education Guidance Research Centers (RAM). As a result of this evaluation, students who have created an individualized education program suitable for them are placed in appropriate educational environments (Uygun, 2020). Educational interventions are applied in special education institutions in areas determined as the needs of these students.

Instructional Intervention

This concept is mostly encountered in relation to students who need special education. Teachers can change the teaching method or use different materials as a result of their evaluations. Whether instructional intervention works or not can be observed in the evaluation after the intervention (Bayrak & Yurdugul, 2016). Based on this evaluation, teachers can choose the most efficient among the different methods they try. Thus, they can try to make the learning process more qualified for their students.

Dyscalculic students may fall behind their classmates in terms of academic achievement in mathematics classes. These students can be interpreted as lazy or indifferent to the course by teachers whose awareness or professional knowledge about dyscalculia is not sufficient (Hacısalihoglu Karadeniz, 2013; Kuruyer, Cakiroglu, & Ozsoy, 2019; Altindag Kumas & Ergul, 2017; Nurkan & Yazici, 2020). As a result, it is thought that these teachers may be inadequate in the process of dyscalculia diagnosis.

Articles on dyscalculia published in Turkiye (TR Index) were scanned with the keywords "dyscalculia", "math difficulty" and "math learning difficulty". As a result of the screening, 16 articles were identified in the relevant literature. These articles tended to reveal the awareness and professional knowledge levels of individuals about dyscalculia mostly in terms of their subjects (Kuruyer, Cakiroglu, & Ozsoy, 2019; Altindag Kumas & Ergul, 2017; Nurkan & Yazici, 2020; Hacısalihoglu Karadeniz, 2013; Baldemir, Ic, & Tutak, 2022; Sezer & Akin, 2011). In these studies conducted with qualitative research methods, data were collected with questionnaires and structured interview forms.

Among the studies involving instructional intervention on mathematics subjects in dyscalculic students, only one (Sonmez, 2021) has a quasi-experimental research that includes music, rhythm and instrument elements. Considering that music is an important material in education, it can be said that only one study is insufficient.

Children sleep, play, dance, sing, play instruments, beat the rhythm, have fun, learn with music (Ozal Goncu, 2016). Playing can be considered as a very important element in children's lives. Children learn about life and communication through play. It can be thought that music has the same importance for education life. The most important material in primary music education, where the first formal music education began, is children's songs (Sonsel, 2018). The fact that educators benefit from this efficient and effective material in all processes of education can provide a much more qualified learning for students.

In the historical process, human beings have sometimes used music for motivation (Demirel, 2022) and sometimes as a treatment tool (Ucaner & Jelen, 2015). Considering these therapeutic and motivating aspects of music, it is thought that it will be beneficial to use it in the field of specific learning disabilities. For this reason, it is predicted that music, which was accepted as a branch of mathematics in the past (Isitan, 2013), may be effective in the education of dyscalculic individuals. This is supported by current medical research. It has been observed that music therapy is useful in the education of individuals with specific learning difficulties (Mina et al., 2021). In addition, it is thought that music and mental calculations such as addition/subtraction in the brain trigger similar brain pathways in both the prefrontal cortex and the parietal lobe (Ribeiro and Santos, 2020, cited by Schmithorst and Holland). Increasing research on this subject may provide more different materials to field experts and may contribute to more qualified dyscalculia education.

Purpose of the Study

In this study, it was aimed to conduct a systematic analysis of the studies on dyscalculia in Türkiye and to propose a music-supported model in the education of dyscalculic students.

Method

Research Model

This research was carried out with the document analysis technique, one of the qualitative research methods. Document analysis is a systematic method used to examine and evaluate all documents, including printed and electronic materials. With this method, literature containing a lot of research can be summarized and interpreted statistically. Researchers generally review previous research, the literature, and incorporate this information into their research (Kiral, 2020, p. 175). The data resulting from these research can reveal the orientation of the research conducted in the literature and the parts of the problem area that have not been researched before. Thus, researchers can contribute to the field by investigating the unilluminated aspects of the subject.

Documents

The universe of this study is the studies on dyscalculia published in Türkiye. The sample consists of articles on dyscalculia published in the TR Dizin between 2011-2022. The keywords "dyscalculia, math difficulty, math learning difficulty" were searched both in Turkish and English inside TR Dizin. As a result, 16 articles, which are samples, were reached.

Data Collection and Analysis Process

Sixteen articles in the sample were examined within the framework of the main themes for content analysis. These themes were determined as "sample type, research method, sample number and sample age group" by taking expert opinion. With these themes, a tabular article review form was created. This table was used to classify the data of the research. In this way, the data are summarized and digitized.

These 16 articles published on dyscalculia were examined in detail and the article review form was filled with the main themes determined. Then, the data in the form were evaluated and interpreted by the researchers. At this stage, this analysis was summarized by creating statistical tables related to the main themes identified.

Results

In this section, a systematic analysis of the studies on dyscalculia in Türkiye and a model proposal for music-assisted dyscalculia education will be presented.

Articles Published on Dyscalculia in Türkiye

In this section, descriptive analysis of 16 articles found as a result of the searches made with the keywords determined was performed. The selected articles were examined in terms of sample type, research method, number of samples and sample age group and the results were tabulated. The sample types of the scanned articles are shown in Table 1.

Table 1. Distribution table of articles by sample type

	f	%
Student	7	43,75
Teacher or Prospective Teacher	6	37,5
Document	3	18,75
Total	16	100

According to Table 1, seven of the sixteen studies examined (Eng et al., 2014; Mutlu & Akgun, 2017; Sonmez, 2021; Ozturk, Durmaz, & Can, 2019; Koc & Korkmaz, 2019; Acar & Higde, 2018; Al-Zoubi & Al-Adawi, 2019) consist of experimental and qualitative research studies for students. Six studies were conducted with undergraduate students who are prospective teachers and teachers with various professional experiences (Kuruyer, Cakiroglu, & Özsoy, 2019; Altındağ Kumaş & Ergül, 2017; Nurkan & Yazıcı, 2020; Hacısalihoğlu Karadeniz, 2013; Baldemir, İç, & Tutak, 2022; Sezer & Akın, 2011). The other 3 studies (Terzioğlu, Curaoğlu, & Yıkmış, 2019; Saygılı, 2017; Filiz, 2021) include document review and descriptive analysis of studies on the literature.

Table 2. Distribution of articles by research method

	f	%
Qualitative	12	75
Experimental	4	25
Total	16	100

According to Table 2, twelve of the sixteen articles (75%) reviewed were conducted using qualitative research techniques (Kuruyer, Cakiroglu, & Ozsoy, 2019; Altındag Kumas & Ergul, 2017; Eng et al., 2014; Terzioglu, Curaoğlu, & Yikmis, 2019; Nurkan & Yazici, 2020; Saygili, 2017; Hacısalihoğlu Karadeniz, 2013; Baldemir, Ic, & Tutak, 2022; Koc & Korkmaz, 2019; Acar & Higde, 2018; Filiz, 2021; Sezer & Akin, 2011), 4 articles (25%) were conducted using experimental methods (Mutlu & Akgun, 2017; Sonmez, 2021; Ozturk, Durmaz, & Can, 2019; Al-Zoubi & Al-Adawi, 2019).

In a study conducted abroad among experimental studies (Al-Zoubi & Al-Adawi, 2019), the results of multiple intelligence theory-based studies on the experimental group were evaluated using the experimental method with pre-test-post-test control group.

Table 3. Distribution table according to the method of qualitative research

	f	%
Survey/Interview Form	6	37,5
Action/Situation Survey	2	12,5
Document Analysis	3	18,75
Achievement Test	1	6,25
Total	12	100

According to Table 3, in six of the twelve studies conducted with qualitative research method (Kuruyer, Çakıroğlu, & Özsoy, 2019; Altındağ Kumaş & Ergül, 2017; Nurkan & Yazıcı, 2020; Hacısalihoğlu Karadeniz, 2013; Baldemir, İç, & Tutak, 2022; Sezer & Akın, 2011), data were collected with structured interview technique or a questionnaire was applied. Two of the studies followed the action/situation research (Acar & amp; Hiğde, 2018; Koç & Korkmaz, 2019) method. In 1 of the studies, a new diagnostic model was proposed by examining the methods used for the diagnosis of dyscalculia. Three document analysis studies including descriptive analyses of previous researches on the subject and comparing various methods were conducted.

Table 4. Distribution table of the articles according to the number of samples

Number of Samples		f	%
Not Specified		1	6,25
Between 1-3		3	18,75
Between 4-10		3	18,75
Between 11-20		4	25
Between 21-30		1	6,25
31 and above		4	25
	Total	16	100

According to Table 4, study was conducted with 1 to 3 samples in three articles (Nurkan & Yazici, 2020; Koc & Korkmaz, 2019; Acar & Higde, 2018). In three other articles (Hacısalihoglu Karadeniz, 2013; Mutlu & Akgun, 2017; Sezer & Akin, 2011), 4 to 10 samples were included in the study. There are 11 to 20 samples in 4 articles (Terzioglu, Curaoglu, & Yikmis, 2019; Sonmez, 2021; Ozturk, Durmaz, & Can, 2019; Al-Zoubi & Al-Adawi, 2019) and 21 to 30 samples in 1 article (Filiz, 2021). 31 and more samples were seen in 4 articles (Kuruyer, Cakiroglu, & Ozsoy, 2019; Altindag Kumas & Ergul, 2017; Eng et al., 2014; Baldemir, Ic, & Tutak, 2022).

The sample numbers of the scanned articles varied. In a study involving document analysis (Saygili, 2017), the number of samples was not specified.

Table 5. Distribution table of the articles by sample age group

Age group		f	%
Primary School Student (6-11 years)		7	43,75
Undergraduate Student (18-22)		2	12,5
Teacher (25 and above)		4	25
	Total	13	81,25
Document Analysis		3	18,75
	Total	16	100

According to the data obtained as a result of the articles examined, the following results were obtained:

As a result of the examination of the sources in the study, it has been seen that the researches on dyscalculia have emerged in our country since 2011. The small number of researches in general shows that the subject has become known in our country recently. On the other hand, the fact that 7 of the 16 studies (Eng, 2014; Mutlu, 2017; Sonmez, 2021; Ozturk, 2019; Koc & Korkmaz, 2019; Acar, 2018; Al-Zoubi, 2019) focus on research on students can be interpreted as a correct perspective. These researches contributed to the field by enabling the emergence of new teaching methods related to the education of dyscalculic individuals. In the studies conducted with teachers and undergraduate students who are prospective teachers, the knowledge levels and awareness of the participants of the research were generally examined. The conclusions drawn from these articles show that the specific learning disability especially dyscalculia is not sufficiently on the agenda in Türkiye and the awareness on this issue is not at a sufficient level.

Considering the sample type, 3 studies (Terzioglu, 2019; Saygili, 2017; Filiz, 2021) are document analysis studies and have compiled previous studies. These studies may have aimed to present different perspectives on the literature and the problem area. Studies conducted as document analysis include different indexes outside of Turkiye. It is understood from the large number and variety of researches scanned in foreign research indexes that more researches have been conducted abroad on the subject.

It was observed that experimental studies were conducted in 4 of the 16 articles examined. These studies were usually conducted on a student or small samples. These articles focused on observing the effects of instructional interventions. The fact that only 25% of the studies examined were conducted with experimental methods, which reveals that there are various difficulties in conducting experimental studies on the subject.

In the studies examined, the studies whose universe is primary school students were conducted with fewer samples. The studies consisting of undergraduate students in the research universe were represented by more samples. This may be due to the fact that dyscalculic students can show very different characteristics from each other. Dyscalculia may be

accompanied by attention deficit and hyperactivity disorder in some cases and dyslexia in others. Therefore, while working with these students, individual characteristics may affect the teaching process. Nevertheless, it is thought that the fact that the studies on dyscalculia focus on primary school students with more samples may contribute to the field.

Four studies conducted with teachers from different levels and different professional experiences were examined. However, in 3 of these studies, it is thought that the sample is not representative of the universe of the research. It should be taken into consideration that the higher number of samples in similar studies will better represent the universe of the research.

In the examinations, it is seen that there are a small number of experimental studies with a small number of samples. It is seen that these are mostly studies involving instructional interventions and conducted with young age group students. This can be explained by the fact that experimental studies can be more challenging for researchers in terms of time and resources; therefore, empirical studies conducted with small study groups are preferred. It was observed that questionnaires and structured interview techniques were used in studies with more samples.

In the articles containing document review, it has been observed that many domestic and foreign research indexes have been examined. In these examinations, it was found that there were hundreds of articles about dyscalculia, especially in foreign research directories. Various criteria were selected by the researchers from among these articles. As a result, it was observed that these studies, which are the compilations of the literature, contain 12-24 samples. It is thought that a more specific point of view was used in the selection of the studies since the examination criteria considerably reduced the number of reviewed studies. In addition, it has been observed that very few academic articles have been published about dyscalculia in Türkiye compared to other countries.

Studies involving instructional intervention research were mostly conducted with primary school students. This shows that the diagnosis process of dyscalculia mostly begins at the primary school level. After the diagnosis, the start of educational interventions in a short time may make it easier for students to keep up with the same level of education as their peers.

Suggestion for a Music Supported Model for the Education of Dyscalculic Individuals

Music, which is considered as one of the sub-branches of mathematics in ancient civilizations (Atli, 2007), can be accepted as both a useful educational tool and an effective teaching method today. It is thought that this teaching method will be very effective in specific learning difficulties. When music is used as a teaching method, it can lead to an efficient learning process, especially in dyscalculic individuals.

Rhythmic counting can be considered a basic skill for elementary school students. It can be said that many numerical skills develop on this basis. It is known that dyscalculic students have problems with rhythmic counting (MoNE, 2014). These students are tried to gain rhythmic counting skills in special education institutions with various methods. It can be accepted that rhythm, which is the most important element of music, is related to mathematics teaching due to its numerical structure. Therefore, it is thought that rhythmic counting education to be given to dyscalculic students can provide more efficient and qualified learning through rhythm and music education.

Implementation of the Model

Students diagnosed with specific learning disabilities in Türkiye receive education in special education centers. The addition of basic music education to the trainings in these institutions can be especially beneficial for dyscalculic students. This basic music education can be designed mainly with rhythm education content. Students may be taught simple musical motifs and asked to perform these motifs. Various musical sentences using these motifs can be created and taught to play them. Then, the student is expected to form and perform some or all of these sentences. As a result, students can learn to perform rhythmic phrase at a certain beat, adhering to measures.

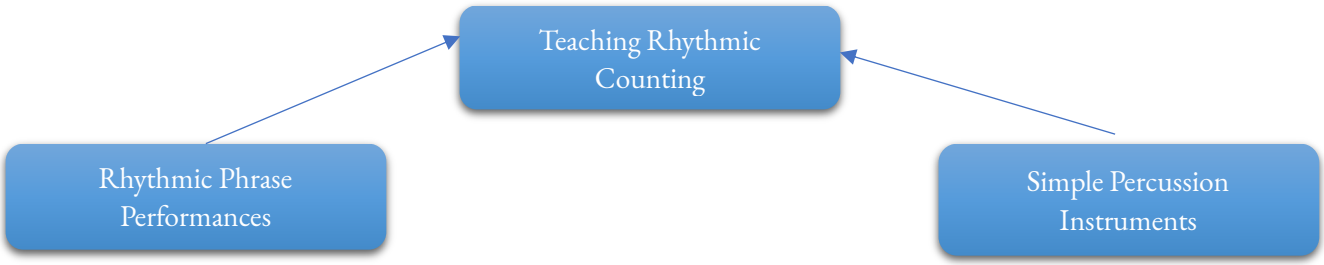

Figure 1. Dyscalculia training model with music support

These rhythmic phrase exercises can be performed with simple percussion instruments using large muscle groups. Rhythm bars, drumsticks and sound pipes can be examples of these. Songs containing the lyrics of these musical rhythm motifs and rhythmic counting numbers can be composed. These songs can be supplemented with accompaniment instruments or audio recording. This can make it easier for the student to learn songs better and remember them later. Songs can be designed melodically or without melody, only in the form of rhythmic poetic (rap) songs. These audio recordings can be sent to the family so that the student can repeat these songs at home. By memorizing these songs, it can be ensured that the student repeats the rhythmic counts everywhere. As a result, rhythmic counting teaching is included in the student's life. The teaching method can be rearranged with the feedback received from the evaluations to be made. Specific learning difficulties can be seen at very different levels and in different ways in individuals. Therefore, updates can be made on this model to develop new methods according to individuals.

Conclusion and Recommendations

As a result of the research, studies on dyscalculia in Türkiye are not sufficient. In addition, the number of qualitative and practical studies on dyscalculia is insufficient. It is very important to increase it. It is also necessary to determine and support the ability areas of students with dyscalculia in terms of their education. It is thought that music-supported dyscalculia education, which we present as a model proposal, can focus on the development of basic mathematics skills as well as enable students to enjoy learning processes. It may be suggested to investigate the effect of this model with experimental studies.

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