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Views of Elementary School Teachers Regarding to Inclusive Education

Bülent DÖŞ[1], Tayyar TUTSOY[2] & Ökkeş OFLAZ[3]

ABSTRACT

Despite special classrooms and educational programs being developed for special needs students in the 19th century, it is now believed that the inclusion of special needs students with mainstream students is the more effective option. The aim of this study was to examine the views of elementary school teachers about inclusive education. Data was collected through interviews and the data analyzed using the content analysis method. Five teachers from a state school in Gaziantep, Turkey, participated in the study. It was found that when families were interested in special needs students, their teachers also shared that interest. The study also found that parents and teachers lacked detailed knowledge about inclusion, as well as measurement and evaluation not being satisfactorily conducted.

Key Words: Special education, Inclusion, Students with special needs

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INTRODUCTION

Today, the number of students requiring special needs education is increasing day by day, making special education even more important. Special education offers significant contributions to the integration of individuals in need of special education, in the development of their self-direction, in addressing their needs, and in their reaching the same level as other individuals in society. These contributions help those in need of special education take their place in society. In terms of inclusion, every student has the right to receive education at fair rates (Salend, 2001). Inclusive education is a process that ensures the educative and psychosocial development of all students. Thus, individuals who receive special needs education increase their self-confidence and become collective beneficiaries. Baykoç (2015) put forward the most comprehensive definition of special education as follows:

> *Special Education is a program that differs from normal development due to its physical, mental, communicative, social and emotional development characteristics and it is also an education for the individuals that do not benefit or that partially benefit from normal education, or that can continue to receive education programs with support programs with the help of special training courses given by specially trained staff with special methods and tools, if necessary, special trainings given in special programs developed specifically for each special needs group even if they benefit from normal education program. (p. 5)*

Avramidis and Norwich (2002) stated that teachers' perceptions are important to the successful implementation of inclusive education. Furthermore, Cross, Traub, Hutter-Pishgahi, and Shelton (2004) pointed out that one of the important conditions needed for successful inclusion of children with special education needs is the positive perspective of school staff members who work with these children. On the other hand, the negative perspective of these professionals could be a primary factor that impedes the process of inclusion of children with special education needs in regular classrooms.

Towards the end of the 19th century, special classes and special education programs developed for individuals with special needs were regarded as a major revolution at first, but it was later understood that such practices worked towards isolating those with disabilities from society (Metin, 2015). For inclusive education to be successful, it is seemingly undeniable that individual differences should be taken into consideration. However, reaching all students in classroom environments including student groups of increasing diversity makes this situation one of the most important challenges for today's teachers (Van de Walle, Karp, & Bay-Williams, 2012). When this fact is realized, the idea that those with disabilities should live with other people in society has become more important in terms of the social, cognitive, and psychological development of the individuals, and the foundations of integration programs have been laid. Inclusion is defined as "educational program appropriate for normal children with individual support in the curriculum and program process, which is regulated by the responsibility of normal education and special education personnel including educational and social cohesion of children with disabilities" (Metin, 2015). In another study, inclusion was defined as the training of individuals with special needs in relation to their disability with their peers at regular schools, with the views of their parents in order to improve their skills and to raise their skills to a higher level (Sarı, 2002, p. 5). The aim of inclusive education is to bring together individuals who are developmentally adequate with developmentally inadequate individuals, and to help them

develop alongside each other in the same classroom environment. Inclusion facilitates the integration of inadequate individuals with society. Individuals with inadequacy are able to find opportunities to develop themselves in terms of their physical, affective, cognitive, psychomotor, and social skills. Through integration, inadequate and non-disabled individuals are also able to communicate better. As emphasized by Sarı (2002), there are three types of inclusion according to legal regulations.

Regional inclusion: Special units can be placed within mainstream schools and private schools to provide inclusive education by sharing the same area.

Social inclusion: Through special classes and units, special needs children are encouraged to attend classes with children at a mainstream school, and are also motivated to eat meals, play in the dining hall or social areas, and even participate in class or out-of-school activities together.

Functional inclusion: These are where children with special needs are able to fulfill regional and social cohesion as well as cooperate with or coexist alongside other children in educational programs.

By applying these three types of integration, it is aimed to educate inclusive students in the best way to afford them a sense of collectivity. There is a considerable responsibility leveled at classroom teachers in practicing inclusion and training inclusive students. These classroom teacher tasks can be listed as (Sarı, 2002, p. 79):

a) Identification of a child's special education needs and consulting with the child and their family about those needs;
b) Informing the special education or guidance teacher regarding the special education of the child;
c) Gathering information about the child and sharing it with other responsible teachers;
d) Taking time to deal with the integration of the child individually;
e) Preparing new practices by following the progress of the child;
f) Maintaining knowledge of the legal regulations about special education, and following any new regulations;
g) Making observations not only to recognize the child's obstacles, but also to reveal their strengths;
h) Keep records of the child's work by making sure that inclusive students can follow the program;
i) Ensuring special education teachers cooperate with other colleagues and also the parents of inclusive students;
j) Undertaking various activities and applications for the integration of inclusive students with other students;
k) In order to meet the interests and needs of inclusive students, they prepare and put into practice an individualized educational plan.

Inclusion in Turkey; education is provided for those with visual impairments, hearing impairments, orthopedic disabilities, mental retardation, persistent illnesses, difficulty with adaptation, and language and speech problems in seven separate groups of schools and institutions (T.C. Başbakanlık Özürlüler İdaresi Başkanlığı [Turkish Prime Ministry Administration for the Disabled], 1999). Individuals grouped with these types of disabilities have different characteristics. While the disabilities of some are immediately noticeable from

their physical appearance, from the devices they use, or from their exhibited behaviors, others may not be. Some individuals' deficiencies may be considered mild and not needing much in the way of support in the classroom environment, whilst some individuals have certain inadequacies and regulations may be needed due to the level of support required in the classroom and general school environment. Despite these different qualities, these individuals have the right to receive a good education in their general education classes alongside their peers through the arrangement of certain programs through legal regulation (Sucuoğlu, & Kargın, 2006, p. 76). Individualized education plans are prepared for integrated students, and targets that the student must reach throughout the year are determined. An individualized education plan is prepared so as to organize the development of the inclusive student more programmatically, by taking into account their characteristics, abilities, interests, and needs with the objectives set and the available tools (Sarı, 2002, p. 51). The individualized education plan significantly contributes to the progress of the inclusive students' development. Thus, the achievement level of inclusive students increases to a higher level, such as those who have difficulties in speaking improve in their speaking, those who cannot express themselves do so better, and those who cannot communicate with their friends start to form better relationships with their friends.

Classroom teachers should prepare Individualized Education Plans according to each student's characteristics, condition, and achievements in order to be successful. In addition, classroom teachers should prepare mainstream classroom students for the concept of inclusion so that inclusive students can be accepted by their peers. Many students will meet a person who needs special education for the first time in the classroom environment, if they have not previously met anyone needing special education in their family or neighborhood; therefore, existing mainstream students may have little or no prior knowledge about inclusive students. Thus, before inclusive students are placed into the mainstream classroom, teachers should inform the mainstream classroom students about their new peer/s by planning various activities, providing information about this topic or by making visits to private schools and classes. The aim being to ensure that mainstream students are aware of the problems faced by and the abilities of inclusive students. In this way, the integration process of inclusive students and mainstream students will more likely be successful (Ataman, 2003, p. 74).

The acceptance of children that need special education by their peers is very important in terms of the development of their understanding, communication, and social skills. This is not just for the development of the child, but also for their happiness and to be creative individuals. It is also important to ensure the integration of children who need special education and to help mainstream students learn (Sarı, 2002, p. 26). Assigning mainstream students to inclusive students in various ways once integrated into classes makes it easier for the teacher to work, as well as making them a part of the integration process (Batu, 2000, p. 83). At the same time, the attitude of the teacher towards inclusive students can also affect the behavior of mainstream students towards inclusive students. Thus, the teacher should pay attention to their own behaviors as a role model for all students. For inclusive education, students in the classroom environment obtain several acquisitions from their peers and school environment, and thereby exhibit progress in terms of their development (Lindsay, 2003). The process which also requires the employment of different teaching methods and techniques in the classroom make sure that students benefit from it (Lewis, & Doorkagi, 1999).

It is necessary to include families in the process in order to achieve success in integration (Republic of Turkey, Law Decree 573). According to the Law, it is stated that if the parents are not included in the integration process, success will not be able to be achieved for the inclusive students in terms of their development (Sarı, 2002, p. 133). Inclusion advocates the idea that the family should be at the fore of decisions about the child because they fully recognize the child's development, all their qualities and what the child is able to do at home. Therefore, the family should be informed about any decisions to be made about the child and they should be included in the study regarding what needs to be done at home and at school (Karatepe, 1992, p. 102).

Classroom teachers may receive information from special education teachers, guidance teachers, and school administrators, as well as from a mobile teacher where necessary, regarding a child's inclusion. The mobile teacher provides services to teachers and the school staff of disabled children at certain schools located within a region (Aral, & Gürsoy, 2009, p. 310).

It is also important to provide tools and equipment for integration applications. Even in special education, it may be necessary to utilize special tools for many groups with disabilities. Education of the visually impaired without equipment such as Braille tablets and typewriters, white cane Taylor crib etc., and the education of hearing impaired without individual table type and group hearing instruments is not feasible. Other disability groups also require certain tools and equipment; therefore, it is necessary to provide, protect, and maintain such equipment in good condition under the responsibility of the school administration (Özsoy, Özyürek, & Eripek, 2002, p. 239).

There are some who believe there are considerable deficiencies while applying inclusion practices in schools. For example, in the research conducted by Saraç and Çolak (2012), it was determined that requests made by primary school teachers were ignored in the inclusion practices within primary schools, that inclusion practices were carried out in inappropriate physical conditions, and that the help provided to the classroom teachers by the school staff was insufficient and not functional. In the study of Cankaya and Korkmaz (2012), the major problems faced by teachers in practice were reported as large classes, having more than one inclusive student in the class, and inadequate educational materials. Kaya (2003) determined that school administrators, class teachers, and guidance teachers had insufficient knowledge about integration, did not exhibit positive attitudes towards integration, and did not include work such as placement, educational evaluation, preparation of individualized education programs, or the provision of support services.

The purpose of the current research is to understand to what extent classroom teachers in Turkey have information about inclusive students, the problems they encounter, and to put forward solution suggestions with a holistic approach. For this purpose, the following research questions were identified:

- To what extent do teachers recognize the inclusive students?
- What kinds of problems do teachers have with their inclusive students?
- What kind of solutions do the teachers recommend to the problems they experience with their inclusive students?

METHOD

Research Model

The research was conducted using qualitative research method. Research data were gathered in the form of interviews with teachers. Five questions were asked in total, with two about participant demographics. The three other questions were about the teachers' knowledge about inclusive students, those students' problems, and their suggestions for solutions. The research was conducted with five primary school teachers with inclusive students in their classes in a primary school located in the city center of Gaziantep, Turkey. For this purpose, this research is conducted as a case study. The most important feature of qualitative case studies is the in-depth investigation of several situations. In other words, the factors related to a situation (environment, individual, events, processes, etc.) are investigated by a holistic approach, with a focus on how they affect the situation and how they are affected by the situation (Creswell, & Clark, 2007). In this study, it was attempted to reveal the views of teachers who have inclusive students in their class regarding the situation in their school.

Study Group

The study group of the research is composed of five classroom teachers working in a state primary school in the provincial center of Gaziantep, Turkey; therefore, convenience sampling was used in the study. The number of inclusive students in the primary school in which the study was conducted played an important role in selecting the research group.

Data Collection

In this study, semi-structured interviews were conducted for the collection of qualitative data. Interview questions were examined by two educational scientists in order to determine the consistency of the questions with the research problem. The experts determined that the desired goal of the research could be reached with the proposed research questions. During the interviews, in the case where there were questions that teachers did not understand, additional explanation was carefully made so as not to guide them. During the analysis of the interview data, each teacher's responses were coded using a pseudonym. In order to conduct the interviews, the guidance teacher of the school was asked to determine the date and time of vacant courses of the teachers in advance. Taking the necessary permissions, interviews were conducted with the teachers on the specified dates and times. The interviews were audio recorded and the recordings numbered according to the interview sequence. At the start of the interviews, the researcher stated that the interviews were to be conducted in order to determine the problems they faced prior to the interview, and emphasized the importance to the quality of the research of their opinions given without hesitation when suggesting solutions to these problems. It was stated that the interviews would be audio recorded and that the recordings would only be listened to by the researcher. During the interviews, the teachers were asked semi-structured questions, including their demographic information.

Data Analysis

The data of the research was analyzed by content analysis technique. After the interviews were completed, the audio recordings were transcribed verbatim. While the interview transcripts were being written, the conversations were written as heard (verbatim)

in the order of interviewer-interviewee without any corrections. The information contained in the data was then systematically coded. The main purpose was to arrive at the concepts and associations that explained the collected data. In doing this, similar data were gathered together under specific themes.

FINDINGS

The findings of the research are presented and interpreted under subheadings according to the three research questions. Prior to the three main questions, the interviewee teachers were asked whether or not they had taken special education for inclusion courses in their pre-service training. Five teachers stated that they had not taken courses for inclusion/special education. Only one of the participants had received any in-service training on special education-inclusion. When the teachers were asked where they received their information about inclusion, they stated the Internet first off and then from the school guidance service. One of the participants said that he did not know whether or not there was a book related to the topic.

Teachers' knowledge about inclusive students

From the data analysis, it was seen that all of the teachers had knowledge about the literacy, general situation, and family situation of their inclusive students. For example, two of the teachers stated that they experienced language-related problems with their students as the students could not express themselves well (T3, T1). T4 stated that there were four inclusive students in his/her class; two of whom were hyperactive and the other two were introverted. T3 stated that there were two inclusive students in his/her class, and that one of them was too aggressive whilst the other was too introverted. T5 gave academic information about his student and expressed it as follows, "The child can read two-digit numbers and do simple additions." T2 stated that there were two inclusive students in his/her class, one of whom had mild mentally retardation and the other had a hearing impairment.

Table 1. *Characteristics of inclusive students*

Characteristic	Frequency
Mental retardation	1
Aggressiveness	1
Unable to express themself	2
Unable to establish relationships with friends	1
Introversion	3
Late starting to speak	1
Speech problems	1
Hyperactivity	2

As can be seen in Table 1, the teachers stated the prominent characteristics of their inclusive students based on their observations. These features were mostly deficiencies in cognitive and affective domains. Psychomotor deficiencies were not mentioned. For example,

My student, who is mentally disabled, is not good in the social field, he is not good at his relations with his friends, he cannot express himself, and he is behind in his lessons. I mean, I have more expression problems with such students. (T1)

T2 stated that the family of his inclusive student, about whom he had significant knowledge, was in constant contact with him. Students' families about whom the teacher had little information was considered very uncommon at the school. It can therefore be said that the family also has a role in ensuring the teacher has adequate information about the inclusive student.

Families of inclusive students

The participants stated that the families of the inclusive students were socioeconomically poor, that their education levels were low, and that they were unconcerned about the education of their children. T3 expressed his opinion as follows. "Families generally have low financial and budget status, and their education levels are low primary school graduates. They are not parents said to help develop the education level of the learners." Some of the features of the inclusive students' parents are presented in Table 2.

Table 2. *Characteristics of inclusive students' families*

Characteristic	Frequency
Father with mental health problems	1
Sibling with mental health problems	1
Parents with disabilities	1
Poor financial circumstances	3
Family unable to accept the situation	1
Family seem indifferent	1

As can be seen in Table 2, there are some economic and psychological problems faced by the inclusive students' families. For example, one of the participant teachers reported that their student's family had a problem of acceptance, and that they did not listen or do what he said (T4). T2 stated that "The father of the student was working with scrap and that he made his son do the same work, so the child had issues with absenteeism due to working." Another participant teacher (T1) stated that the father of the student experienced psychological distress from schizophrenia, and that the student's sibling (sister) had psychological problems. T3 said that the family seemed indifferent, and that they did not buy or let the student use the medicine that the doctor prescribed. T4 said that the family did not accept the situation of the child, stating the following:

Generally, the family does not accept the situation of the child much. I'm teaching Grade 3. The family took the child out of school this year, but it was reported that the child should receive 50% inclusive education. The families are generally indifferent and have problems of acceptance. They do not help teachers about it in this regard. They do not apply or listen very much to what is being said.

Problems teachers experience with inclusive students

The participants were asked about the problems they encountered during inclusion. Table 3 presents the characteristics and frequencies of their responses.

Table 3. *Problems encountered by teachers with inclusion*

Characteristic	Frequency
Communication problems with peers	5
Overcrowded classrooms	4
Measurement-evaluation problems	4
Communication problems with student's family	3
Time allocation for the student	2
Loneliness or isolation of the student	2

All of the teachers said that they experienced problems with student peer relations. Four of the teachers stated that they had problems that stemmed from their inclusive students. They said that the inclusive students were very aggressive and jealous, or did not adapt to their friends by exhibiting introverted or isolated behaviors (T1, T2, T3, and T4). One of the teachers stated that the problem resulted from the other students trying to stay away from the inclusive student (T5). Another problem is that the classes are overcrowded and the teacher is not very interested in the inclusive student. Four of the participants (T1, T2, T3, and T5) expressed the need to reduce the classroom overcrowding for inclusive students, stating the following:

> *The biggest problem we have with inclusive students is that we do not spend enough time with them, we have 33 students, two of whom are inclusive students. Our biggest problem is time. For example, I cannot show enough interest to them because of my crowded classroom. We usually give homework to them, and when we finish that homework, we give them more homework. We spend the time in that way. (T3)*

> *Of course, it would be better to have fewer students in our classrooms. For example, I have 38 students in my class, so I am not able to spend as much time with them. In fact, we need to show more interest to them. But because of the number of students in the classrooms, we do not give enough attention to them. We need to do more individual work with them. (T1)*

Another problem area that most teachers mentioned in addition to classroom overcrowding was measuring and evaluation. As the teachers experienced difficulty communicating with the inclusive students, they stated that they only apply lower-level measurements, that the students do not perform their duties and that the measurement-evaluation process takes a long time. For example T4 said;

> *I usually try to give a passing grade. We cannot evaluate them together with the other students. I am trying to go down to their level and to make evaluations by preparing activities appropriate to their level. It is tiring and time-consuming for the teacher.*

Participant teacher T4 stated that he evaluates inclusive students at a lower level and that it is time-consuming. Another participant (T3) said,

> *We are not able to obtain the efficiency of measurement and evaluation in most of the studies that we give. The work done is forgotten. These students need to be interested in it*

> *individually. We are not able to achieve academic success as much in the classroom environment because they are often unable to complete their work and it is not followed at home either, so we cannot make an assessment. Because the work is not finished, you cannot get anything from an incomplete work.*

Therefore, he said that he often had difficulty in evaluating their homework and tasks because they were incomplete. Interviewee T1 also stated having difficulty in evaluating the child's writing because he could not read it most of the time.

After problems encountered in measurement and evaluation activities, the most common issues were family-related problems. Three of the teachers stated that the families did not come to the school for any co-work, and that they were indifferent to the education of their children (T3, T4, and T5). Two of the teachers stated that they experienced no problems with the families' support and that they were constantly in contact with them (T1 and T2). However, T4 expressed that the families do not believe in what their children do at school, saying; "I tell them about their behaviors in the classroom, but they say that their children do not do it. They do not care and remain uninterested as they do not want to believe it." Another participant (T1) talked of the indifference of the family to their child, stating; "They usually have poor living conditions and education levels, mostly they are primary school graduates. They also do not try to do anything for the improvement of their child's education." Similarly, T5 said that "When it comes to family support, they are not in good communication with the school. They are well-intentioned people, but we do not see that support when we want something from them."

On the other hand, both T1 and T2 stated that they were constantly in contact with the families and that they experienced no problems with them. T1 stated that the family was constantly calling and talking. In fact, it is a question of the crowdedness of the classes and has been examined separately here because of its significance. The participant coded T2 stated that he spent time with the inclusive students by engaging other students with homework and tried to explain the necessity that families should afford special time to such children: "When I assign homework to the other students, I spend time with the inclusive student." T3 stated the problem of spending time with the inclusive student as follows:

> *The biggest problem I have is time. For example, I cannot show enough interest to the inclusive students because of the crowded classroom. We usually give homework, and when they finish that homework, we give more homework again. We spend our time in that way.*

Lastly, isolation-loneliness was reported as one of the problems faced by the teachers. Inclusive students often appear to be lonely and cannot fully integrate with the other students. For example participant T1 mentioned that:

> *I have a student called Fatma. She is not communicating with her other friends very much. She usually sits alone. Here I am saying to other children that they should take care of their friends and they should not leave them alone. However, she does nothing to communicate with her friends. The biggest problem they have is communication and inability to express them well.*

The teacher tried to explain the loneliness and isolation of inclusive students from the perspective of their social environment.

Suggested solutions for teachers with inclusive students

Suggested solutions to the problems faced by the participant teachers with inclusive students were to increase the students' communication skills, reduce the number of students in the classrooms, make more appropriate evaluation of the students, increase familial support, and conduct social and mental activities that contribute to the students' awareness. The suggested solutions are presented in Table 4.

Table 4. *Suggested solutions to teachers' problems with inclusive students*

Characteristic	Frequency
Communication skills should be improved	4
Student numbers in classrooms should be reduced	3
Making appropriate assessment of students	3
Increasing familial support	2
Conducting social activities	2
Conducting mental activities that increase awareness	1

As can be seen in Table 4, the biggest problem faced by teachers with inclusive students in their classes relates to problems the students have in communicating with their friends and teachers. In order to resolve these issues, the participants coded T5 and T4 said that "We usually warn the other students that they should get along well with each other, be friends, to not break the hearts of one another and to tolerate them [inclusive students] even if they make mistakes." T3 expressed his thoughts as follows:

> *Social activities are needed to address the problems of [inclusive] children related to peer relations. Here we are trying to do in-class activities such as games apart from lessons. By creating groups we enable students to integrate with each other. We are also trying to make groups in physical education classes so that they can spend time with each other and understand and show respect to each other.*

Participant T1 stated that he advised mainstream children to play with inclusive students and not to leave them alone. He also stated that;

> *What I do in my class is to tell children to take care of their friends, not to leave them alone, go out with their friends when they go out in the garden and let other students know not to leave such students alone.*

Another problem regarding the inclusive students is that there are crowded classrooms and that the teacher cannot spend much time with inclusive students. In this regard the participant coded T3 suggested the following as a solution: "Now, first of all, as I have already mentioned, inclusive students have to be distributed equally and the number of students in the classrooms must be reduced as much as possible." Another participant (T2) suggested solving this problem by reassigning other students, and T4 stated that each class should not be given more than two inclusive students. Teachers experienced difficulties in making appropriate assessment of inclusive students; regarding this issue, participants coded T4 and T3 stated that they only simply evaluated such students and gave them assignments that they could manage. Participant T1 emphasized the need for in-service training as follows;

The Ministry of National Education could organize courses on this subject. They could better inform us about this. I mean, it would be better if education was given in this regard as we do not have much of an academic sense about it. It would be better if there were seminars and courses.

Familial support and awareness-raising activities were seen as important for the inclusive students as well. In this regard, the teachers indicated that the families of inclusive students could be trained under special education plans, and that success could be achieved with the help of the families and the school. For example, the participants coded as T3 and T4 supported that idea as follows;

The families generally do not have enough knowledge about these inclusive students. In this regard, they should be educated about this topic by means of seminars at schools. Most of the people regard inclusive students as insane or they think that they are problematic students, but they do not know that they can be educated. I think that kind of work could be done by the school guidance teachers by means of seminars. (T3)

Families should also be informed in the same way with the help of guidance teachers. They should be called to the school at certain times. Thus, the family accepts the child as he is and teaches him as it should be. (T4)

Similarly, T2 stated that families should spend more time with the children as follows;

I think the family has a more important place here, so there should be more time to share with these children, so cooperation with the teacher should be more. The lack in these children should be resolved in this way.

As the participant coded as T3 mentioned, they were engaged in social activities in physical education classes and outside of the class in order to integrate the students with each other.

RESULTS AND DISCUSSIONS

In this study, the teachers stated that they did not receive education in their preservice training on the area of student inclusion, and only one had received in-service training. However, since 1983, a course called Special Education has been given to teachers (Yükseköğretim Kurulu Başkanlığı [Turkish Council of Higher Education], 2007). On that course, one of the sections covered is inclusion. In this sense, the participants may have forgotten it or this section may have been omitted in their course. The teachers stated that they did research on the internet and took help from guidance services in their schools. In this regard, it is a significant result that the teachers did not have any books to support their professional development. It is necessary that teachers' awareness and specific activities should be obtained and formulated for further developing inclusive education, as pointed out by Shimizu (2012, p. 78), through "teacher organization with a vision of inclusive education". For such a purpose, it is clear that teachers should be able to achieve an appropriate conceptual understanding of inclusive education, as well as accurate knowledge, by being given the opportunity to undertake various types of teacher training. Teachers have general knowledge about their students, but they do not have in-depth knowledge. For example, the teachers did not mention about any special things they tried to do such as undertaking special research, special teaching methods, special materials, etc. for their

inclusive students. This may be due to the teachers not being interested in such students as much as their mainstream students or those they have received inadequate or no training in this area.

In the current study, the teachers attributed their inability to deal with inclusive students to overcrowded classrooms and the indifference of the inclusive students' families. Many studies have shown that teachers are not interested in inclusive students (Diken, & Sucuoğlu, 1999; Kargın, Acarlar, & Sucuoğlu, 2003; Buell, Hallam, Gamel-McCormick, & Scheer, 1999). For example, Saraç and Çolak (2012) indicated that most teachers do not make special arrangements for their inclusive students. For this reason, Gök and Erbaş (2014) found the special education course taken in preservice training to be inadequate. Special education courses are given in faculties of education in Turkey for a period of two hours per week. However, it is perhaps more appropriate to give this course for two more semesters considering its intended purpose of practice. Teachers need to be provided with more courses and in-service training opportunities that focus on inclusion, as studies show those teachers having received more courses focusing on inclusion and having attended in-service training have more positive ideas towards inclusive education (Materechera, 2002; Subban, & Mahlo, 2017). After certain training activities, the qualifications of teachers on inclusive education as well as their self-confidence increases and they approach inclusive education more positively as a result (Harvey, & Greenway, 1984).

In addition, the lack of interest in the families of inclusive students leads teachers to not deal with the students. In the current study, the teachers stated that the parents of inclusive students were uneducated and that they also have problems themselves. According to one study, 11% of families claimed that inclusive students do not receive adequate education in schools (Kargın, Acarlar, & Sucuoğlu, 2003). Families blame the teachers and teachers blame the families. However, teachers will be better able to overcome their problems if they cooperate with the parents. When the parents participate in education and teaching activities, inclusive students show faster progress in their development (Bauer, Battle, & Johnson, 2004). Reviewing the literature and from the current study's teacher interviews shows that cooperation between the school administration, teachers, and parents are critical to the development process of students with disabilities and in raising them to the desired level of achievement. Therefore, in Turkey, it has been legally stipulated that the family should participate in the education of children that require special needs education. For this reason, it is important that both the teachers and the parents of inclusive students are kept informed about the subject by specialists in the field.

Spending time with the inclusive students and taking care of them is one of the most significant problems faced by teachers. This problem has been mentioned in many studies (e.g., Kargın, Acarlar, & Sucuoğlu, 2003; Saraç, & Çolak, 2012; Vural, 2008). In the current study, the primary reason for teachers not being able to spend time with inclusive students has been due to the overcrowding of classrooms, and also a fear of not catching up with the schedule on time. In this sense, the teachers stated that the number of mainstream students and inclusive students in each class should not be outside the limits specified in the regulations. It was also mentioned that inclusive students exhibit problems in their communication with their peers and teachers. Gök and Erbaş (2014) also mentioned communication problems with inclusive students. Increasing the communication skills of such students is the most important factor according to the current study research. While

such students need to be integrated and socialized in mainstream classes, they tend to lead an independent life. For this reason, the teachers also stated that the communication skills of such students should be increased. However, the students still have to do it for themselves. In order to increase the communication skills of inclusive students, collaborative activities could be arranged with families outside of the school environment.

Another important problem is the assessment and evaluation of inclusive students, which needs to be undertaken in a valid and reliable way. In many studies (e.g., Güven, 2009; Sanır, 2009; Saraç, & Çolak, 2012) as well as in the current study, teachers have stated that they could not properly measure or evaluate inclusive students. The teachers do not push these students in any way, but still make evaluations according to the general level of progress. When evaluations are performed according to an ITP (Individualized Education Program), it may be possible to provide teachers with training on the measurement and evaluation of inclusive students.

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TÜRKÇE GENİŞ ÖZET

Sınıf Öğretmenlerinin Kaynaştırma Uygulamalarına İlişkin Görüşlerinin İncelenmesi

Bülent DÖŞ[4], Tayyar TUTSOY[5] & Ökkeş OFLAZ[6]

GİRİŞ

Günümüzde özel eğitime gereksinim duyan kişi sayısı her geçen gün artmaktadır. Bu durum özel eğitimi daha da önemli hale getirmektedir. Özel eğitim, özel eğitime gereksinim duyan bireylerin topluma uyum sağlamasında, kendini her yönden geliştirmesinde, gereksinimlerinin giderilmesinde ve toplumdaki diğer bireylerle aynı seviyeye gelmesi konusunda büyük katkılar sağlamaktadır. Bu katkılar özel eğitime ihtiyaç duyan bireyleri topluma kazandırmaktadır. Böylece özel eğitime ihtiyaç duyan bireylerin kendilerine olan güvenleri artmakta ve topluma faydalı bireyler olmaktadırlar. Baykoç (2015) özel eğitimin en kapsamlı tanımını şöyle yapmıştır: " Özel Eğitim, fiziksel, zihinsel, iletişimsel, sosyal ve duygusal gelişimlerindeki özellikler nedeniyle normal gelişimden farklılık gösteren ve normal eğitim/öğretimden yararlanamayan, kısmen yararlanan veya yararlandığı halde destek programları ile eğitimlerini devam ettirebilen bireyler için; özel yetiştirilmiş elemanlar tarafından ekip anlayışıyla sunulan, özel yöntem ve araçlarla gerekirse özel mekanlarda her özel gereksinimli grup için farklı olarak geliştirilmiş özel programlarla verilen eğitimdir".

Kaynaştırma, "normal eğitim ve özel eğitim personelinin sorumluluğunda düzenlenmiş eğitim programı ve program sürecinde bireysel destekleme ile birlikte normal çocuklara uygun engelli çocukların eğitimsel ve sosyal birleşimi" olarak tanımlanmaktadır (Metin, 2015). Başka bir çalışmada ise kaynaştırma özel eğitime gereksinim duyan bireylerin engel derecesine göre ortaya çıkan ihtiyaçların giderilmesini sağlamak ve yeteneklerini daha üst seviyeye çıkarmak için ailelerinin de görüşleri alınarak normal okullarda akranlarıyla birlikte eğitilmesidir (Sarı, 2002, s.5) şeklinde tanımlanmıştır. Kaynaştırma eğitiminin amacı, yetersizliği olan bireylerle yetersizliği olmayan bireyleri bir araya getirip aynı sınıf ortamında birbirlerine yardımcı olarak birbirlerini her yönden geliştirmelerini sağlamaktır.

Türkiye'de kaynaştırma; görme engelliler, işitme engelliler, ortopedik engelliler, zihinsel engelliler, süreğen hastalığı olanlar, uyum güçlüğü olanlar, dil ve konuşma problemi olanlar, üstün ve özel yetenekliler, olmak üzere yedi ayrı gruba okul ve kurumlarda eğitim hizmeti verilmektedir (1. Özürlüler Şurası Raporu, 1999). Kaynaştırma öğrencileri için bireyselleştirilmiş eğitim planları hazırlanmaktadır ve öğrencinin yıl boyunca ulaşması gereken hedefler belirlenmektedir. Bireyselleştirilmiş eğitim planı, kaynaştırma öğrencisinin özellikleri, yetenekleri, ilgileri, ihtiyaçlarıyla yapılabilmesi öngörülen hedefler, araç-gereçler dikkate alınarak gelişimini daha planlı programlı düzenlemek amacıyla hazırlanan plandır (Sarı, 2002, s.51). Kaynaştırma uygulamalarında sınıf öğretmeni; özel eğitim öğretmeninden,

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rehber öğretmenden ve yönetimden destek aldığı gibi gerektiği yerlerde gezici öğretmenden de yardım alabilir. Gezici öğretmen, bir bölgede bulunan birkaç okuldaki engelli çocukların öğretmenlerine, okul personeline ve engelli çocukların gelişimi için her yönden hizmet götüren kişidir (Aral ve Gürsoy, 2009, s.310).

YÖNTEM

Araştırma, nitel araştırma yöntemiyle gerçekleştirilmiştir. Araştırma verileri öğretmenlerle görüşme yöntemiyle toplanmıştır. Beş öğretmene demografik soruların yanında üç soru sorulmuştur. Bu üç soru öğretmenlerin kaynaştırma öğrencileri hakkındaki bilgilerini, karşılaştıkları sorunları ve çözüm önerilerini ortaya çıkarmaya yönelik sorulardır. Bu araştırma Gaziantep şehir merkezinde bulunan bir ilkokulda sınıflarında en az 2 kaynaştırma öğrencisi bulunan beş (5) sınıf öğretmeni ile gerçekleştirilmiştir.

Bu araştırma verilerin toplanması, nitel veri toplama yöntemlerinden yarı yapılandırılmış görüşme yöntemi ile gerçekleştirilmiştir. Görüşme soruları iki eğitim bilimciye inceletilerek soruların araştırma problemi ile tutarlılığı belirlenmeye çalışılmıştır. İki eğitim bilim uzmanı bu sorularla araştırmada istenilen hedefe ulaşılacağını belirlemiştir. Görüşme sorularının sorulması sırasında öğretmenlerin herhangi bir soruyu anlamama ihtimaline karşı kendilerine yönlendirici olmayacak şekilde açıklamalar yapılmıştır. Verilerin analizi sırasında her öğretmene kod isim verilmiştir. Gerekli izinler alınarak belirlenen tarih ve saatlerde öğretmenlerle birebir yapılan görüşmeler ses kayıt cihazıyla kaydedilmiş ve görüşme sırasına göre ses kayıtlarına numara verilmiştir. Araştırmacı, her görüşme öncesinde görüşme yapacağı öğretmenlere kaynaştırma uygulamalarında karşılaştıkları sorunları ve bu sorunların çözümüne ilişkin görüşlerini belirlemek amacıyla bu görüşmelerin yapılacağını belirtmiş ve bu nedenle öğretmenlerin görüşlerini çok açık bir dille çekinmeden aktarmalarının araştırmanın niteliği ve araştırma için önemli olduğunu vurgulamıştır. Öğretmenlere görüşmelerin ses kayıt cihazıyla kaydedileceği ve kayıtların sadece araştırmacı tarafından dinleneceği belirtilmiştir. Görüşmeler esnasında öğretmenlere demografik bilgilerde dâhil olmak üzere sorular yöneltilmiştir.

Araştırmanın verileri içerik analizi tekniği ile çözümlenmiştir. Görüşmeler tamamlandıktan sonra, ses kayıtlarının yazıya döküm işlemine başlanmıştır. Görüşmelerin dökümü yapılırken her konuşma duyulduğu şekliyle, hiçbir düzeltme yapılmadan ve görüşmeci-görüşülen sırasıyla yapılmıştır. Bu çerçevede dökümü yapılan verilerin içindeki bilgiler sistematik olarak kodlanmıştır. Burada temel amaç toplanan verileri açıklayabilecek kavramlara ve ilişkilere ulaşmaktır. Bunun için birbirine benzeyen veriler belirli temalar çerçevesinde bir araya getirilmiştir.

BULGULAR TARTIŞMA VE SONUÇ

Bu araştırmada, bir öğretmen dışında diğerleri kaynaştırmaya yönelik hizmet öncesinde eğitim almadıklarını belirtmiştir. Ancak 1983 yılından itibaren özel eğitim adlı bir ders öğretmen yetiştiren kurumlarda verilmeye başlanmıştır (YÖK Öğretmen Kitabı, 2007). Bu dersin içerisinde bir bölüm de Kaynaştırma bölümüdür. Bu anlamda katılımcılar bunu unutmuş olabilir ya da o ders içerisinde bu bölüm atlanmış olabilir. Öğretmenler araştırmalarını İnternetten ve okullarındaki rehberlik servisinden öğrendiklerini belirtmişlerdir. Bu konuyla ilgili olarak öğretmenlerin profesyonel gelişimleri için kitap alıp okumamaları önemli bir sonuçtur. Öğretmenler öğrencileri hakkında genel bilgi sahibidirler ancak derinlemesine bilgi sahibi değildirler. Örneğin kaynaştırma öğrencileri için özel bir

araştırma yapıp, özel öğretim yöntemleri, özel materyal üretme gibi şeylerden bahsetmemişlerdir. Bunun nedeni olarak öğretmenlerin bu tür öğrencileri ile ilgilenmemeleri ya da aldıkları yetersiz eğitim olabilir. Bu çalışmada öğretmenler kaynaştırma öğrencileriyle ilgilenememelerini sınıf mevcudunun kalabalıklığına ve ailenin ilgilenmemesine bağlamışlardır. Birçok çalışmada öğretmenlerin kaynaştırma öğrencileriyle ilgilenmedikleri ortaya konulmuştur (McCormick, 1999; Diken ve Sucuoğlu, 1999; Kargın, Acarlar ve Sucuoğlu, 2003). Örneğin Saraç ve Çolak (2012) öğretmenlerin çoğunun kaynaştırma öğrencileri için özel bir düzenleme yapmadığını ifade etmektedir. Bunun nedeni olarak Gök ve Erbaş (2014) hizmet öncesinde alınan özel eğitim dersinin yetersiz olmasını bulmuşlardır. Özel eğitim öğretmen yetiştiren fakültelerde bir dönemde haftalık iki saat olarak verilmektedir. İçeriği geniş olan bu dersin aslında iki dönemde uygulamalı bir şekilde verilmesi daha uygun görülebilir.

Ayrıca ailenin de ilgilenmemesi öğretmenin de kaynaştırma öğrencisi ile ilgilenmemesine yol açmaktadır. Bu çalışmada öğretmenler ailelerin eğitimsiz olduğunu ve genellikle ailede sıkıntılar olduğunu belirtmektedirler. Ailelerin ise %11'i kaynaştırma öğrencilerinin okulda yeterli eğitim almadığını iddia etmektedirler (Kargın, Acarlar ve Sucuoğlu, 2003). Aileler öğretmenleri, öğretmenler de aileleri suçlamaktadırlar. Özel eğitim yönetmeliğinde ise ailenin kesinlikle özel gereksinimli çocuğun eğitimine katılması gerektiği kanunen belirtilmiştir. Bu nedenle hem öğretmenlerin hem de ailelerin bu işin uzmanları tarafından bilinçlendirilmeleri önemli görülebilir.

Kaynaştırma öğrencisine zaman ayırıp onunla ilgilenme öğretmenlerin karşılaştıkları en büyük sorunlardan birisidir. Birçok çalışmada bu sorun dile getirilmiştir (Vural, 2008; Saraç ve Çolak, 2012; Kargın, Acarlar ve Sucuoğlu, 2003). Zaman ayıramamanın en büyük nedeni olarak bu çalışmada sınıf kalabalıklığı ve programı zamanında yetiştirme korkusu olarak görülmüştür. Bu anlamda öğretmenler sınıf mevcutlarının ve kaynaştırma öğrenci sayılarının yönetmelikte belirlenen sayılar dışında olmaması gerektiğini ifade etmişlerdir.

Anahtar Sözcükler: Özel eğitim, Kaynaştırma, Özel gereksinimli birey

Investigation of Nonverbal Proof Skills of Preservice Mathematics Teachers': A Case Study

Handan DEMİRCİOĞLU[1]

ABSTRACT

The importance of both proof and visualization has been frequently emphasized in mathematics education. Visual proof or nonverbal proofs are defined as diagrams or illustrations that help us to see why a mathematical expression is correct, and how to begin to prove the accuracy of this statement. The aim of this research is to examine nonverbal proof skills of preservice mathematics teachers. The study was carried out with case studies, one of the qualitative research designs. The participants of the study consisted of 53 preservice mathematics teachers at a state university in Central Anatolia, Turkey. The data were collected with a sample of three nonverbal proof samples directed to preservice teachers. The analysis of the data classified the preservice teachers' responses according to their similarities and differences. The findings showed that preservice teachers generally associate images with geometric figures. In addition, it was also seen that those who saw the visual relationship between the given visual and mathematical expression used it to show the expression as correct instead of proofing the visual.

Key Words: Proof, Nonverbal poof, Visual proof

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INTRODUCTION

The importance of both proof and visualization has been frequently emphasized in the learning and teaching of mathematics. A proof is used to show whether or not an assumption is correct (Heinze, & Reiss, 2004) and is at the core of both mathematics and mathematics education (Ball, Hoyles, Jahnke, & Movshovitz-Hadar, 2002; Knuth, 2002a, 2000b). Nevertheless, it has always been a difficult issue (Jones, 2000). Although it is a challenging subject or skill, one of the alternative methods that can be applied to acquire the skill of proof is gaining the ability of proof by visualization; that is, the use of nonverbal proofs. The nonverbal proof is one of the methods that supports both making proof and proof skill. Alsina and Nelsen (2010) described nonverbal proofs as "visual arguments." A picture is better than a thousand words (Rösken, & Rolka, 2006; Thornton, 2001). As Casselman (2000) stated, proofs are common in many cultures. In fact, proof with diagrams-pictures has a long history (Foo, Pagnucco, & Nayak, 1999). Nonverbal proof studies have been published in various journals since the mid-1970. Especially in recent years, nonverbal proofs have started to form part of mathematics education (Polat, & Demircioğlu, 2016), and this interest has been increasing rapidly in both mathematics research and mathematics education practices (Bardelle, 2009).

Nonverbal proof is a mathematical drawing describing the proof of a mathematical expression, but without proving the formal argument with words (Bell, 2011). Bardelle (2009) defined visual (nonverbal) proofs as deductive steps based on figures, diagrams, and graphs. According to Alsina and Nelsen (2010), they are pictures or diagrams that help to see *why* a certain mathematical expression can be correct and also to see *how* that expression can begin to prove it. According to Bardelle (2009), visual proofs are those which are not presented with any comments in verbal language (that is nonverbal), but are only based on diagrams, maybe numbers, letters, arrows, dots, and symbolic expressions associated with each other; the proof that is, or configuration of the proof, is left to the reader. The nonverbal proof uses visual representation, meaning that pictures and visuals are used to represent a mathematical equation, theorem or idea (Casselman, 2000; Gierdien, 2007). In summary, the nonverbal proof is also used to acquire the ability to make a proof or to explain the proof process better in addition to demonstrating why a proof is correct.

Nonverbal proofs play an important role in mathematics classes from primary education through to university level (Alsina, & Nelsen, 2010). In general, there are many examples in proofs of many theorems in many fields such as algebra, analysis, trigonometry and more specifically, "Total of cubes" or the "Nicomachus theorem" (Stucky, 2015), and "Alternate series test" by using the fields of rectangles (Hammack, & Lyons, 2006). It can also be used in the history of mathematics courses (Bell, 2011). There are indeed examples of verbal evidence with almost every subject, and these examples can be found on various websites (e.g., www.illuminations.nctm.org, www.cut-the-knot.org, in two books written by Nelsen (1993, 2000), as well as in journal articles (e.g., Bell, 2001; Gierdien, 2007). Some nonverbal proofs can also be found on interactive sites such as nonverbal proof of Pythagoras (Bell, 2011); see http://illuminations.nctm.org/ActivityDetail.aspx?ID=30. Stucky (2015) stated that nonverbal proofs are a useful pedagogical tool. Nonverbal proofs are more interesting and acceptable for students than classical proofs (Štrausová, & Hašek, 2013), effective in understanding students' process of proof (Bell, 2011), and can play an important role in the process of understanding various mathematical features (Štrausová, & Hašek, 2013). Miller

(2012) stated that nonverbal proofs are a valuable tool in mathematics, especially in the teaching of mathematics. To support this claim, he expressed that a student who can show the accuracy of the formula of first n integer sum by the inductive method cannot be convinced why this is true. Here, he explained that nonverbal proofs can be effective. Hammack and Lyons (2006) stated that in using visual proof for the convergence of Alternate series, student success increased and the generated proofs were clearer than the proofs found in the standard books. He explained that by using the area of rectangles, concreteness and abstraction replaced and eliminated some of the difficulties.

Although there are many nonverbal proofs to be found in the literature, it can be observed that there have not been many studies about the effects of nonverbal proofs on teaching and proofing skills. The studies carried out generally show the theoretical structure, history and examples of nonverbal proofs (Alsina, & Nelsen, 2010; Miller, 2012) in the classroom with application examples (Bell, 2011; Gierdien, 2007), or student difficulties in nonverbal proof practices (Bardelle, 2009), approaches of talented secondary school students' making proof (Uğurel, Moralı, & Karahan, 2011), and the approaches of preservice primary school teachers about making proof with concrete models (Doruk, Kıymaz, & Horzum, 2012). In their studies, Demircioğlu and Polat (2015, 2016) stated that preservice teachers expressing nonverbal proofs were effective in gaining problem-solving, understanding, mental, reasoning, generalization, processing, analysis and thinking skills. At the same time, it has been seen that the most difficult aspects of nonverbal proofs are being unable to understand given figures, the lack of explanation, inability to establish a relationship between a nonverbal proof and an algebraic proof, lack of field knowledge, and lack of adequate sources. Indeed, since only one visual is used in nonverbal proofs, it is an important skill to be able to recognize when seeing it, to make a proof using only the visual information, and to make comments. Therefore, the current study aims to examine both the nonverbal proof and visualization skills of mathematics teachers.

METHOD

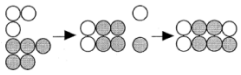
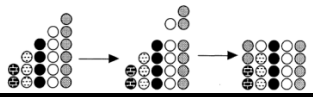
Research Model

This study employed case study methodology to investigate preservice secondary mathematics teachers' nonverbal proof skills. Case study research is a qualitative approach in which a bounded case is explored over time, through detailed, in-depth data collection involving multiple sources of information (Yıldırım, & Şimşek, 2005; Yin, 2003). The participants of the study consisted of 53 preservice teachers in the final year of secondary mathematics undergraduate education at a state university in Central Anatolia, Turkey. 32 female and 21 male preservice mathematics teachers participated in the current research. Participants were identified by convenience sampling method. All of the preservice teachers who took part in the study had received field and field education courses given at the bachelor's level as they were in their final year. For this reason, it was accepted that they had the necessary conceptual and procedural knowledge about the concepts contained in the nonverbal proofs and that they had already gained the ability of proofing. The fact that these preservice teachers would be practicing teachers in their near future made the studying of these skills particularly meaningful.

Data Collection Tool

Three questions were constructed in order to examine the nonverbal proof skills of the participant preservice teachers. The first of these questions is an example of modeling the sum of numbers from 1 to n, which are included in many sources. The second and third questions were obtained from Miyazaki (2000). The second question relates to "the sum of two odd numbers is even" and the third question is similar to the first, but can be used in the proof of different expressions.

Table 1. *Data collection tool questions*

Question	Image	Text
1		Explain what it means to you
2		Explain what it means to you
3		Explain what it means to you

Although the first and third questions appear to be similar, the first question is a visual that can reveal the generalization process and would be familiar to the preservice teachers. However, the third question is accepted as an example of specialization skill and includes a process of making a provision about the general rule based on similar examples. Therefore, the findings of these two problems are important for comparative purposes. The second question bears similarity with the third question. This example is similar to the visuals used when modeling skill is being examined, but here specialization skill has been examined. It provides pieces of evidence about whether or not a general rule can be seen from specific examples. In this sense, it is important to compare the findings of the second and third questions.

Data Collection Procedure and Data Analysis

Data were collected in writing. Each participant was assigned a random number. Data were then transferred to a computer environment. The participants' responses were then grouped according to their similarities, and content analysis was subsequently performed. Content analysis is the access to concepts and relationships that can explain the collected data. In content analysis, the fundamental process is to bring together similar data in the context of specific concepts and themes and to interpret them in a way that the reader can understand (Özdemir, 2010; Yıldırım, & Şimşek, 2005).

In this way, the category and subcategories were obtained so as to reveal what the preservice teachers understood from the given visuals and to examine their nonverbal proof skills. In the process of obtaining the categories and subcategories, the expressions included in the answers given were coded directly. In other words, "Sum of numbers from 1 to n…," "Triangle," etc. were coded and a frequency table created. In the following stage, each category was examined and subcategories were formed. These categories and subcategories were examined separately by two different experts in the field. The researcher and the independent reviewer discussed each of these categories and subcategories. As a consequence of the discussion, the categories were finalized. Direct quotations of the participants' statements have been used within the reporting of the findings in order add to the reliability of the data.

FINDINGS

Three research questions directed this study in the examination of nonverbal proof skills of preservice mathematics teachers. The findings obtained from each question are first evaluated separately and then together.

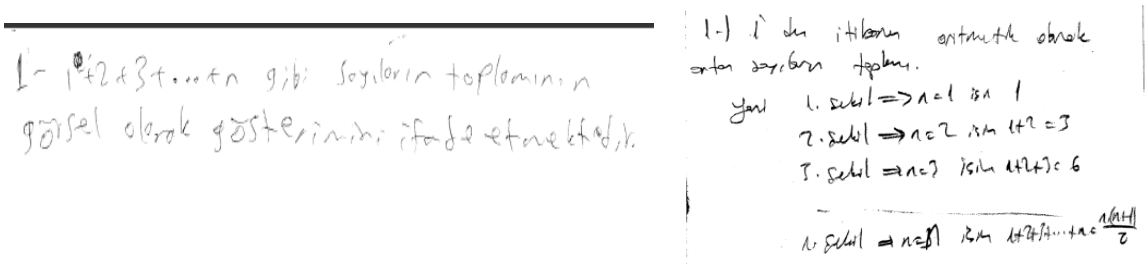
Findings from the First Question

The first question directed to the preservice teachers was regarding "the sum of numbers from 1 to n," which is usually proofed by way of the induction method in analysis courses. The answers given by the preservice teachers to the given image (see Table 1) are summarized in Table 2.

Table 2. *Preservice teachers' answers to first question*

Category	Subcategory	*f*
Sum of numbers from 1 to n	Sum of numbers from 1 to n and formula Example of modeling the sum of numbers from 1 to n	12
Triangle	Triangle Isosceles triangle Right-angled triangle Isosceles right-angled triangle	14
Pattern	1, 3, 5,…,2n-1 Pattern as figure 1, 3, 6, 10,… and amount of increase 1,2,3,…	13
Pattern and Triangle	Triangle Increasing triangles Nested parallel triangle Isosceles right-angled triangle	5
Other	Pascal's triangle, Right-angled triangle, Euclidean relation Pascal's triangle Binomial expansion Reaching generalizations Geometric series Dots	9

As can be seen from Table 2, a total of 12 preservice teachers participating in the study stated that the given visual was related to the sum of numbers from 1 to n. Four of these preservice teachers explained the visualization of the sum of numbers from 1 to n (see Figure 1a), while eight attempted to verify the number of dots with the formula $\frac{n(n+1)}{2}$ for each unity step (see Figure 1b). However, none of the preservice teachers made a connection between the given visual and the formula $\frac{n(n+1)}{2}$.



a) b)

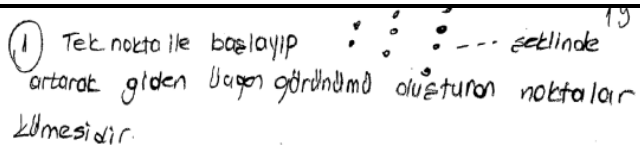
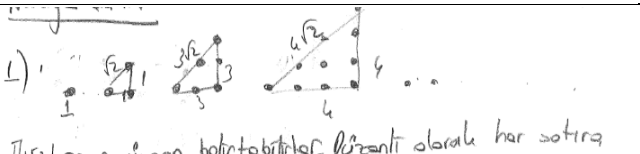
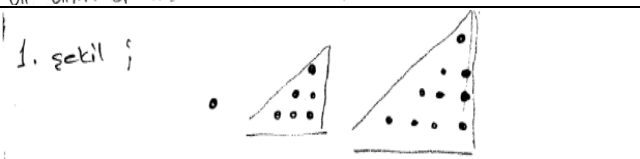
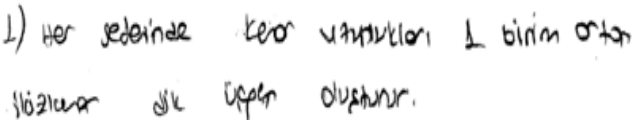
Figure 1. *Preservice teachers' response as "visual related to sum of numbers from 1 to"*

This example has been given in many sources and undergraduate courses. When the answers in this category were examined, it was observed that the preservice teachers were unable to express themselves using the visual $\frac{n\,(n+1)}{2}$, although they stated that the given visual was related to the sum of numbers from 1 to n. It was interpreted as they saw in this example, but they did not perform any activity related to nonverbal proof skills.

Of the preservice teachers, 14 expressed that the given visual was related with "forming a triangle." More specifically, three of the preservice teachers stated that the figure resembled a triangle by combining the dots, three mentioned an isosceles triangle, four stated a right-angled triangle, and four of the preservice teachers mentioned an isosceles right-angled triangle.

As can be seen from Table 3, all three preservice teachers combined the dots around the edges of the figure and expressed the figure as triangles whose edge lengths became longer by one unit for each side (triangles, right-angled triangles, isosceles triangles, isosceles right-angled triangle).

Table 3. *Preservice teachers' responses to "triangle" category*

Category	**Subcategory**	**Sample response**	*f*
Triangle	Triangle		3
	Isosceles triangle		3
	Right-angled triangle		4
	Isosceles right-angled triangle		4

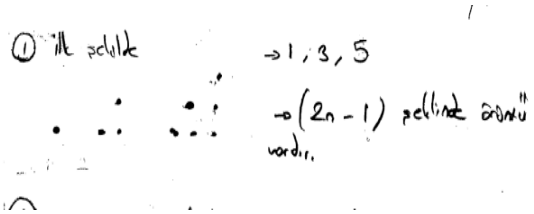
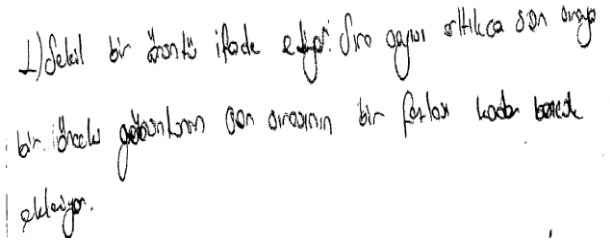
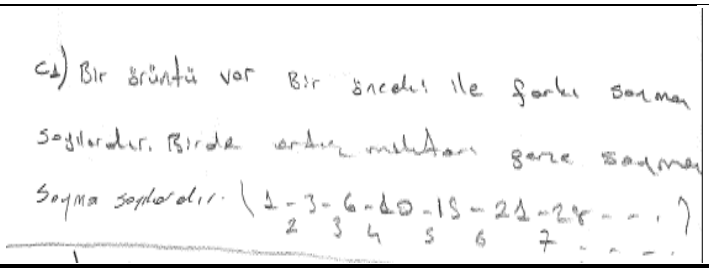
Here, only one of the three preservice teachers in the "isosceles right-angled triangle" subcategory stated that there was an isosceles triangle, made a connection with dot numbers and wrote the number of points as 1,3,6,10,... This preservice teacher may have inadvertently linked with the triangular numbers. Since this preservice teacher did not mention the pattern, their answer was not evaluated in the pattern category as well.

A total of 13 preservice teachers stated that there was a pattern based on the increase in dots in each step. When Table 4 is examined, it can be seen that the majority of preservice teachers expressed the pattern as 1, 3, 6, 10,… dots and with increasing dots in each step as 1, 2, 3,... In addition, one preservice teacher counted the points incorrectly and thought that

after one dot there were three dots; and then generalized this situation by expressing it as 1, 3,... 2n-1.

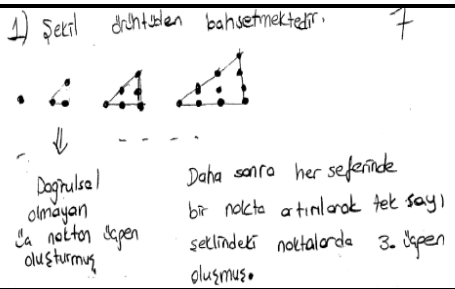
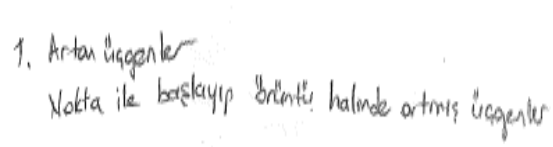
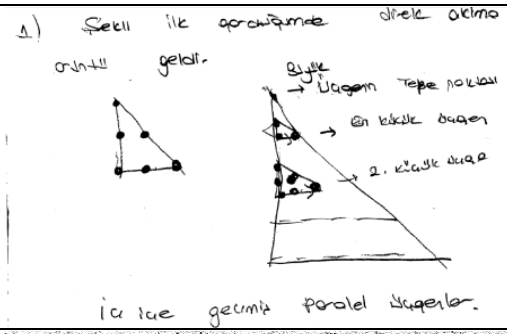
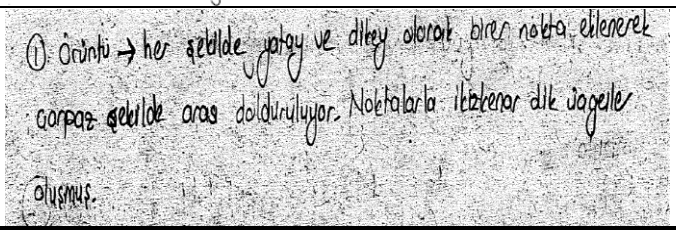
Lastly, three of the preservice teachers stated that a pattern was formed by adding points up to the right or lower side of the previous row. Based on given visual, three of the preservice teachers indicated that a pattern was formed by adding a dot to either the right or lower side of the previous row each time.

Table 4. *Preservice teachers' responses to "Pattern" category*

Category	**Rule of Subcategory Pattern**	**Sample Responses**	*f*
Pattern	1, 3, 5,…, 2n-1		1
	Pattern as figure		3
	1, 3, 6, 10,… and amount of increase 1, 2, 3,…		7

Five of the preservice teachers mentioned both the pattern and the formation of triangles. As can be seen from Table 5, the respondent preservice teachers in the "pattern and triangle" category realized that there was a pattern and explained that the rule of this pattern was increasing, isosceles right-angled, or parallel triangles. Therefore, the responses of these preservice teachers were not evaluated in the category of patterns or triangles, but were considered as a separate category.

Table 5. *Preservice teachers' responses to "pattern and triangle" category*

Category	Rule of Subcategory Pattern	Sample responses	*f*
Pattern-triangle	Triangles		2
	Increasing Triangles		1
	Intertwined parallel triangle		1
	Isosceles right-angled triangles		1

The responses of the remaining nine preservice teachers were not found to be similar, and were therefore evaluated in the "other" category. One preservice teacher in the subcategory of "Pascal triangle, right-angled triangle, and Euclidean relation" stated that the visual given were both similar to the Pascal triangle and that triangles can be obtained by combining the dots and that the Euclidean relationship can be taught. Similarly, another preservice teacher likened the visual given to the Pascal triangle. Another preservice teacher expressed generalization. There is also a generalization skill in the pattern. However, since this preservice teacher did not express the pattern, but only emphasized the generalization, hence this response was placed under a separate subcategory. One preservice teacher (see Figure 2) likened the visual to a geometric sequence. However, the expression that the dots that are two times at every turn only three times in the first step indicated that a difficulty in estimating the number of dots given and seeing the rule of the pattern.

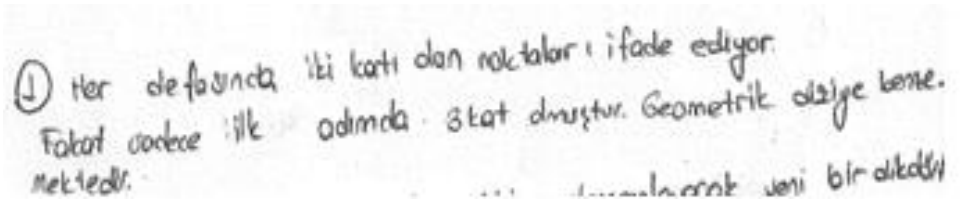


Figure 2. *Preservice teacher's response as "visual is similar to geometric sequence"*

Two of the preservice teachers likened the visual to Binomial expansion, with both establishing a connection with Binomial expansion. Two preservice teachers tried to explain the visual given by the increasing amount, whilst three searched for the relationship between the dots.

Findings from the Second Question

The responses of the preservice teachers to the second visual (see Table 1) are summarized in Table 6. Some of the categories in Table 6 were divided into subcategories.

Table 6. *Preservice teachers' responses to second question*

Category	Subcategory		*f*
No response	No response	7	12
	I can't find – I can't see	2	
	Doesn't mean anything	2	
	I can't comment	1	
Addition	Sum of two odd numbers is even	2	4
	Modeling of 3 + 5	1	
	Modeling of -3 + 5	1	
Area	Area conservation	3	5
	Area calculation by completing a rectangle	2	
Forming figure	Forming new figures by combining figures	7	22
	Forming a rectangle	14	
	Forming a geometric figure by combining the center of circles	1	
Other	Substitution	2	10
	Double figure group	1	
	Form a whole	1	
	Class placement	1	
	Different alignment	1	
	Equation	1	
	Probability – ball pull	2	
	Permutation	1	

In total, 12 of the preservice teachers were unable to write about the given visual. Seven of them left this question blank, one responded as "I could not see," one as "I could not find," and two preservice teachers responded as "It does not mean anything." One preservice teacher mentioned that they could not establish a rhythmical logic as the reason for not making comment. This preservice teacher's response was interpreted as the question not being one that required inductive reasoning skills as in Question 1; that is, the preservice teacher could not see a regular increase and therefore could not make a comment.

From this perspective, it can be said that nonverbal proofs traditionally mentioned in Question 1 are used more widely but that the preservice teachers do not encounter other nonverbal proofs frequently enough. Four of the preservice teachers stated that the given

visual was related to the operation of multiplication. Two stated it was modeling that the sum of two odd numbers is an even number, and that the reason for the different colors was that they were brought together in the last figure. The response of one of the preservice teachers is given in Figure 3.

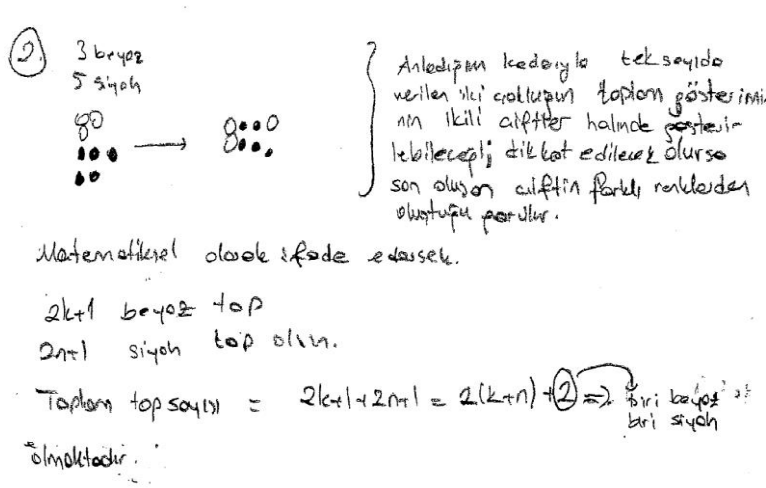


Figure 3. *Preservice teacher's response as "sum of two odd numbers is even"*

As can be seen from Figure 3, this preservice teacher expressed a view based upon the total number of balls being an odd number, as 2k + 1 and the other number as 2n + 1, and thereby found the total number of balls. The other two preservice teachers stated that 3 + 5 and -3 + 5 were modeling. The preservice teacher who stated that it was -3 + 5 modeling considered that the white colored balls were negative and the others were positive, and stated that it was modeling the operation of multiplication by coining.

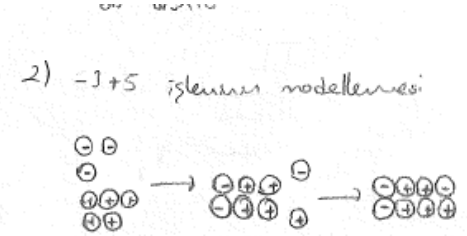


Figure 4. *Preservice teacher's response as "-3 + 5 modeling"*

One of the three preservice teachers stated that *"the area of all geometric shapes is the same even if the parts of the parts change."* This preservice teacher's response was interpreted as he/she thought that the given visual was related to the conservation of the area. Two others stated that the rectangle relates to the field calculation by completing the rectangle.

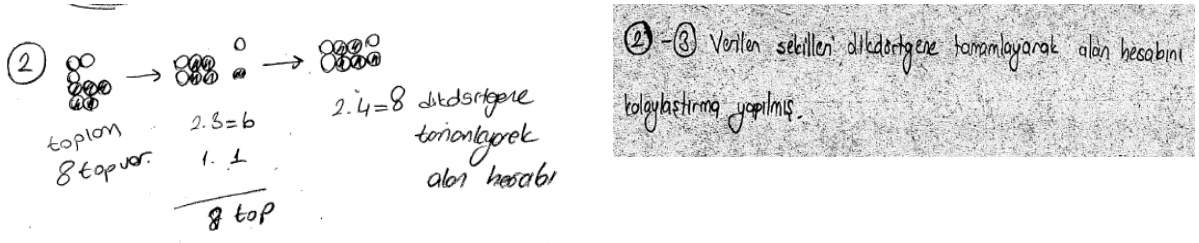


Figure 5. *Preservice teachers' responses as "given visual is related to the field"*

Seven of the preservice teachers thought that the new shape was created by changing the placement of the balls, whist 14 of them stated that it was attempted in order to create a rectangle. Here, the preservice teachers described the shapes given in the visuals as jigsaws, objects, filled/empty circles, filled/empty circulars, rounds, rings, and black/white balls. This was interpreted as the existing schemas of the given visualization were very different. One preservice teacher stated that unlike the others, it was related to creating a triangle, square, pentagonal, trapezoid, and parallelogram by merging the centers of the circles.

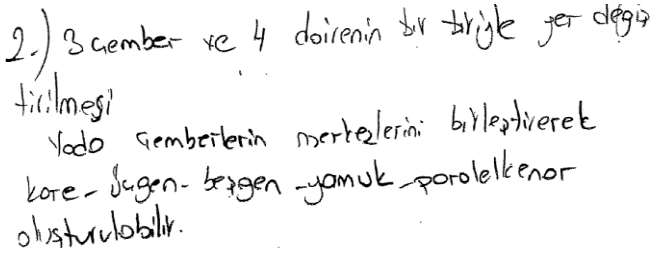


Figure 6. *Preservice teacher's response as "related to creating a geometric shape by merging the center of circles"*

The response of the remaining 10 preservice teachers was evaluated under the "other" category. Two preservice teachers mentioned that only the balls were replaced. One preservice teacher stated that it was attempted to create only one or two groups, another stated that it was to connect pieces to see the whole, one stated that it represented the females as the black balls and the males as the white balls in the classroom, so one female, and one male had to sit in the classroom, whilst one preservice teacher mentioned the different array of the balls. One preservice teacher stated seeing the equations with a shape.

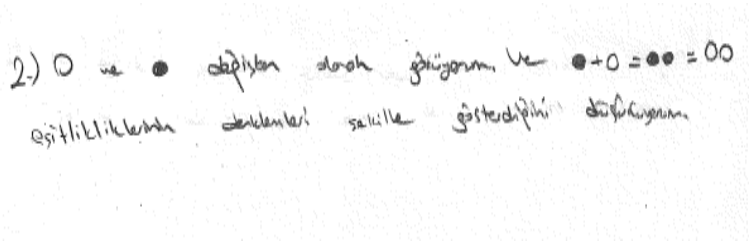


Figure 7. *Preservice teacher's response as "related to the equation"*

As can be seen from Figure 7, the preservice teacher considered the black and white shapes to be variables such as x and y, and as a result wrote $x + y = x + x = y + y$. However, this is only possible if $x = y$. Three preservice teachers stated thinking like a black or white ball and that it could be related to permutation, or ball drawing probability.

Findings from the Third Question

The responses of the preservice teachers to the third image (see Table 1) directed to the preservice teachers are summarized in Table 7. Some of the categories in Table 7 were divided into subcategories.

Table 7. *Preservice teachers' responses to third question*

Category	Subcategory	*f*	
No response		1	1
Modeling sample	Modeling of operation of multiplication	3	4
	Modeling of exponential expression of numbers	1	
Creating a figure	Creating a rectangle	21	23
	All geometric shapes can be obtained	2	
Other	Area	12	25
	Abacus	2	
	Problem question	1	
	Convert to symmetric format	1	
	Number of balls	5	
	Smoothing the shape	1	
	Replacement of balls	3	

As can be seen in Table 7, only one of the preservice teachers did not respond. Four of them stated that the visual might be related to modeling, similar to the second question. The majority of the preservice teachers perceived the visual as creating new shapes by way of the replacement of points. When the responses were examined, it was perceived as creating a rectangle by transforming from the rectangle above, trapezoid, and especially a right trapezoid. Along with this, they also stated that it could be used to calculate the area.

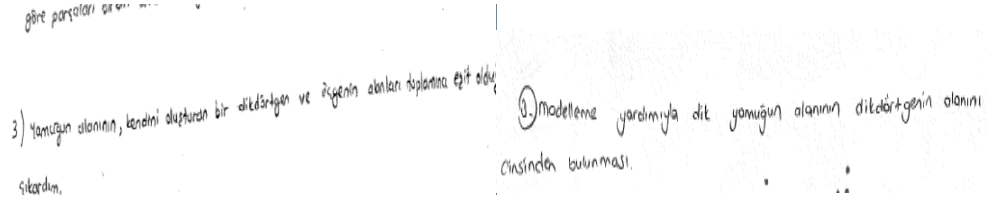


Figure 8. *Preservice teachers' response as "Creating a figure"*

The responses of the other preservice teachers were based on replacement of the points.

DISCUSSION

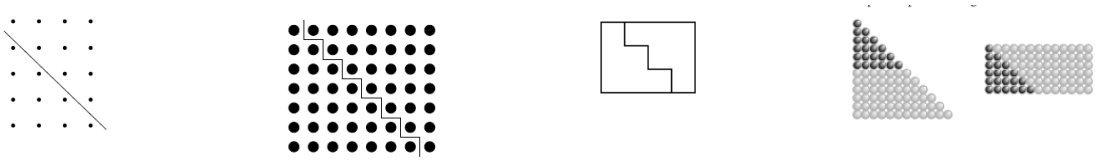
There are many studies on the role of visualization and visual thinking in mathematics teaching. Thornton (2001) stated that visualization provides mathematical rules, simple, elegant, powerful approaches to extracting results, and may even be an effective method in the classroom for students with different learning styles. For this reason, the ability of preservice teachers to work with visual proofs and visual proving is becoming an important dimension. The purpose of the current study was to examine these skills. Only 12 of the preservice teachers who participated in the study stated that the image given in Figure 9 related to "the sum of numbers from 1 to n."

Figure 9. *Image of first question used in the study*

Four of these preservice teachers explained the visual as "the sum of numbers from 1 to n," while eight of them tried to verify the number of points using the formula $\frac{n\,(n+1)}{2}$ for each unit step. However, none of the preservice teachers made a connection between the given visual and the formula $\frac{n\,(n+1)}{2}$. This example can be seen in many sources and undergraduate

courses. When the responses in this category were examined, it was seen that the preservice teachers were unable to express using the visual $\frac{n\,(n+1)}{2}$, even though they indicated that the given visual relates to the sum of numbers from 1 to n. It was interpreted that they had previously encountered this visual, but that they were unfamiliar with activities related to nonverbal proving skills.

A total of 14 of the preservice teachers likened the visual to a triangle (isosceles and right-angled triangles etc.) based on the given shape. 15 of the preservice teachers realized that it formed a pattern. The "other" category included the responses of 11 preservice teachers. Although it is a frequently encountered visual, the preservice teachers were unable to establish a relationship between the given visual and the sum of numbers from 1 to n. The preservice teachers who established a connection tried to verify the rule on the visual instead of using the visual to explore the formula. Of course, it is possible to use different visuals to help prove the same expression. Pease, Colton, Ramezani, Smaill, and Guhe (2010) expressed that in using the triangular numbers for the sum of the consecutive numbers, the visual in Figure 10a could be obtained. Similarly, Figure 10b was given by Miller (2012), in which n and (n + 1) can be in the form of half the area of a rectangle with side length. Additionally, Figure 10c is sourced from the study of Britz, Mammoliti, and Sørensen (2014) and Figure 10d from Alsina and Nelsen (2010).



a) b) c) d)

Figure 10. *Visuals related to the sum of consecutive numbers*

Of course, the visuals given in Figure 10 were all directed to the same expression. However, each shape could be difficult to perceive when given in this form if the student or preservice teacher had not previously encountered them. Miyazaki (2000) further explained these as shown in Figure 11.

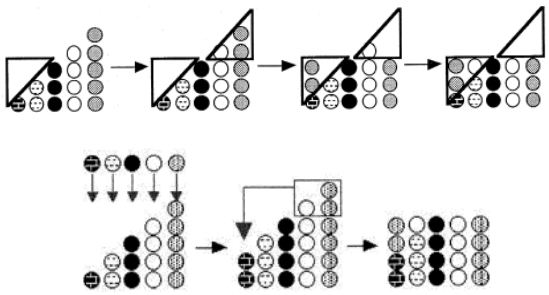


Figure 11. *Visual proof given by Miyazaki (2000)*

As can be seen in Figure 11, explaining what the nonverbal proofs are and how they are thought can make it easier to understand.

The third question of the study (see Figure 12) relates to a similar image, but rather than starting from 1 it starts from 2. The idea being to see whether or not the similarity would be established with the visual from the first question, related to the proof of another expression,

or would it be customized or generalized. In short, this question was asked in order to compare the thinking processes of the participant preservice teachers.

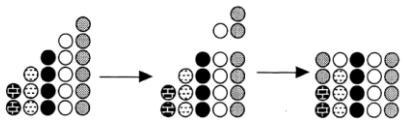
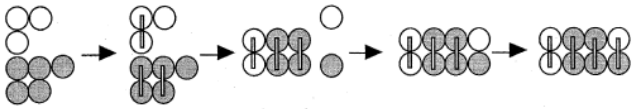


Figure 12. *Image of third question used in the study*

When given in this form, none of the preservice teachers were able to establish a relationship between the sum of consecutive numbers, or the sum of five consecutive numbers in the special case – being five times the number in the middle that was $2 + 3 + 4 + 5 + 6 = 4.5$. In fact, it is a rather simple proof when given the rule and asked to prove; however, it becomes difficult to understand when simply working from the visual proof.

Although the first and third questions were similar, none of the preservice teachers managed to combine or link the two visuals. The difference between these two visuals as a thinking processes can be interpreted as causing different perceptions and are therefore non-interpretable; a view supported by Pease et al. (2010). In fact, Pease et al. (2010) expressed that the visual given in Figure 10a was illustrating the visual status of $1 + 2 + 3 + 4 = 4 * 5 / 2$, and based upon this particular case generalization was applied to the expression "the sum of the first n consecutive number is $n.(n + 1) / 2$." Based on such a visual, proving not only requires mathematical thinking, but can be a difficult skill for students, preservice teachers or even serving teachers who have not encountered visualization. Another difficulty here is the generalization problem, as Kulpa (2009) stated. It is a problem of not perceiving an idea about a rule from a few special cases.

The second question directed to the preservice teachers was similar to the first question, since it was considered that preservice teachers would remember the modeling examples, as well as the third question since it is related to customizing skill. In a different expression, while inductive thinking plays an important role in the first question, the second question was expected to give the visual and generalize it for a special case as in many proofs according to Nelsen. As Alsina and Nelsen (2010) stated, the aim in this nonverbal proof is to provide an understanding by visualizing mathematical expression for any given situation. Customization, generalization, proof, and assumption are sub-dimensions of mathematical thinking skills. Therefore, the findings obtained from these questions also provide important evidence about mathematical thinking processes. The findings obtained from this question showed that only four of the preservice teachers stated that it could be modeling examples related to the given visual, whilst others made no comments, either associating them with the field or attempting to create a shape. One important finding is that in both questions, the preservice teachers generally perceived each step as creating a new shape. At the same time, it was observed that it was associated with the area that does not change with the replacement. The second question has been described by Miyazaki (2000) as follows (see Figure 13). Here, both the formal and nonverbal proof is given one under the other.



$$X+Y \rightarrow (2n+1)+(2m+1) = 2n+2m+1+1 = 2n+2m+2 = 2(n+m+1)$$

Figure 13. *Visual proof given by Miyazaki (2000)*

It would be perhaps easier to make a comment when given in this form. Indeed, as Alsina and Nelsen (2010) stated, "*Proofs without words are pictures or diagrams that help the reader see why a particular mathematical statement may be true, and also see how one might begin to go about proving it true*" (p. 118). In the study of Doruk and Güler (2014), it was determined that participant self-confidence was low in proving and in the understanding of proofs. The inclusion of nonverbal proofs can help students increase their self-confidence in proving. On the other hand, as stated by Altıparmak and Öziş (2005), teaching and development of students' proof and reasoning skills are dependent on the teacher. If teachers afford their students a wide range of learning opportunities and provide different proof methods, the students will likely better understand mathematics and logical thinking, and thereby increase their level of creativity. Based on this thought, nonverbal proofs can be an effective tool. However, as the teachers of the future, preservice teachers are recommended to have a level of experience with nonverbal proofs.

Another important factor is a lack of visual reasoning skills. Iannone and Inglis (2011) showed the same question in a university setting in the manner of "Prove a mathematical argument"; and the results showed that it was difficult for students to produce a correct argument rather than recognizing the proof given in the deductive argument. It can be said that nonverbal proofs may help in this sense to develop proofing skills or even to produce new arguments or proving. Bardelle (2009) explained the reasons behind a lack of visual reasoning skills as, "*poor knowledge of certain basic mathematical tools, poor acquaintance with the use of figural representations, a conflict between the conceptual and perceptual nature of diagrammatic proofs and sometimes poor understanding of the concept of mathematical proof itself*" (p. 259). Reasoning and proof are one of the process skills areas that students, as well as prospective and serving teachers need to master. As Bell (2011) stated, it is important to provide students with opportunities to improve their process skills and to help them understand the processes of proof. At the same time, Bell stated that using nonverbal proofs could help students to understand the process of proof. Moreover, Bell stated that they could improve reasoning skills so that students were better able to understand how to start a formal proof. In this context, the importance of proof in mathematics teaching at every level should be emphasized and it is recommended that students, especially in undergraduate education, gain experience with nonverbal proofs.

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TÜRKÇE GENİŞ ÖZET

Matematik Öğretmen Adaylarının Sözsüz İspat Becerilerinin İncelenmesi: Bir Durum Çalışması

Handan DEMİRCİOĞLU[2]

GİRİŞ

Matematiği öğrenmede ve öğretmede hem ispatın hem de görselleştirmenin öneminin vurgulanmasına paralel olarak sözsüz ispatlar son yapılan çalışmalarda hem ispat yapmayı hem de ispat becerisini destekleyen yöntem olarak karşımıza çıkmaktadır. İlköğretimden üniversite matematiğine kadar her düzeyde karşımıza çıkan sözsüz ispatlar belli bir matematiksel ifadenin *niçin* doğru olabildiğini görmesine ve ayrıca o ifadenin ispatlamaya *nasıl* başlayabileceğini görmeye yardım eden resimler veya diyagramlar olarak tanımlanmaktadır (Alsina ve Nelsen, 2010). Bir resim bin kelimeden daha iyidir (Thornton, 2001; Rösken ve Rolka, 2006). Casselman'ın (2000) ifade ettiği gibi bu söz birçok kültürde ortaktır. Aslında diyagramlarla-resimlerle ispatlar uzun bir tarihe sahiptir (Foo, Pagnucco ve Nayak, 1999). Tarihsel süreçte çok kullanılmasına rağmen, matematik öğretiminde kullanımı oldukça yenidir.

Gerçekten Stucky (2015) sözsüz ispatların faydalı bir pedagojik araç olduğunu ifade etmiştir. Sözsüz ispatlar öğrenciler için klasik ispatlardan daha çok ilgi çekici ve kabul edilebilirdir (Štrausová ve Hašek, 2013), öğrencilerin ispat sürecini anlamada etkilidir (Bell, 2011) çeşitli matematiksel özellikleri anlama sürecinde önemli rol oynarlar (Štrausová ve Hašek, 2013).

Literatür incelendiğinde yapılan çalışmalar genellikle sözsüz ispatların kuramsal yapısı, tarihçesi ve örneklerine (Alsina ve Nelsen, 2010; Miller, 2012) sınıf içi uygulama örneklerine (Bell, 2011; Gierdien, 2007), sözsüz ispat uygulamalarında öğrenci zorluklarına (Bardelle, 2009), yetenekli ortaöğretim öğrencilerinin sözsüz ispat oluşturma yaklaşımlarına (Uğurel, Moralı ve Karahan, 2011), sınıf öğretmeni adaylarının somut modeller ile ispat yapma ile ilgili görüşlerine (Doruk, Kıymaz ve Horzum, 2012) yöneliktir. Demircioğlu ve Polat (2015; 2016) öğretmen adaylarıyla yapmış oldukları çalışmada öğretmen adayları sözsüz ispatların ispat, problem çözme, anlama, zihinsel, akıl yürütme, genelleme, işlem, analiz ve sentez yapabilme, görme ve düşünme becerilerini kazanmada etkili olduklarını ifade etmişlerdir. Aynı zamanda sözsüz ispatlarla ile en fazla zorlandıkları yerlerin verilen şekilleri anlayamama, açıklama olmaması, sözsüz ispat ile cebirsel ispat arasında ilişki kuramama, alan bilgisi eksikliği, kaynak sıkıntısı olduğunu göstermiştir. Gerçekten sözsüz ispatlarda yalnızca bir görsel kullanıldığı için, gördüğü zaman tanıyabilme, görseli kullanarak ispat yapabilme, yorum yapabilme önemli bir beceri olarak karşımıza çıkmaktadır. Bu nedenle bu çalışmada hem matematik öğretmen adaylarının sözsüz becerilerini incelemek ve elde edilen bulgular doğrultunda öneriler sunmak amaçlanmıştır.

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YÖNTEM

Çalışma nitel araştırma desenlerinden durum çalışması ile yürütülmüştür. Çalışmanın katılımcılarını İç Anadolu'da bulunan bir devlet Üniversitesi'nde öğrenimlerine devam eden son sınıftaki 53 öğretmen adayı oluşturmaktadır. Veriler öğretmen adaylarına yöneltilmiş olan 3 sözsüz ispat örneği ile yazılı olarak toplanmıştır. Bu sorulardan birincisi birçok kaynakta yer verilen 1'den n'ye kadar sayıların toplamının modellemesine örnek olarak verilen örnektir.2. ve 3. soru ise Miyazaki'den (2000) alınmıştır. 2. soru "iki tek sayının toplamı çifttir" ve 3. soru ise ilk soruya benzemekle birlikte farklı ifadelerin ispatı içinde kullanılabilmektedir. Verilerin analizi öğretmen adaylarının cevaplarının benzerlik ve farklılıklarına göre sınıflandırılarak yapılmıştır. Kategori ve alt kategorilerin elde edilme sürecinde öncelikle verilen cevaplarda yer verilen ifadeler direk alınarak kodlanmıştır. Yani "1'den n kadar sayıların toplamı", "Üçgen", ,… vb gibi kodlanmış ve frekans tablosu oluşturulmuştur. Daha sonraki aşamada ise her bir kategori kendi içinde ele alınarak alt kategoriler oluşturulmuştur. Bu şekilde elde edilen bu kategori ve alt kategoriler alanında uzman iki farklı araştırmacı tarafından ayrı ayrı ve sonra birlikte incelenmiştir. Bu aşamadan sonra kategorilere son hali verilmiştir. Katılımcıların yazılı ifadelerinden direk alıntılar yapılarak, verilerinin güvenilirliği artırılmıştır.

BULGULAR

Elde edilen bulgular öğretmen adaylarının verilen görselleri genellikle geometrik şekillerle ilişkilendirdiklerini göstermiştir. Ayrıca verilen görsel ile matematiksel ifade arasındaki ilişkiyi görenlerin ise görseli ispat yapmak için kullanmak yerine ifadenin doğru olduğunu göstermek için kullandıkları görülmüştür. İlk yöneltilen 1'den n'ye kadar olan sayıların toplamı ile ilgili olan görsel, birçok kaynakta ve birçok lisans dersinde sıklıkla verilmektedir. Fakat sıklıkla karşılaşılan bir görsel olmasına rağmen öğretmen adayları verilen görsel ile 1'den n'ye kadar olan sayılar arasında ilişki kuramamıştır. İlişki kuran öğretmen adayları ise formülü keşfetmek için şekli kullanmak yerine kuralı görsel üzerinde doğrulamaya çalışmışlardır. İkinci sorudaki görsel ilk görsele benzerdir fakat 1'den başlatmayıp 2'den başlatılmıştır. İlk soru ile benzerlik mi kurulacak yoksa başka bir ifadenin ispatı ile mi ilişkilendirilecek ya da özelleştirme veya genelleştirme mi yapılacak görülmek istenmiştir. Kısaca öğretmen adaylarının düşünme süreçleri karşılaştırılmak istenmiştir. Birinci ve üçüncü sorular benzerlik göstermesine rağmen iki görseli birleştiren hiçbir öğretmen adayı da olmamıştır. Bu iki görseldeki düşünme süreçleri olarak farklılık göstermesi farklı algılanmasına, yorum yapılamamasına neden olmuştur şeklinde yorumlanabilir. İlerideki çalışmalarda aynı ifadenin ispatı için farklı görselleri aynı ölçme aracında vererek düşünme süreçleri incelenebilir. Ayrıca $1+2+3+4=4*5/2$ özel durumunu gösteren görselden yola çıkılarak "ilk n ardışık sayının toplamının $n(n+1)/2$" ifadesine genelleştirme yapıldığı görselleştirmeler ilk defa karşılaşan öğrenciler, öğretmen adayları hatta öğretmenler için bile zor bir beceri haline gelmektedir. Burada diğer bir güçlük de genelleştirme problemidir. Özel birkaç durumdan hareketle kural hakkında bir fikir elde edememe problemidir. Bu nedenle kuralların öğretiminde veya kuralların ispatları yapılırken bu düşünme veya ispat yöntemini de bir pedagojik araç olarak kullanmak hem matematiksel düşünmenin gelişimine hem ispat becerisinin gelişimine hem matematiği anlamlı öğrenmeye yardımcı olacaktır.

Anahtar Sözcükler: İspat, Sözsüz ispat, Görsel ispat

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