

## PREPARING DATA REPRESENTATION ACTIVITIES FOR YOUNG LEARNERS

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### ABSTRACT

This study aimed to investigate pre-service pre-school education teachers' data representation activities in terms of their relation to real life, the appropriateness of the data that the children can collect, the conformability of the graphs required for the data representation to the children's level, and the clarity of open-ended questions asked to children during the activity. Six senior pre-service teachers participated in this study. Findings revealed that pre-service teachers determined their subjects for graph activities related to real life based on children's interests. They have chosen the data that the children can collect and they used real objects or pictures in order to concretize data for children. Pre-service teachers mostly chose picture graphs as children are familiar with grouping and classifying activities and they are more capable of making and interpreting picture graphs. Pre-service teachers asked effective questions about the activities to help students understand the graphs.

**Keywords:** childhood education, graph activities, mathematics education, pre-service teachers.

## KÜÇÜK ÇOCUKLAR İÇİN VERİ GÖSTERİMİNE YÖNELİK AKTİVİTELER HAZIRLAMA

### ÖZ

Bu çalışmanın amacı, okul öncesi eğitimi öğretmen adaylarının veri gösterimi etkinliklerini, gerçek hayatla ilişkilendirebilme, çocukların toplayabileceği verileri seçebilme, veri gösterimi için gerekli grafikleri çocukların düzeyine uygun olarak hazırlayabilme ve etkinliğin anlaşılmasına yönelik soru sorabilme açısından incelemektir. Araştırmaya okul öncesi eğitim dördüncü sınıfa devam eden altı öğretmen adayı katılmıştır. Öğretmen adaylarının grafik etkinliklerinin konularını çocukların anlayabilecekleri düzeyde gerçek hayatla ilişkilendirdikleri görülmüştür. Çocukların toplayabileceği veya sağlayabilecekleri veri gruplarını seçerek uygulamada verileri somutlaştırmak ve öğrencilere yardımcı olmak için içeriğe uygun gerçek materyaller veya resimler hazırlamışlardır. Çocuklar bu verileri öğretmen adaylarının hazırladıkları taslak grafiğe yerleştirmek suretiyle grafikler oluşturmuşlardır. Genel olarak öğretmen adaylarının veri gösterimi için resim grafiğini seçtikleri gözlenmiştir. Çocukların sınıflama-gruplama etkinliklerine alışkın olmalarından dolayı resim grafiği yapmakta ve yorumlamakta daha başarılı oldukları görülmüştür. Ayrıca öğretmen adayları çocukların kavramları sayma, organize etme ve karşılaştırma gibi eylemleri yerine getirmeleri için çocukların seviyesine uygun sorular yöneltilmiştir.

**Anahtar kelimeler:** okul öncesi eğitim, grafik etkinlikleri, matematik eğitimi, öğretmen adayları.

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## INTRODUCTION

Children can save their experiences and make connections between them through training and child's rearing in pre-school period which forms the basis of human life (Önder, Balaban-Dağal, & Şallı, 2016). School assists children to acquire basic life skills and competences that are necessary for their development. Early childhood education is pretty important to prepare children for the secondary level of their education (Eurostat, 2017). The quality of education is closely related with teaching standards and teacher knowledge. Preparing effective learning activities depends on teacher quality and a rich and stimulant environment. In this respect teachers who assist the requirements of learning for children and supply all their needs have an important role in children's life. One of the necessary skills children should develop in early childhood education is data representation skills. Early child education (Ministry of National Education [MoNE], 2013) and primary education mathematics curricula (MoNE, 2018) emphasize the importance of data representation activities.

Data representation is an essential component of early childhood education curriculum. Data representation refers to the way in which data are summarized, presented, and interpreted by using appropriate tables, charts, or graphs (Lajoie, Lavign, Munsie, & Wilkie, 1998). The process of constructing graphs provides a meaningful opportunity for children to represent and communicate important mathematical relationships related to real life situations. According to MoNE (2013), 60-72 months children can do matching, grouping, and sorting the objects and make relations between them. Children can explain similarities and differences between objects. Moreover, they can create graphs using objects and read the graphs (National Council of Teachers of Mathematics [NCTM], 2000).

At early ages, children mostly engage in the construction processes of picture graphs. A picture graph is the type of graph that children use symbols or pictures to represent given data. The difference between a picture graph and a bar graph is how the information is shown. Picture graph uses pictures, icons, or symbols

and a bar graph uses bar slices to show how many data are in each group (NCTM, 2000).

In Turkish primary school mathematics curriculum (2018) students learn reading simple tables with up to two groups of data at first grade. At second grade, they learn data collection, representation, and interpretation using tables, picture graphs, frequency tables, and tree diagrams. At third grade, children are expected to read and interpret simple tables with up to three data groups. At fourth grade, students learn bar graphs. In some other countries bar graphs are taught pretty earlier than Turkey. For instance, the Common Core State Standards in the United States introduce bar graphs at the second grade (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). Knowing that at international exams (e.g., Trends in International Mathematics and Science Study) Turkish students' graph reading performance is lower than other countries, it might be better for our curriculum to introduce bar graph earlier, as well.

Being introduced to graphs at an early age can support children to understand mathematical concepts such as sorting, organizing, counting, comparing, and analyzing. The results of the studies revealed that it is pretty difficult for teachers to have children develop those skills especially at early age (Ertem & Alkan, 2002; Garfield & Ben Zvi, 2007). Learners need to be guided in order to understand how to organize the data that allows them to create the proper graphs and answer data related questions (Wessels, Wessels, & Nieuwoudt, 2006). Teachers need to have enough appreciation of tasks undertaken in the classroom so that they can recognize appropriate uses of a variety of graphical representations (Garfield & Ben-Zvi, 2004). While doing mathematics activities with children, teachers should remember two principles. Firstly, children should get involved in the process actively. Secondly, the inquiry should begin with children's own experiences. It is better to use daily life objects and investigate familiar subjects to children. The second premise of teaching underlies transferability of content to children's everyday experiences. More precisely, the teaching process should lead children to a

better understanding of the immediate situation (Isaacs & Randall-Kelso, 1996). In this sense topics should be chosen from children's everyday lives and familiar situations.

In this study pre-service teachers prepared data representation activities for young learners after they had an education about graphics types: picture, bar, and pie chart. The purpose of the study is to examine pre-service pre-school education teachers' data representation activities. Precisely, this study designed around the following research question:

- How was the senior pre-service pre-school education teachers' data representation activities in terms of their relation to real life, the appropriateness of the data that the children can collect, the conformability of the graphs required for the data representation to the children's level, and the clarity of open-ended questions asked to children during the activity?

## PHASES OF IMPLEMENTATION

Six senior pre-service pre-school education teachers studying in their last year in a teacher education program and taking both Practicum and Research Project courses participated in this study. All of the participants were assigned to the same lecturer (the second author) in both courses. The lecturer first offered to pre-service teachers some topics for research project course and pre-service teachers reached a consensus on preparing and applying graph activities. Then, the researcher asked them if they had prepared activity plans about graphs. All of the participants said that they had not prepared activity plans about graphs. Then the researcher provided three classes about graphs activities. In these lessons, she explained graphics types, picture, line, bar, dot graphs and pie chart, and gave examples about how to use these graphs with young learners.

Actually pre-school curriculum includes only object and picture graphs at this level for pre-school children (MoNE, 2013), however, to develop a broader perspective about graphs, all these graphs were taught in detail to pre-service teachers in the class. Their similarities and differences were explained and then discussed which data fit with which graphs

best. Pre-service teachers were encouraged to read research and discuss the research findings with each other to integrate graphs in their activity plans. Then, each pre-service teacher prepared a graph activity and they showed these activities to practicum teachers to ensure that the class did not have a similar activity previously. Yet, none of the teachers applied data representation activities with children in their class.

Finally each pre-service teacher applied graphs activities with children. Each activity is implemented in a separate class as all participants having their practicum in different classes. Pre-service teachers were interviewed about their experiences in these activities. Interview questions were developed by researchers based on related literature (Larson & Whitin, 2010; MoNE, 2013; Whitin, 1997). After that, a faculty member in pre-school education program and a pre-school education teacher having three years experiences investigated appropriateness of questions (not the activities) and made minor changes on them. Pre-service teachers told the activity implementation process in detailed during the interviews. The interview questions asked pre-service teachers about their goals and the lesson process. Some interview questions were as follows. What was the aim of the activity? Why did you prefer this type of graph? What kind of object or picture did you use in the activity? What kind of questions did you ask to children related to activity, and why?

The schools in which pre-service teachers applied their graphs activities are located in the center of Van, a city in eastern Turkey, and they all provide education for children coming from low and middle socio-economic backgrounds. Through this study almost 135 five years old children were involved in graphic activities. After completing the activities, the pre-service teachers were interviewed about the activities they carried out in the class. Pre-service teachers' activity plans and photographs taken during the activities were also investigated for this study. However, researchers could not have a chance to observe implementation of graph activities in class with children. Instead pre-service teachers wrote reflection papers about the implementation process of their activity plans.

As the data of this study consist of transcription of semi-structured interviews, written activity plans, and reflection papers of pre-service teachers, basic qualitative design was embraced in this study (Merriam, 2009). In order to analyze data, open coding was utilized as there are limited codes on the subject of teaching graphs to young children in the literature. Researchers read interview transcripts several times and determined significant statements about pre-service teachers' experiences in applying graphs activities. Researchers determined coding sheet based on their research questions. When they both finished reading through the text, they began to code data separately. As their coding was explicit, they reached high consensus on coded data. Still, in order to reach total agreement, they compared their coded data and inter coder reliability ended with total agreement. Once codes were determined similar codes gathered under the categories and categorized data gathered under themes based on interrelationships among the categories. Because the activity plans were written content of data set, content analysis technique was used to analyze the activity plans (Frankel & Wallen, 2006). The content analysis is based on relating data under common themes and interpreting and presenting them in a narrative way so that the readers could understand the meaning of study (Yıldırım & Şimşek, 2006).

The name of the activities were Egg laying and milk giving animals, favorite fruits of children, daily forecast, emotions, the way to reach school, sink or swim, and objects in parts of the house. The summary of the activity plans prepared by pre-service teachers are given in Appendix 1.

## FINDINGS

Findings revealed that pre-service teachers determined their subjects for graphic activities based on children's interests. All of the participants stated that they chose their topic based on children's interests, developmental characteristics, and readiness. They also preferred materials that they could easily reach and contexts children were familiar with. None of the pre-service teachers had planned and applied data representation activity before and they all expressed that graph activities took children's attention very much. Pre-service

teachers mostly preferred to apply activities involving picture graphs. There were five picture graph activities out of six graph activities. Only one participant used a pie chart activity with young children. Pre-service teachers did not only focus on teaching graphics, they also aimed to teach the topic that they chose to represent data.

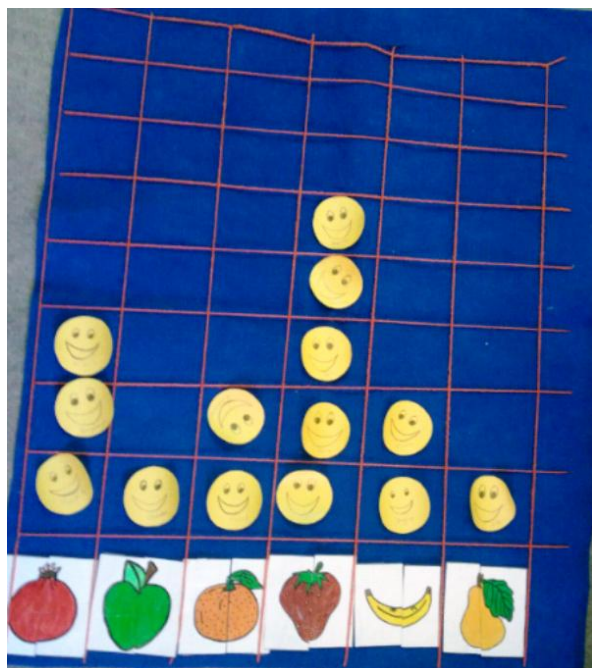
The first activity was egg laying and milk giving animals. At the egg laying and milk giving animals activity, most of the children had the basic information about the animals and they could divide the data into two groups as egg laying and milk giving animals. The pre-service teacher provided children with animal photos and also the graph offers necessary clues to children (Figure 1). Even if they couldn't calculate the total numbers for each group, they could make a comparison between the bars and decide whether the bar constructed for egg laying animals is taller than the bar for milk giving animals, or not.



**Figure 1.** Egg Laying and Milk Giving Animals Graph

The second activity was favorite fruits activity. Children talked about their favorite fruits. Then, the pre-service teacher delivered smiley face and each child placed the smiley face on his/her favorite fruit at the graph. When they finished they constructed a picture graph together. The graph clearly showed the distribution of the data. Then children could read the graph and answer the questions the pre-service teacher asked. Can you show your answer on the graph? Which is the most favorite fruit in the class? Which is the least favorite fruit in the class? Which two fruits were equally favorable in the class? Is there anything you want to talk about the graph? Children were able to give valid answers to inquiry based questions as showing their

smiley face on the graph, saying the most favorite fruit in class is strawberry, the least favorite fruits in the class are pear and apple, and orange and banana are two favorite fruits equally loved in the class. Questioning did play an important role in this activity to assist children interpret the graph. In addition, in this activity the pre-service teacher divided the base of the graph into equal areas to put the smiley face on it (Figure 2). This might support students in future to have the knowledge that in bar graphs each slice represents one data and slices for each data come together and construct the bar. With the help of this kind of picture graph activities, students might be careful while drawing a bar graph in near future.



**Figure 2.** Favorite Fruits Graph

Pre-service teacher applying favorite fruits graph admitted that she was afraid of not being able to explain the graph to children:

I have not applied a graph activity before. Children were not involved in graph activity too. I thought that it might be difficult for them. That is why I chose fruits as the topic. Children really like sticking something and they like making classification, grouping, and sorting. They easily constructed the graph, and then they also interpreted it correctly.

The third activity was the emotions. The emotions activity was very similar to the

favorite fruit activity. After the pre-service teacher asked "How do you feel today?" each child chose an emotion picture representing his/her emotion. Children chose their emotions from happy, sad, tired, and mad emoji based on their feelings at that time and they placed it on the graph hanging on the wall. This was a picture graph activity once again.

The fourth activity was the way to reach school. The way to reach school activity was another activity used in this study. The pre-service teacher calculated central angles based on number of children in the class. Then she brought previously constructed pie chart manipulative to class. Children chose the photo of each way; bus, car, and walk that they came to school and placed it on the table. The teacher directed children to mark same arrival type side by side. Then the teacher asked children to color school bus part with yellow, car part with red, and walking part with blue. After coloring each part, the teacher asked open ended questions to children such as "Which arrival way to reach school is the most used by children?" and "Which one is the least used?" In this activity, the teacher constructed the pie chart, children observed the teacher. When they colored the central angles they could give valid answers to the questions.

The fifth activity was sink or swim. At the sink or swim activity, children first participated in an experiment to collect data (Photograph 1). The teacher and children put the objects into the water and honey respectively to check whether they sink or swim. After that, children marked how many objects sank or swam in the water and honey. They constructed a picture graph for the swimming objects in water and honey, and compared the categories. The picture graph was easy for children to read. They could decide easily which one is more than the other and answer the questions the teacher asked.

The pre-service teacher who designed the sink or swim activity realized that graph activities are easier than his initial expectation:

I did not think of implementing a graph activity before. I have not observed its implementation in my practicum. When you first mention about it, no idea has occurred to me. Then I decided to integrate it in an experiment. After implementing

this activity, I realized that it could be associated with all of the activities including story-telling, field trip, play, and even art. Besides, all of the subjects or concepts could be taken as a graph topic.

He further stated that “Activities trigger children’s curiosity are always more successful.”



**Photograph 1.** Sink or Swim Activity

Objects in parts of the house, was the last activity used in the study. In this activity, children constructed a picture graph (Figure 3). Children matched the object photos with the column they belong on the graph prepared by the teacher. Then, they discussed which room has more objects and which room has fewer objects. The teacher evaluated graph with children and finished the activity with a song. Overall, during the activity children were engaged in, tried to answer open-ended questions, and assisted the teacher while constructing the graph.



**Figure 3.** Objects in Parts of the House

The pre-service teacher explained the importance of using real objects in activities as follows:

It is really funny. Children see spoon, sponge, or shampoo in their home all the time but when they see these objects in class you may think that it is the first time they see them. Our lecturers in university always emphasize the importance of concretizing for young children. In this practicum, I recognize it very well.

## DISCUSSION and CONCLUSIONS

Egg laying and milk giving animals, favorite fruits of children, emotions, the way to reach school, sink or swim, and objects in parts of the house were the six data representation activities developed for this study by pre-service pre-school education teachers. All of the pre-service teachers expressed that it was their first time to prepare graph activities. It was also same for children that they were involved in graph preparation and interpretation activities in their class for the first time. All of the participants stated that graph activities reached a great success. Pre-service teachers measured the success of activities in three ways. As they were trainee in school, they had difficulties in maintaining classroom management, taking children’s attention, and involving children in activities. When they accomplish all three components, they consider their activity successful. They all reported that graph activities took children’s attention more compared to other activities that they implemented throughout the practicum course. Young children always need visualization or concretization in activities. Pre-service teachers either used real objects or pictures in graph activities and this increased the success of activities.

Children’s accomplishment in the current graph activities could be explained in three ways. Firstly, all of the activities were directly related to children’s real life conditions. Children could easily understand the concepts and interpreted the data. Analysis of interviews revealed that the most of the pre-service teachers believed that the topics were interesting and enjoyable and were not very difficult for children. Children got interested and involved in the activities. We noticed that children benefited from having a "real" context. They often referred to the context in their discussions of the graphs or to explain their reasoning. Conducting a short survey and

obtaining a data set from the class was effective since majority of the children could produce and collect data when the teacher asked. However, some of the children did not prefer to participate into the activity and to give information about them. During such cases, teachers should motivate children to participate in the data collection process. Making an experiment or singing a song might be useful exercises to motivate children.

The second reason why the graph activities were successful is using real objects or pictures in order to concretize data for children and make them place the data on graph appropriately. Pre-service teachers mostly chose picture graphs as children were familiar with grouping and classifying activities, and they were more capable of making and interpreting picture graphs. The picture graphs were the most applicable graphs for young learners. After children shared their real data they could see where their own data were located in the picture graph. This made it easier for children to give meaning to the graphs. Realizations of the frequencies for each group generated in the data-organization step were quite difficult, but they could make a comparison between columns and read the graphs. Pie chart was quite difficult for children to transform the grouped data into a valid graphical representation. As such, pie chart was mainly constructed by the teacher and children explored the graph. We believe that with further experience over an extended period of time, most of the remaining children would be able to master these skills, as well.

The third reason for activities' success is that the open-ended questions were clear for children. They participated into the discussion and shared their individual interpretations about the graphs and gave valid answers to the questions. Less, more, fewer, most, equal concepts were also recognized by children during these discussions. They could see the different point of views about the same data and develop a mathematical ritual that helps reading graphs in a right way in the future. This study showed that young children are capable of refining data; exploring concepts and representing data. Young children are able to make feasible explanations about basic graphs when they are involved in the construction process (Karadeniz-Hacısalıhoğlu,

2016). We recommend that teachers require children to extend their graph reading abilities. Through these kind of activities, teachers can help children to be successful in their mathematics growth. This might enhance the potential that children have and carry them into higher levels of mathematics in near future.

The teacher has an important role in providing experiences that help students construct a solid understanding of the graphs. The teacher should provide learning experiences that will promote students' conceptual understanding. Teachers should be facilitators of learning and ask reasonable questions to children. Teachers can encourage interest in mathematics, so that all children gain confidence in their abilities. In the activity implementations, children had the opportunity to work together on the task in groups. Children invented, questioned, discovered, learned, and practiced important mathematics strategies. They represented the data by graphs. By creating a positive learning environment and expecting children to explain their understanding of mathematics, a diverse mathematics classroom can be successful. To sum up, our experience suggests that although it is important for children to learn how to construct picture, bar, and pie graphs during their elementary school years, it is even more crucial that they have opportunities to gather and display data by themselves during pre-school education. Young children will continue to have these sophisticated insights if we only give them the opportunity to show us what they really know (Whitin, 1997). This study revealed that data representation activities are ignored in pre-school education. Considering the Turkish children's poor scores on international exams, data representation activities should be more emphasized in pre-school education.

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## Appendix 1

### Activities

#### **Tools and Equipment**

- A4 sized paper, cardboard
- Scissors
- Several pictures
- Several objects
- Crayon, Glue, Tape

#### **T1. Egg Laying and Milk Giving Animals**

Teacher showed animal pictures to children (camel, penguin, dog, cow, chicken, etc.) and asked their characteristics. Then the teacher asked children which animals are egg laying and which animals are milk giving. The teacher showed a graph with two columns representing egg laying and milk giving animals to children. She showed animal pictures and children marked the corresponding columns. Then they made another graph with the teacher, and children compared their previous graph with the new graph. In this way children reviewed their graph knowledge and constructed new information. This was an example of a picture graph. This kind of graph activities creates a base line for constructing bar graph in future for young children.

#### **T2. Favorite Fruits of Children**

Teacher talked about fruits with children. Then she asked “Why should we eat fruits?” “What are the benefits of fruits?” “Do you like fruits?” “What are your favorite fruits?” The teacher said that “We are going to make our class favorite fruits graph.” The teacher rolled out a carpet on the floor which is divided into equal parts (square) with ropes. The teacher gave smiley faces with each child’s name written on them. Children placed smiley faces on their favorite fruits. When they finished their graphs, results were discussed with children. This activity was also an example of a picture graph.

#### **T3. Emotions**

Teacher prepared an emotion graph including happy, sad, tired, and mad moods. Then she met each child when they came to class and asked them “How do you feel today?” Each child chose an emotion picture representing their emotion. Then they placed it on the picture graph hanging on the wall. When all children arrived to school, the teacher examined and discussed the results of the picture graph with children.

#### **T4. The Way to Reach School**

Teacher prepared a pie chart on which each child’s name was written. She asked children how they come to school. She already knew that children come to school by school bus, car, or walk and had prepared a pie chart based on that information. She prepared school bus, car, and walk photos. Children came one by one and chose a photo representing their arrival to school. Then they placed the photo on their part on the pie chart. Children colored the school bus part with yellow, the car part with red, and the walking part with blue. When they finished, the teacher hang the pie chart on the wall and discussed the results with children. With this pie chart children could observe the part-whole relationship. In Turkish mathematics curricula pie chart is introduced at seventh grade. This basic pie chart activity was pretty difficult for young students. However, it is observed that young learners could

answer the questions asked by the teacher related to pie chart. Basic pie chart activities might be used at kindergarten level as a real life activity.

#### **T5. Sink or Swim**

Teacher brought two glasses filled with water and honey. He introduced several objects such as coins, plastics, woods, lids, and orange. The teacher asked children which object would sink or swim in water and honey. He listened to the children's ideas and then made an experiment with children. Afterwards, children marked how many objects sank and swam in honey and water and made two picture graphs. Finally they compared the results of these two picture graphs. The teacher talked about children's guesses and the results that were obtained from the experiment. This activity was an example of a picture graph activity.

#### **T6. Objects in Parts of the House**

Teacher brought a box in the class and asked children what could be in that box. After listening to their guesses, the teacher talked about objects in kitchen, bathroom, and living room. Then children opened the box, examined the objects in it, and classified them. The teacher showed a picture graph including kitchen, bathroom, and living room photos and delivered object photos located in these rooms. Children placed the object photos on the graph and discussed which room has more objects and which room has fewer objects. This was also a picture graph activity. Teacher evaluated the graph with children and finished the activity with a song "Have you ever seen?":

Have you ever seen a shampoo in living room?

No! You can't see. It is not possible

Have you ever seen a dish in bathroom?

No! You can't see. It is not possible.