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Manipulative Assisted Mathematics Activities in Early Childhood

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Abstract

It was aimed to support preschool teacher candidates' target views about early childhood mathematics education and it was aimed to evaluate manipulative material supported mathematics activities within the framework of the pre-service teachers' opinions. 20 preschool teacher candidates were included in the study. The study was conducted in preschools located in Usak province. Qualitative research methods were used in the study; observation and interview techniques were used to obtain the data. Each preschool teacher candidate planned two mathematical activities, which were regularly directed by the instructor. Two different materials were used in the two planned activities; worksheet and manipulative materials. Pre-service teachers presented the activity in the classroom environment to the other pre-service teachers and the instructor of the course; then, they applied these activities in preschools which voluntarily involved in the research. Data were collected through observation and video recording methods in order to evaluate the effectiveness process in the applications and the records were examined and interpreted together with the instructor and other prospective teachers. As a result of the research, in the interviews with the prospective teachers, they stated that their opinions about early mathematics education changed and they became aware of misconceptions about mathematics education; According to the observation results, it was concluded that children were not interested in math activities using worksheets and they were more active in activities using manipulative materials.

Keywords: Preschool education, early childhood, early math, mathematics manipulatives.

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Erken Çocukluk Döneminde Manipülatif Materyal Destekli Matematik Eğitimi Etkinlikleri

Öz

Araştırmada, manipülatif materyal destekli matematik etkinliği uygulamalarının, okul öncesi öğretmen adaylarının görüşleri çerçevesinde değerlendirilmesi hedeflenmiştir. Araştırmaya 20 okul öncesi öğretmen adayı dahil edilmiştir. Araştırmanın uygulama aşaması Uşak ilinde yer alan, araştırmaya gönüllü olarak destek veren anasınıfı ve anaokullarında gerçekleştirilmiştir. Araştırmada nitel araştırma yöntemleri kullanılmıştır. Araştırmada verilerin elde edilmesinde nitel araştırma yöntemlerinden gözlem ve görüşme tekniklerinden yararlanılmıştır. Her öğretmen adayı, öğretim elemanının düzenli olarak dönütleri ile yön verdiği iki matematik etkinliği planlamıştır. Planlanan iki etkinlikte çalışma sayfası ve manipülatif materyaller olmak üzere iki farklı materyal kullanılmıştır. Öğretmen adayları etkinlik planını, önce sınıf ortamında, diğer öğretmen adayları ve dersin öğretim elemanına sunmuştur, daha sonra bu etkinlikleri araştırmaya gönüllü olarak dâhil olan anasınıfı ve anaokullarında uygulamışlardır. Uygulamalarda etkinlik sürecinin tam olarak değerlendirilebilmesi amacı ile gözlem ve video kayıt yöntemleri ile veriler toplanmıştır ve alınan kayıtlar derste dersin öğretim elemanı ve diğer öğretmen adayları ile birlikte incelenip, değerlendirilmiştir. Değerlendirme sürecinde çocukların planlanan etkinliklere katılım durumu, ilgi ve dikkat süreleri dikkate alınarak, araştırmacı tarafından kaydedilmiştir. Araştırmanın sonucunda, öğretmen adayları ile yapılan görüşmelerde, adayların erken dönemde matematik eğitimine yönelik görüşlerinin olumlu yönde değiştiğini belirttikleri ve matematik eğitimi ile ilgili kavram yanılgılarının farkına vardıklarını ifade ettikleri; gözlem değerlendirmelerine göre ise çocukların çalışma kâğıdı kullanılan matematik etkinliklerine yönelik ilgilerinin olmadığı, manipülatif materyal kullanılan etkinliklerde daha etkin ve istekli oldukları sonucuna ulaşılmıştır.

Keywords: Okul öncesi eğitim, erken çocukluk, erken matematik, matematik manipülatifleri.

Introduction

Individuals interpret and internalize information through the experiences they have with their environment (Kamii, 2004; 2). According to Piaget, Bruner, Vygotsky and Donaltson, in the preschool period, the child learns math by interacting with the environment (Akman, 2002). Children form concepts when they actively interact with their environment, and as they discover the objects around them, they structure their knowledge. Piaget, in particular, underlined that the child constructs information by interacting with his/her environment (Charlesworth and Radeloff, 2013: 3). Adults need to talk to the child while he/she is interacting with the environment. For example, playing with blocks, eating and daily routine activities offer excellent opportunities for adults to play games or chat about spatial ideas with the child (Zimmermann, Foster, Golinkoff, and Hirsh-Pasek, 2019). As children use mathematical concepts in their daily routine, teachers and adults should prepare active, creative and entertaining educational environments for them (Maryani, 2019).

In the early childhood, the mathematics activities in the pre-school curriculum constitute the basis of children's mathematics experience (Dağlıoğlu, Dağlı & Kılıç, 2014). Math activities can be planned as integrated and independent activities. It is evident that regarding the characteristics of the ideal preschool teacher, his/her supporting and guiding role in ensuring the active participation of children by creating the optimal educational environment is emphasized by the curriculum. The

curriculum describes the teacher as not simply an authority who directly transmits information, but as the figure that shows children ways to access information and helps them create their knowledge (Orçan Kaçan & Halmatov, 2017). When planning a math activity, the teacher should offer the children a rich stimulating environment and plan activities that support the active participation of the child. It is important to recognize that preschool children have knowledge of informal mathematics and that this knowledge can be structured through well-informed adults and peers, appropriate materials and interactions, and planned opportunities. During the preschool period, children, by nature, have feelings of curiosity and enthusiasm for learning. Aware of this fact, parents and educators can teach children the concepts of mathematics and develop their math skills by following a fun and exciting method (Charlesworth & Lind, 2013: 6). The play is the most appropriate method in this sense. The current classroom practices indicate that mathematics education activities are planned as learning processes in which mostly the teacher is active and that only the counting skills as a mathematics skill are emphasized with a heavy focus on copying or solving textbook exercises. For example, in their study on how preschool teachers plan and teach the mathematics curriculum, Orçan, Kaçan and Halmatov (2017) found that 82.4% of the teachers considered the counting skills very important.

During the implementation of the mathematics activities, when the preschool teacher presents an interesting learning environment, induces curiosity, and encourages enthusiasm to explore (Tuğrul, 2002), and provides sufficient instructional material support (Kandır & Orçan, 2010), the formation of mathematical concepts in the child's mind is ensured with higher academic success. Educational environments should be planned in a way to allow children to produce mathematical ideas, get hands-on experiences, apply their knowledge to solve problems and interact actively (Boz, 2019). In this way, the child will gain experience with concrete materials and understand the concepts of mathematics. National Council of Teachers of Mathematics (NCTM) made decisions to improve mathematics education in 2000 and supported the use of manipulatives as a resource. Manipulative materials facilitate interaction and enhance learning experiences (Boz, 2019). Hynes (1986) calls concrete models that support mathematical concepts, which can be touched and moved by children, as "manipulative materials". Serving as a bridge from informal mathematics to formal learning, manipulative materials require careful planning and implementation. They include natural materials, cones, tree branches, and stones in the environment as well as blocks, legos and other instructional materials produced for the purpose of teaching mathematical concepts (Boz, 2019).

The encounters of children with educational materials in early childhood help make many concepts tangible and make sense of learning (Erdoğan, Parpucu & Boz, 2017). Instructional materials used in learning processes enable children to be active in this process, but also play a role in facilitating learning. Supporting the educational process with materials guides children towards discovery and learning (Gürbüz, 2007; Güven & Karataş, 2005; İnan, 2006). Many studies conducted on teachers and pre-service teachers show that they are aware of the importance and function of teaching materials (Aksoy Tokgöz & Şahin Taşkın, 2015; Şahin, 2015), they consider preparing and using materials as important to attract attention, ensure permanent and easy learning and to motivate the student (Özer & Tunca, 2014), and that they view these

materials as an indispensable part of educational environments (Erdoğan, Parpucu & Boz, 2017). The child's developing a positive attitude towards mathematics through mathematics education in the early childhood is very important for the child to support his/her basic academic skills, and to ensure that he/she grows up as an individual who questions, wonders, investigates, and solves problems by reasoning well. Planning mathematics education by integrating educational materials in this process supports the child's development, a conclusion confirmed byextensive research. For example, Laski, Jor'Dan, Daoust, and Murray (2015) used Montessori mathematical materials and concluded that children's spending time with math-related manipulative materials is effective in achieving problem-solving, critical thinking, and mathematical learning outcomes in children.

Before starting the profession, preschool pre-service teachers need to understand the importance of children's active role in the education process and realize that mathematics activity does not mean a desk-based activity. It is important to train prospective teachers with this awareness and sensitivity in their undergraduate education. In the current study, a training program was implemented for the pre-service teachers and they were supported in the process of planning math activities and they were given the opportunity to apply their activity plans in pre-school education environments. Through this process, the study aimed at obtaining and analyzing the opinions of pre-service teachers. In addition, it aimed to evaluate the degree of participation by the children in the applied mathematics activities by examining the video recordings of the planned activities. The study further evaluates the planning process of early childhood mathematics education activities to support the active participation of the child from the perspective of both the teacher candidate and the child, thus making an important contribution to the literature.

Method

Research Design

This study employed qualitative research methodology. Qualitative research provides a realistic and holistic reflection of various perceptions and phenomena that collect qualitative data (Yıldırım, 1999). It was aimed to evaluate the manipulative material-supported math activities process based on preschool teacher candidates' opinions and to evaluate the effect of using mathematics education materials on preschool children. Two of the qualitative research techniques, the interview and observation, were used. In qualitative research, interviewing is a technique frequently used during the data collection phase. Allowing participants to speak for themselves gives them the opportunity to directly express their world of meaning, feelings, thoughts and experiences (Tekin, 2006).

In order to describe the effects of mathematics education materials developed by pre-service teachers within the curriculum on children's mathematical skills, the observation method was used in the study implementation process, and the observations were video-recorded. The data were collected through observations and interviews, and the qualitative data analysis is presented in the results section.

Study Group

The study group of the research consists of 20 preschool education teacher candidateswho were taking the 'Mathematics Education in Early Childhood' undergraduate course in the 2018-2019 academic year spring semester. For the implementation of the activities, 100 children who were 48-60 months of age, attending preschool education institutions in the 2018-2019 academic year were included in the research. Each pre-service teacher implemented the activities they planned in the volunteer kindergartens and nursery classes. Five randomly selected children were included in the practice group of each pre-service teacher.

Implementation of the Study

The pre-service teachers participating in the study were given a four-week, 16-hour theoretical knowledge-based training. After the training, they planned math activities individually and designed manipulative materials to implement in these activities. The activities were planned as an integrated activity of mathematics and games and instructional materials were designed so that children could play in small or large groups. The pre-service teachers were given two weeks for the planning of the activities and the design of the materials, during which they were given regular feedback. The planned activities were presented to the other teacher candidates and the instructor of the course in the classroom for two weeks. By providing the necessary feedback, the teacher candidates were guided in organizing their activity plans. The pre-service teachers were given two weeks for the implementation of the planned activities in kindergarten and nursery classes, in one week of which they applied the activities they planned by using the manipulative material they had developed and the other week they used only worksheets. The implementation of the activities was videotaped and the children's activity participation status and their behavior during the activity were evaluated. Upon completion of all the classroom activities, the videotaped classroom learning interactions were examined together with all the pre-service teachers participated in the study. After a total of ten weeks of study implementation including the supportive instructional process, activity planning and monitoring stages, the pre-service teachers' opinions were obtained through a semi-structured interview form.

Data Collection and Analysis

The observation and semi-structured interview techniques were used to collect the data. Four open-ended interview questions to be asked to the pre-service teachers were created. To ensure the content validity of the questions, preschool education expert opinions were obtained during the preparation of the interview questions. The questions were revised in line with the feedback given by the experts. The data were collected by interviewing each participant for an average of 20 minutes. The semi-structured interviews about the implementation process with the pre-service teachers were voice-recorded. The audio-recordings obtained during the interviews were transcribed into a text by the researchers. The written documents were presented to the participants and their confirmation was received. To analyze the data, the descriptive analysis, a qualitative data analysis technique, was used. This descriptive analysis includes the processes of correlating and interpreting the obtained data according to the themes, determining and interpreting the cause-effect relationships,

and revealing the results (Yıldırım & Şimşek, 2013). The data were separately examined by each of the researchers, grouped into themes and coded. The codings made were gathered and compared by the researcher. The differences in the codings were revised and collected into a single document. The emerging themes were then tabulated and some direct quotations from the participant responses were included under the themes created. During the observation process, observation data were collected via video recordings. The processes of implementing the two activities planned by the pre-service teachers were recorded and analyzed. In video analysis process, it is noted that; the childrens' attention, duration of attention and active participation about activities.

Results

The results reached through observation and interview technique are given below in detail.

Preschool Teachers' Opinions about Early Childhood Mathematics Education

In this section, the findings obtained as a result of interviews with pre-service teachers are organized in line with the research questions. The documented data were coded under the themes in line with the concepts in the relevant literature. The participating pre-service teachers were coded as A1, A2,… A12.

1. Research question: During the implementation process, which methods do you think pre-school teachers use when planning a math activity?

Pre-service teachers' opinions on teachers' mathematics activities during the implementation process are coded and given in the table below.

Table 1.
Teachers' Activities

Worksheet-photocopy	6
Workbook- supplement	5
Coloring	3
White board	2

This part of the study aimed to determine which methods were applied in general in mathematics activities in the classroom where the teacher candidates practice. It was concluded that materials such as worksheets and photocopy (6), workbook-supplement (5), coloring (3), and white board (2) were used while planning maths activities in the nursery class and kindergartens.

2. Research question: How did your use of the manipulative material you developed in the math activity affected the implementation process? Please provide your reflection.

The emerging themes regarding how the teacher candidates evaluate the manipulative material in the mathematics activities during the implementation process are given in the table below.

Table 2.
Children's Reaction (*Instructional Play Material)*

Eager	5
Children are active	3
Careful	6
Fun	8
Excited	6
The desire to learn	2
Curious	7
Active senses	5

The teacher candidates were asked to evaluate the activities planned with the support of instructional materials in terms of children's participation. 8 pre-service teachers stated that the children had fun, and 6 pre-service teachers stated that the manipulative materials they used excited the children who wanted to begin doing the activity as soon as possible. In addition, the pre-service teachers stated that children were more careful in the activities when using materials (5), children actively used their senses during the activity process (5), they were careful (6) and curious (7), and full of learning enthusiasm (2). Some statements expressed by the pre-service teachers are given below.

A2: In the activity where I used a material, the children waited curiously about what I was going to do, and whenever they drew a number from the pouch, they asked questions to each other in excitement, like 'I got number 1' 'What number did you get?'. They had a lot of fun.

A6: The children were very excited to see the material. They wondered about it and loved it. They completed their game activities without getting bored and wanted to play again.

A8: Unlike the worksheet activity, they were not interested in when the activity would end, but in the process of the activity. They had a lot of fun.

3. Research question: How did your use of a worksheet affect the implementation process in the math activity you planned? Please provide your reflection.

The themes that emerged about how the teacher candidates evaluated the math activities they conducted with worksheets are given in the table below.

When the pre-service teachers' evaluations about the activities using worksheets were examined, it was found that children exhibited reluctant (15), passive (5) and sloppy (4) behaviors and some children cried (2) not to participate in the activity.

Table 3.
Childrens Reaction (Worksheet)

Reluctant	15
Passive	5
Sloppy	4
Crying	2

Some statements of the pre-service teachers are given below.

A8: When I used the material, I saw that the children were excited and eager. The only problem was that they had trouble understanding the instructions while playing the educational game, I think this was due to their having been accustomed to only working on working sheets.

A4: When I used the worksheet, they asked questions such as "when it will end,""is it OK if I do not color all of it", or "when we will play a game".

A9: In my activity with the worksheets, while I was distributing the papers, they started coloring without waiting for my explanation, and they did that very sloppily.

4. Research Question: How would you evaluate the activity implementation process?

The themes that emerged regarding how teacher candidates evaluate the implementation process are given in the table below.

Table 4.
Childrens's Reactions

Positive	18	**Negative**	2
Professional development	14	Management of the learning environment	2
Creativity	4	-	-

The pre-service teachers' opinions indicate that the majority (18) are positive. They stated that their professional development is supported, they have improved in planning an effective math activity, they have become aware of their shortcomings, applying the activities they planned in preschool education environments were much more effective thancarrying them out in the undergraduate education environment, and their creative skills improved during the design of instructional mathematics game materials. When the negative evaluations of the teacher candidates (2) were examined, it was found that they did not experience any negativity towards the process but that the children did not listen to the teacher candidates because they were not the actual teachers of the class they were teaching.

Some statements of the pre-service teachers are presented below.

A2: I had no problems in ensuring participation in the activitywhen I was teaching my classmates (peers) in my undergraduate class. (But) I tried very hard to get the children's attention.
A9: While planning an activity for children, I realized that I had to think about each stage in detail and that every sentence coming out of my mouth had an impact on children.

Observation Evaluations of the Preschool Children's Mathematics Activities

The observations on children's mathematics education materials were analyzed by content analysis, which revealed three themes. The findings were supported by direct quotations to ensure the reliability of the study.

Active participation. The children included in the research participated more eagerly in the activities where the materials were used, and during the activity, the children looked happier and interacted with the materials by having fun. In the activities planned individually at the desk, it was observed that children verbally stated that they were bored, and that they did not want to do the activity. The anecdotal record below supports this conclusion.

Attention. The planning and implementation of math activities supported by instructional materials affects children's attention span positively. The anecdotal records clearly evince that children's attention periods were very short in the activities that used worksheets, whereasthey were more careful, curious, and eager to learn in the activities supported by materials.

Classroom interaction. The activities using materials in teaching math in the early period support classroom communication. Based on the anecdotal records, it was concluded that the teacher played a key role in ensuring the participation of children in the learning process, children had difficulty in understanding the instructions while practicing with the materials, but they adapted to the process in a short time with the guidance of the teacher, and in this process, they positively communicated with the teacher. Furthermore, it was observed in the worksheet activities that the children started the activity without listening to the teacher's instructions, they demonstrated hardly any interaction with the environment and the teacher during the activity, and that they were very reluctant to participate in the activity.

Discussion and Conlusion

This study aimed to analyze preschool teacher candidates' views on the implementation of manipulative material-supported math activities in the planned supportive education curriculum, to analyze pre-service teacher curriculum outcomes, and to evaluate the participation of preschool children in the math activities. Regarding the qualitative data, the participation of children in the activity process was analyzed through the opinions of teacher candidates and the observation of children in the activity process. According to the results of the analysis of the qualitative data, the planning and implementation of mathematics activities supported with the material supports the communication of the children with their teachers and peers, affects the attention span of the children positively, and ensures their active participation in the activity process. Planning math activities using worksheets

negatively affects children's communication and attention span. Erdoğan, Parpucu and Boz (2017) found a significant increase in the mathematics scores ofthe experimental group children taught by using instructional materials in mathematics activities compared to the children in the control group, concluding thatinstructional materials were effective in improving mathematics skills. This conclusion coincides with the observation results of the current study. In addition, Peterson and McNeill (2012) emphasize the importance of manipulatives while teaching children mathematical concepts. Clements and Sarama (2007) underscore the use of daily life experiences, art studies and manipulative materials in teaching mathematics to children. Bennett (2002) states that stories and math manipulatives positively affect children's mathematics achievement. Sarama and Clements (2016) assert that concrete materials support math skills, as well. The related research literature clearly shows that early math manipulative materials and early mathematics activities which planned targeting the active participation of the child, support math skills (Boggan, Harper and Whitmire, 2010; Holmes, 2013; Laski et al. 2015; Moyer, 2001; Tutak, Aydoğdu & Erşen, 2014). Zimmermann, Foster, Golinkoff, and Hirsh-Pasek (2019) also confirm that guided play practices are effective in supporting the child's early math ability, underlining the importance of adults' communication with the child in this process. In addition, Ramani and Eason (2015) assert that for children to learn new skills, to apply and develop their existing skills it is necessary to spend time and play with their peers and toys, and suggest that teachers must include play in their mathematics teaching practices.

The preschool pre-service teachers had the opportunity to plan, prepare and carry out math activities with the applied training. Then they had the opportunity to evaluate the effect of their instruction on the children. Based on the observation data, it was concluded that the children did not show interest in the activities held at the desk, but they were actively involved in the learning process and were interested in the math activities supported by manipulative materials integrated with the game activity.

A great amount of research is available on the inclusion of manipulative materials in the mathematics learning process (Bennett, 2002; Bjorklund, 2012; Guha, 2002; Laski, Jordan, Daoust & Murray, 2015; McPhee, 1994; Moyer, Bullock, Shumway, Tucker, Watts, Westenskow & Jordan, 2016; Sarama & Clements, 2016). The present study is expected to contribute to this literature by adding the results specifically from the Turkish context. However, this research has some conceptual and methodological limitations. Within the scope of the study, the implementation of manipulative material supported activities is planned in kindergarten and nursery classes in the city of Uşak and the activity processes are examined in the light of the opinions of 20 preschool pre-service teachers who continue their undergraduate education. Thus, the study is limited to the specified study group. Therefore, replicating it on different groups is highly recommended. Another limitation of the study is that it was conducted only during the school year. For the verification of the obtained results, it is suggested for future research to work on larger and more diverse samples from different regions of Turkey. Another factor is that there may be errors in the evaluation of activity participation status and behavior of the children during the math activities because they were based on the preservice teachers' observations. For this reason, it is

recommended to plan longitudinal study and evaluate activity participation status and behavior of the children during the activity by conducting research in which children are also evaluated by practice. A longitudinal study will definitely make a further contribution to the existing literature.

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Araştırmanın Etik Taahhüt Metni

Yapılan bu çalışmada bilimsel, etik ve alıntı kurallarına uyulduğu; toplanan veriler üzerinde herhangi bir tahrifatın yapılmadığı, karşılaşılacak tüm etik ihlallerde "Cumhuriyet Uluslararası Eğitim Dergisi ve Editörünün" hiçbir sorumluluğunun olmadığı, tüm sorumluluğun Sorumlu Yazara ait olduğu ve bu çalışmanın herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiş olduğu sorumlu yazar tarafından taahhüt edilmiştir.

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